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Climate Resilient Urban Sanitation in Indonesia:

Hazards, impacts and responses in four cities

November 2021

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Disclaimer

FOREWORD

The global climate crisis is already having a devastating impact on the survival and well-being of children globally, especially the vulnerable ones living in areas less resilient to climate risks. The most recent UNICEF's publication "Climate Crisis is a Child's Rights Crisis" reports that almost every child on earth is exposed to at least one climate and environmental hazard, shock or stress such as heatwaves, cyclones, air pollution, flooding and water security. Climate and environmental hazards aggravate children's lack of access to essential services and reduce their resiliency and adaptive capacity further increasing their vulnerability to climate hazards and overlapping risks such as COVID19.

Indonesia, located on the Pacific ring of fire is highly susceptible to the impacts of climate change seen through high sea level rise and increased frequency of floods, droughts and strong winds. Climate models indicate these hazards will increase in frequency and intensity and 40 million people living in low-lying coastal areas of Indonesia are also at risk from sea-level rise. Population growth and urbanization will increase this risk, with the country's urban poor being most vulnerable.

The Water, Sanitation and Hygiene (WASH) services are the first to bear the brunt of climate hazards, with attendant adverse consequences on other essential services including the wider public health. Hence, with the Government of Indonesia, UNICEF commissioned this research to better understand the vulnerabilities of sanitation systems, its impact on sanitation services and how communities and systems respond to past and current climate hazards.

Evidence from the research in all the four cities showed that climate hazards impact the whole sanitation service chain beginning at the household toilet to the treatment site encompassing emptying, transportation and treatment services, while also contaminating water supply. Floodwaters, high tides and storm surges caused water to enter toilet facilities and drains to back up. Strong winds did not frequently impact sanitation facilities, but when they do, create privacy concerns. Lack of access due to flooding, high sea-levels and wind damage was also reported to cause open defecation or use of alternatives, such as neighbours' toilets or public facilities.

Women and girls, and households with a disabled family member bear the greatest brunt of the impact of climate change through higher levels of stress, discomfort, and anxiety in meeting their defecation needs during climate hazards. Meeting menstrual hygiene needs during drought created shame and embarrassment for women. Climate hazards thus undermine progress in access to WASH services, especially in vulnerable areas and pose a substantial threat to achieving safely managed sanitation targets of 15% and Indonesia's vision of an Open Defecation Free country by 2024.

This research presents one of the first multi-city in-field studies of climate impacts on sanitation services and importantly considers the social and institutional impacts and actions for the community as well as local and national governments. It provides a sound evidence base to inform local and national government policies and plans and prepare for climate resilient sanitation systems. For a global audience, this provides important learning ground for how the broader global sanitation sector tackles climate change.

This study is a further demonstration of Indonesia's leadership in both climate change and sanitation and aligns with the theme "**Building Forward Better for Recovery and Resilience** "of the upcoming global Sanitation and Water for All (SWA) Sector Minister's Meeting in 2022, hosted by the Government of Indonesia. A climate resilient sanitation system with robust infrastructure, supportive policies and regulations, clear institutional responsibilities, societal engagement and appropriate financing is key to realizing Indonesia's SDG-6 vision of reaching everyone everywhere (including in schools, health centres, public places), Leaving No One Behind with access to WASH services. Improving resilient WASH services can considerably reduce overall climate risk of 415 million children globally while also contributing to reduction in greenhouse gas emissions.

Following up on the research recommendations, climate considerations are being incorporated into the national SDG-6 Plan and the various roadmaps under development. UNICEF is also assisting the Government of Indonesia in developing a national framework and guidelines for mainstreaming climate resilience in the WASH sector. The framework is expected to build awareness and national capacities, and advance the sector thinking around WASH and climate change with the objective of providing sustainable and climate resilient WASH services.

I hope this report will provide valuable guidance for local and national governments, sanitation service providers and operators, and the communities to take incremental, doable actions for a resilient sanitation system that can continue to serve the population even during climate hazards.

I would like to acknowledge and thank the Government of Indonesia for their strong leadership throughout the period of the study and the Team from University of Technology Sydney's Institute for Sustainable Futures and Universitas Indonesia for their diligent and meticulous efforts in conducting the study and preparing this document. Profound thanks are due to the communities, service providers and local government representatives in Bekasi, Lombok Timur, Makassar and Palu for their active participation in the research during COVID, without which this study would not have been possible.

Kannan Nadar
Chief of WASH
UNICEF Indonesia

Indonesia is committed to achieving the Goal 6 of SDGs 2030, which is to provide access to safe drinking water and sanitation for all. The SDGs targets have also been integrated with the national targets in the 2020-2024 *Rencana Pembangunan Jangka Menengah Nasional* (National Medium-Term Development Plan) document.

As an archipelagic country which 60 percent of the territory is covered by ocean, Indonesia is certainly very vulnerable to the impacts of climate change, besides the fact that climate change also has the potential to increase the incidence of climate hazards. The government is aware that climate change is a cross-sectoral issue. It also underlies the government to make low-carbon development and climate resilience as one of the national priority agendas in the 2020-2024 RPJMN, namely the 6th National Priority (PN).

In climate-resilient development, drinking water and sanitation are two priority sectors, but not all stakeholders understand the link between climate resilience and development of drinking water, sanitation and hygiene (WASH). For this reason, we view that a study is needed to identify climate-related hazards and their impact on access to WASH so that they can be useful for strengthening WASH strategies, policies and programs.

With the preparation of the "Climate Resilient Urban Sanitation in Indonesia: Hazards, impacts and responses in four cities" study by UNICEF, the Institute for Sustainable Future (UTS), and the University of Indonesia, it is hoped that it will help many parties understand the impacts of climate change hazards on access to WASH from the perspective of environmental and public health, especially the development of children and other vulnerable groups. In addition, the presence of this study is expected to become an advocacy material and an opportunity for the development of climate-resilient WASH policies, as one of the contributions in supporting two national priorities, namely PN 5 "Strengthening Infrastructure for the Economy and Basic Services" and PN 6 "Building the Environment, Disaster Resilience, and Climate Change".

With the development of climate-resilient WASH, we hope to be able to help and continue to support the acceleration of achieving access to safe drinking water and sanitation both at the national and regional levels, as well as opening greater opportunities for access to climate finance to support equitable distribution of WASH access throughout Indonesia. Finally, I hope this book can increase the knowledge of readers and inspire many parties.

Tri Dewi Virgiyanti
Director of Housing and Settlement
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ABBREVIATIONS

AF	Adaptation Fund
Bappenas (Kementerian PPN)	National Development Planning Agency/ Ministry of National Development Planning
BMKG	Badan Meteorologi, Klimatologi, dan Geofisika (Meteorology, Climatology and Geophysical Agency)
BNPB	Badan Nasional Penanggulangan Bencana (National Disaster Management Agency)
CWIS	Citywide Inclusive Sanitation
EHRA	Environmental Health Risk Assessment
FGD	Focus Group Discussion
FSM	Faecal Sludge Management
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas
IPALDD	Instalasi Pengolahan Air Limbah Domestik (Domestic Wastewater Treatment Plant)
IPCC	Intergovernmental Panel on Climate Change
IPLT	Instalasi Pengolahan Lumpur Tinja (Faecal sludge treatment plant)
Kemenkes	Kementerian Kesehatan Republik Indonesia (Ministry of Health)
KLHK	Kementerian Lingkungan Hidup dan Kehutanan (Ministry of Environment and Forestry)
KOTAKU	Kota Tanpa Kumuh (Cities Without Slums)

M&E	Monitoring and Evaluation
MCK	Mandi, Cuci, Kakus (Public bathing, washing and toilet facility)
MOHA	Ministry of Home Affairs
NDC	Nationally Determined Contribution
OD	Open Defecation
ODF	Open Defecation Free
PUPR	Ministry of Public Works and Housing
RAN API	Rancana Aksi National – Perubahan Iklim (National Action Plan on Climate Change)
RAP	Regional Action Plan
RPJMN	Rencana Pembangunan Jangka Menengah Nasional (Medium-Term National Development Plan)
SANIMAS	Sanitasi Berbasis Masyarakat (Community-based Sanitation)
SPALD-S	Sistem Pengelolaan Air Limbah Domestik Setempat (Local Domestic Wastewater Management System)
SSK	Strategi Sanitasi Kota (City Sanitation Strategy)
STBM	Sanitasi Total Berbasis Masyarakat (Community-based Total Sanitation)
UPTD-PAL	Unit Pelaksana Teknis Daerah Pengelolaan Air Limbah (Wastewater Management Regional Technical Implementation Unit)
SDG	Sustainable Development Goal
SWA	Sanitation and Water for All
WASH	Water, Sanitation and Hygiene

Putra (left), 11, and Nugi, 10, look out at the Waladuna Mosque in the Muara Baru neighbourhood of North Jakarta, Indonesia, on 29 September 2020. The mosque has been partially submerged in seawater since 2000 as the ground beneath it sank and the waters of the Java Sea continued to rise due to climate change.

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EXECUTIVE SUMMARY

Introduction

Climate hazards are already impacting Indonesia's sanitation systems and are expected to increase in frequency and severity. Climatic trends over the last 30 years demonstrate an increase in surface temperatures, rainfall, more intense wet and dry seasons and an increased frequency of extreme events.[1] Climate models indicate these hazards will increase in frequency and intensity and 40 million people living in low-lying coastal areas of Indonesia are also at risk from sea-level rise.[1,2] Population growth and urbanization will increase this risk, with the country's urban poor being most vulnerable.[3] To understand how sanitation systems may respond to more frequent or severe future hazards this research assessed the impacts and response of communities and systems to past and current climate hazards.

This report presents the findings of data collected in 2020-2021 from predominantly low-income households, service providers and local government in four locations with diverse climate conditions: Makassar City, Lombok Timur Regency, Palu city and Bekasi city. The hazards assessed in these cities included sea-level rise, flooding, drought or water shortage and strong winds. Sanitation systems included communal scale and onsite sanitation, as none of the cities had centralized sewerage. The research methods included: Household survey; community focus group discussions; local government workshops; and key informant interviews. The sampling criteria targeted locations with high proportions of low-income households and relatively high exposure to climate hazards, therefore the results reflect the experiences of these groups. The report presents the combined findings on impacts to sanitation systems, capacity to prepare and respond, as well as principles of climate resilient sanitation and recommendations for local and national government and broader water and sanitation stakeholders.

Evidence of climate hazards limiting access to safe sanitation was found in all four cities in Indonesia and across the entire sanitation service chain. The report explains how people revert to open defecation, suffer from distress in meeting defecation needs and are faced with overflowing toilets and on-site systems, restricted emptying services and damaged treatment plants. Close interaction of sanitation with the wider water cycle means that precious water resources may be increasingly contaminated. At the research outset there was limited awareness of climate impacts on sanitation by both local and national government. In addition, sanitation was typically not included in climate priorities, nor were there climate change considerations in current sanitation policies.

These impacts may prevent Indonesia from achieving and importantly sustaining, their sanitation targets of 0 per cent open defecation and 15 per cent safely managed sanitation by 2024 and may disrupt efforts to ensure safely managed sanitation services (SDG 6.2) which are needed to protect human and environmental health. Already, even under current conditions a recent study conducted by Ministry of Health revealed 70 per cent of the water sources tested were positive for faecal contamination.[4]

As Indonesia has previously demonstrated leadership in both climate change and sanitation, this report aims to inform local and national government of the current impacts and provides a targeted set of recommendations to improve proactive response. This report provides the basis to increase awareness and motivate actions to improve climate resilient sanitation, ahead of Indonesia's leadership of the global Sanitation and Water for All (SWA) Sector Minister's Meeting in 2022 focused on climate change and water, sanitation and hygiene (WASH). For a global audience, this study presents one of the first multi-city in-field studies of climate impacts on sanitation services and importantly considers the social and institutional impacts and actions for the community as well as local and national governments.

Key climate impacts on sanitation

Cities in Indonesia already experience the climate hazards to different degrees. Dry spells and flooding were more pronounced climate hazards in the four case study cities, however high sea levels and strong wind also affected households, particularly in Palu.

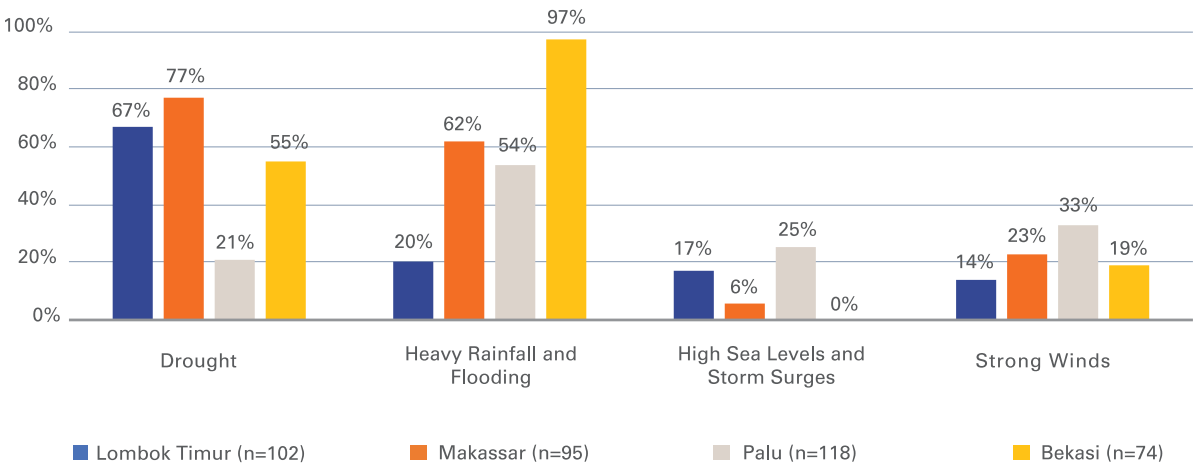

Figure 1 Proportions of respondents experiencing each climate hazard by city

These and other important findings are presented below. These relate to sanitation access, effects on communities including in relation to open defecation, the effect of the type of household sanitation containment, gendered impacts and those related to children and vulnerable groups.

Climate change poses a substantial threat to the achievement and sustaining of an open defecation free Indonesia. Climate hazards were found to strongly reduce access and use of sanitation facilities amongst respondent households. Different climate hazards create different issues for household sanitation access, use and functionality. Water shortages prevented toilet use due to insufficient water supply, causing more than 50 per cent of surveyed households to lose sanitation access multiple times per month or even per week. If water was not sufficiently available for using the toilet, 30 per cent of participants reported they would practice open defecation. This was highest in Lombok Timur, where 71 per cent reported practicing open defecation if water was unavailable. Floodwaters, high tides and storm surges caused water to enter toilet facilities and drains to back up. Strong winds did not frequently impact sanitation facilities, but when they do, create privacy concerns. Lack of access due to flooding, high sea-levels and wind damage was also reported to cause open defecation or use of alternatives, such as family or neighbours' toilets or public facilities.

Key impacts

- Climate hazards create a substantial threat to the achievement and sustaining of an open defecation free Indonesia
- Heightened stress and discomfort meeting defecation needs was experienced during climate hazards, especially for women, children, and vulnerable households
- All stages of the sanitation chain were affected by climate hazards, including to their function, their acceptability and ability to protect health
- Climate hazards creates intersecting impacts on sanitation, water-supply and drainage systems

Heightened stress and discomfort meeting defecation needs during all climate hazards, especially for women, children and vulnerable households. Respondents overall felt less comfortable and more stressed about meeting their defecation needs during all climate hazards compared to normal conditions, including in meeting children's sanitation needs. Households with no containment or basic sanitation facilities were worse off and experienced more severe discomfort during climate events. Respondents with a family member with a disability reported even higher levels of discomfort than respondents without a family member with a disability. Households practicing open defecation were more likely to have increased cases of diarrhoea during climate hazards than households with sanitation facilties.

> **When the seawater overflows the septic tanks cannot be used, the community will do open defecation again and it is difficult to reach ODF.**
>
> Palu Public Health Office

The impact of gender on children and vulnerable groups will require targeted attention, as gender appeared to influence perceptions of climate hazards, stress experienced when hazards occur and responses to climate hazards to meet defecation needs.

Several gendered climate impacts on sanitation were recorded. Women noticed and experienced more issues with sanitation in dry conditions, while more men noticed and experienced issues with heavy rainfall and flooding. Men were more likely to return to open defecation than women when there was insufficient water for toilet use. During flooding, women preferred alternatives, such as use of neighbours and family toilets whereas men preferred public or communal toilets. High sea levels created more distress in meeting defecation needs for women than men. Meeting menstrual hygiene needs during drought created shame and embarrassment for women. In the survey men reported higher investment and willingness to invest in sanitation improvements than women, however reasons for this were not clear.

> **When the septic tank overflows, it is certain that the faeces will go everywhere and risks that faecal-related diseases will contaminate the water, it is a risk to the family and the surrounding population.**
>
> Palu Public Health Office

Some child faeces disposal patterns may create problems given climate hazards, as one-fifth of child faeces was reported to be unsafely thrown or rinsed into wastewaters (drain, river, sea), in uncovered garbage or left in open, all of which present issues that could be made worse given climate hazards. Children experienced reduced ease in meeting their defecation needs during climate hazards. Like adults, it was found that climate hazards can cause children to also return to open defecation.

Respondents with a family member with a disability experienced less ease both generally and during climate hazards than other respondents. Minority ethnic groups were more likely to experience climate hazards, most notably for sea-level rise and strong winds.

The SDG target of safely managed sanitation cannot be achieved without paying attention to climate resilience and all stages of the sanitation chain were affected by climate impacts. The extent of functionality issues was dependent on the type of containment. Pit latrines and communal sewer systems were the containment/transportation systems with the worst issues in extended dry periods, including reduced acceptability and problematic quality issues like clogging. Householders also reported worse smells in toilets and drains during the wet season. Toilets flushing in twin chamber septic tanks performed better on acceptability and quality issues compared with other containment types. However, it was reported by some households that washed out contents of pits and tanks were seen during flooding, presenting severe risks for public health by contamination of urban living environments with faecal matter.

In terms of emptying services, the service providers reported an increase in demand for emptying during heavy rainfall or flood periods. However, at the same time flooding caused restrictions in access due to flooding on roads, while emptying was more difficult during dry season or when containments have not been emptied for long periods. For the sludge treatment plant, flooding caused both physical

damage to the infrastructure and management issues for operators. Drought also negatively impacted treatment plant operation, through increased blockages and limiting water for cleaning. Even under normal climate conditions, some sludge treatment plants were not operational. To date, most of the observed communal-scale systems had not been significantly negatively impacted by climate hazards. Risk of damage and flooding are likely as systems are often located at the lowest point in the community, on the coast or along rivers and canals.

The interactions between water supply, sanitation and drainage become even more pronounced due to climate hazards including risks environment and public health and could also undermine progress on safely managed water.

- Impacts from climate hazards on the urban water cycle affects the use and function of sanitation. Insufficient water during dry periods was the most reported hazard and occurred in all four cities and is a concern for sanitation as Indonesians typically use water flush toilets and water for cleansing. Inadequate drainage infrastructure or clogged drains contributed to larger scale flooding or inundation of containments or decentralized treatment systems, particularly those discharging to drains.

- Impacts from climate hazards on sanitation facilities and services, such as overflowing, reduced performance or open defecation, increase the risk that untreated faecal waste is discharged to urban waters. Water scarcity due to climate change is predicted, therefore contamination from inundated or overflowing sanitation systems poses a threat to maintaining safe water supplies. Contamination of drains and surface water is more likely to spread during increased flooding and potentially increased interaction.

Capacity of government, service providers and community to prepare and respond

Local government agencies were starting to adapt and take initiatives to prepare or respond to climate impacts ton sanitation. In performing their functions, local government agencies were found to have undertaken a mix of initiatives to solve problems related to climate hazards and sanitation across the four cities. These included investments in climate resilience infrastructure (water-tight septic tanks) in Makassar and Bekasi, proactive pit and septic tank emptying during flooding in Bekasi, rapid flood response to install pumps in priority areas in Bekasi and Makassar, mapping of drought risk areas and water resource protection in Lombok Timur and community awareness raising in Makassar.

Challenges that limited local government capacity to prepare and respond to climate impacts on sanitation included: Limited expertise in climate resilient sanitation and unconsolidated data to understand vulnerability and risk. Unclear responsibility and lack of coordination for climate resilient sanitation (particularly amongst sanitation agencies and those focused on climate change) and for investments that bridge disaster response and long-term repairs. Challenges to setting and achieving objectives focused on climate resilient sanitation included low awareness and priority of climate change impacts on sanitation, insufficient sanitation budget for ensuring existing systems are well operating and insufficient disaster funds to meet increasingly frequent yet uncertain events. Current

funding was focused on disaster response rather than proactive investment in increasing resilience. Lastly, local government felt uncertain about appropriate climate resilient technical sanitation options and requested national guidance on climate change and sanitation.

Service providers and operators had made minor adaptations due to hazards, but some struggled to maintain operation even in normal conditions. Private emptying operators had implemented a limited number of adaptive actions including avoiding operation of trucks in deep floodwater, considering moving location of their garage to a low-flood risk area and planned training of staff in climate risks. One sludge treatment plant frequently experiencing flooding built a temporary flood barrier, proactively shut off electrical equipment to avoid flood damage and proposed to raise the ground of a planned a second treatment plant to reduce flood risk. The other treatment plant operators had low capacity to perform current functions, including fixing or adapting operation of plant to current inflows, therefore adapting to increasing and varied hazards will be difficult. The community-based operators of the communal treatment plants faced reduced motivation and difficulties operating the systems after climate hazards. Previous research shows these systems suffer from inadequate management due to requirements beyond the capacity of their community operators.

Households were already employing some coping mechanisms for climate events and willing to invest in more climate resilient sanitation facilities. Other important findings included the need for early warning to households about climate events, that repairing sanitation systems was shared between women and men and that emptying practices were not yet in place in response to flooding. Negative responses also occurred, with the previously mentioned reverting to open defecation when private toilets were unavailable, and some households reported flushing out their tanks or pits into floodwater. Households made requests for government to address drainage systems and more reliable water supply to reduce climate impacts on sanitation. Some households have already invested in upgrading their sanitation facility to ensure it works in bad weather while 43 per cent of households reported they were willing to invest 1 million IDR to make to make their toilet more climate resilient. For reference, average monthly expenditure per capita in urban areas of Indonesia in 2020 was 1,455,637 IDR.[11]

Moving towards climate resilient sanitation in Indonesia

Resilient sanitation integrates considerations of climate change into multiple aspects of a sanitation service delivery system and wider enabling environment. There are many ways that resilience can be built and national and local governments in Indonesia can begin taking incremental, doable actions. This research delineated key dimensions of a 'climate resilient sanitation system' (see Figure 2) and used these to guide climate response workshops with local governments, as well as key areas for action and recommendations going forward. Such dimensions are fundamental to and aligned with achieving city-wide inclusive sanitation (CWIS), where all inhabitants have access to services (whether onsite, decentralized or offsite) with appropriate institutional arrangements and incentives in place for the full-service chain.

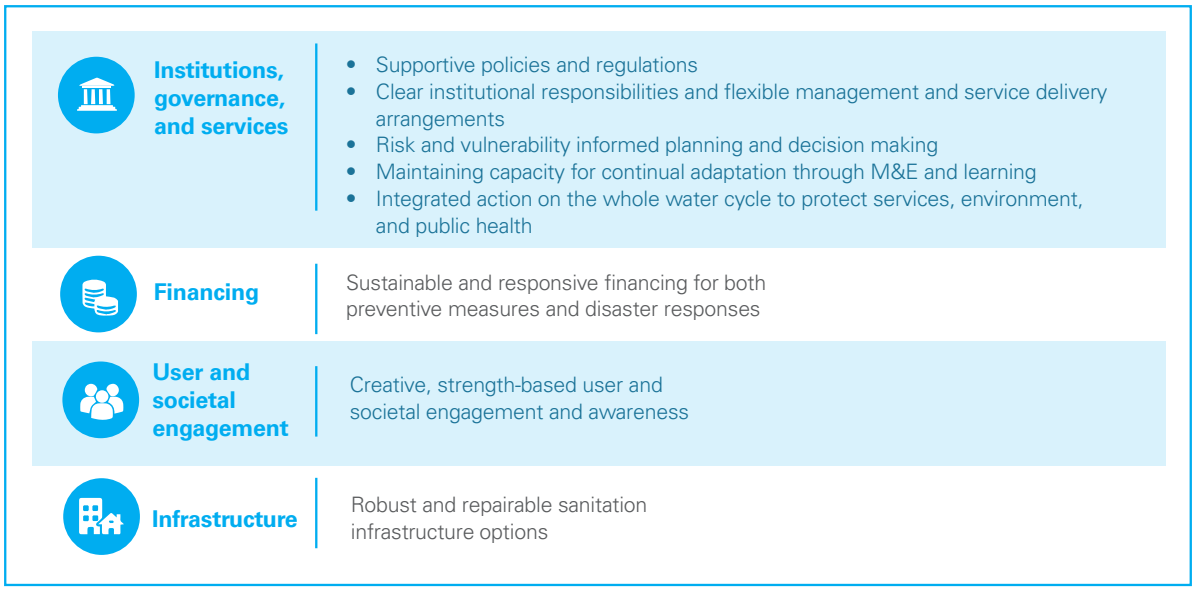

Figure 2 Dimensions of a climate resilient sanitation system

Practical actions and key recommendations

Local and national governments in Indonesia and the sanitation sector more widely, can take many practical actions to incrementally achieve climate resilient sanitation. More detailed actions and recommendations are outlined in the full report, with brief summaries provided here. These actions span each of the dimensions shown in Figure 2. In essence, the key immediate priorities include:

- Development of a policy framework to support climate resilient sanitation services including clarification of institutional responsibilities, strengthened coordination across the urban water cycle and provision of capacity building on climate resilience for local governments
- Approaches to identify locations at-risk from climate hazards both nationally and at local scale, integration of these into existing sanitation planning processes and on this basis, development of responsive financing frameworks for adaptation actions and disaster response.
- Increased user-awareness of climate change building on existing coping mechanisms and ensuring access to support for those most vulnerable.

Dimensions	Local Government	National Government[a]
INSTITUTIONS, GOVERNANCE AND SERVICES		
Clear institutional responsibilities and flexible management and service delivery arrangements	Delineate roles and responsibilities for climate resilience in sanitation into existing structures (e.g. Pokja sanitasi, UPTD-PALs), arrange for the management of shared climate resilient infrastructure and capacitate sanitation authorities on climate resilience.	Bappenas, MOHA, PU, Kemenkes and KLHK to increase coordination with BNPB and BMKG, confirm cross-agency sanitation working group leadership role on climate resilient sanitation, promote total urban water cycle management and develop training materials for local government. Bappenas, PU, KLHK and Kemenkes to develop appropriate policies, frameworks and guidelines for climate resilient sanitation services and integrate sanitation into climate adaptation planning

Dimensions	Local Government	National Government[a]
Risk- and vulnerability-informed planning and decision-making	Map at-risk sanitation infrastructure exposed to climate hazards to identify most at-risk locations and integrate assessments of climate vulnerability and sanitation risks into various processes from city strategies to regional action plans to construction approval checks.	Bappenas, PU, KLHK to develop national level and sub-national mapping of locations at-risk from climate hazards.
Maintaining capacity for continual adaptation through monitoring evaluation and learning	Strengthening knowledge, awareness and capacity for climate resilient sanitation systems with support of national authorities Monitor and evaluate direct impacts of climate on sanitation and take action accordingly. Identify indicators to monitor status and progress of sanitation climate resilience.	Bappenas, Kemenkes and BNPB to develop standardized approach for rapid climate assessment of sanitation as an input to SSK and combine existing datasets relating diseases, climate hazards and sanitation into a common portal. Bappenas, PU and Kemenkes to develop capacity building modules and training of Local Government service providers on climate resilient sanitation services.
Integrated action on the whole water cycle to protect services, environment and public health	Manage the availability and quality of water resources linked to sanitation and assess public health risks from climate impacts on sanitation. Regular water quality monitoring to track risk events or identify critical sanitation/ water interactions	PU and Bappenas to support strengthened coordination across water supply, sanitation and drainage such that planning and management takes into account interlinkages under different climate change scenarios.
FINANCING		
Sustainable and responsive financing for both preventive measures and disaster response	Consider the existing sources of funding and increased funding needs to prepare for and respond to climate impacts and ensure it is available to vulnerable populations most exposed to climate change.	PU, Bappenas, KLHK and BMKG to clarify readiness criteria for existing sanitation grant programs to support those facing climate risks, provide guidance on budget predictions given heightened operational costs and coordinate climate finance proposals for sanitation adaptation. Additional support for climate resilient interventions in locations at-risk from climate hazards.
USER AND SOCIETAL ENGAGEMENT		
Creative, strengths-based user and societal engagement and awareness	Build on existing capacities and provide the public and community groups with critical information for preparing for and responding to climate impacts, building on existing sanitation programs (STBM).	Kemenkes to expand ODF campaign and grant targeting to focus on locations suffering climate impacts on sanitation or vulnerable communities and socialize updated STBM materials and guidance that Integrate climate change with local governments.

[a]Ministry of Planning (Bappenas), Ministry of Home Affairs (MOHA), Ministry of Public Works and Public Housing (PU), Ministry of Health (Kemenkes), Ministry of Environment and Forestry (KLHK), National Disaster Management Agency (BNPB), Meteorology, Climatology, and Geophysical Agency (BMKG).

Dimensions	Local Government	National Government[a]
INFRASTRUCTURE		
Robust or repairable sanitation infrastructure options	Promote and implement technologies that are more resistant to climate hazards and have processes to verify presence of resilient infrastructure and services. Put in place mechanism to endorse sanitation projects based on climate resilience criteria. Review of sanitation facilities in locations with climate hazard risks and provide support to make them climate resilient.	PU to collaborate with relevant stakeholders, including private sector and research institutes, to innovate and pilot climate resilient sanitation solutions suitable to the varied needs in Indonesia as well as flexible sludge treatment plants for extreme weather and standard operating procedures to operate current facilities under different weather extremes. Provide special funding support to enable existing facilities in locations at risk of climate hazards to be climate resilient.

For global level actors this research provides evidence to underpin a call to action on climate change in sanitation. Climate change risks to significantly undermine progress and to particularly impact disadvantaged groups. There is an urgent need to evolve sector policy frameworks on climate resilience sanitation, develop vulnerability indicators, common methods for risk and vulnerability assessment and to pilot and evaluate climate resilient sanitation infrastructure and service options.

A mother and child in a newly constructed toilet. Safe sanitation even in times of climate hazard is vital to health, child development and social and economic progress.

1

WHY ACTION IS NEEDED ON CLIMATE CHANGE AND SANITATION IN INDONESIA

Seawater inundating households in Palu
© UTS-ISF

1.1 The opportunity and the need to integrate climate change into sanitation

Indonesia has both a great opportunity and pressing need to integrate climate resilience into sanitation improvement and climate adaptation programs.

The impacts from climate change are already being felt in Indonesia, with more frequent droughts, heat waves and floods and will pose an increasing threat to the country's development.[1] Climatic trends over the last 30 years demonstrate an increase in surface temperatures, particularly for Sumatra and Java, increased rainfall, particularly in northern regions, more intense wet and dry seasons and an increased frequency of extreme events.[1,2] Climate change models for Indonesia predict increased average rainfall, yet considerable spatial and temporal variation, warming including extreme heat and drought, extreme flooding and increased mean sea-level by the middle of the century.[2] Indonesia also has one of the longest coastlines with 42 million people living in low-lying coastal areas at risk from the impacts of sea level rise and storm surge.[1] Indonesia is also affected by the El Niño Southern Oscillation which creates years of drier or wetter conditions.

The consequences are high, with the impacts of climate change on water resources, agriculture, urban and coastal areas costing an estimated 2.5-7 per cent GDP.[5] Human health is also at risk with Indonesia facing a relatively high mortality risk from multiple hazards and an increase in infections and vector-borne diseases.[6,2] Population growth and urbanization will increase this risk, with the country's urban poor being most vulnerable.[3] Assessing the impacts and response of communities and systems to past climate hazards can inform action to increase sanitation resilience.[7]

Precipitation

While the changes to precipitation vary significantly across the country, overall, there is predicted to be an increase in average annual rainfall; changed timing of monsoon; increased frequency and intensity of heavy rainfall events.

Sea level rise

Indonesia is among the world's most vulnerable countries to sea level rise. Currently 23 million people live in areas that are at risk to inundation from sea level rise by 2050. Global sea level rise is estimated at 0.44-0.74m, a rise of 0.5m could inundate Jakarta and Bekasi affecting 270,000 people. Erosion of coastal areas is also expected due to sea level and storm surge increases.

Strong winds

Windstorms accounted for 9% of disasters between 2001-2007 damaging infrastructure and electricity supply. Tropical cyclones are difficult to predict by are projected to increase in intensity. Coastal and informal settlements are most at risk.

Drought and increased temperature

Predicted temperature rise of 0.8-1.4°C by 2050 with higher rates expected for inland areas and a predicted dramatic increase in extreme heatwaves. Rainfall predictions vary and particularly in the south of the country where rainfall is predicted to decrease, dry spells will increase in duration and an increase in droughts is expected.

Figure 3 Climate change predictions for Indonesia[1,2,10]

Toilet inside house in Lombok with buckets for storing water

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Indonesia made significant progress in recent years on sanitation. The country has achieved 'basic' access to sanitation for 90 per cent of urban households. However, more effort is needed to address inequalities in access and to progress towards 'safely managed' sanitation, which requires that all faecal waste be disposed or re-used safely. There is a gap in access between wealth quintiles, with 16 per cent of the poorest urban households still practicing open defecation (OD) (JMP, 2019, Figure 4). These households are often in the areas most at risk to climate change, such as low-lying coastal or flood prone areas. Such locations create challenges for improving sanitation and risks the loss of open defecation free (ODF) status in the face of higher intensity and increasing frequency climate hazards. These areas face heightened health risks as extreme precipitation events can overburden sanitation systems and increase spreading of disease and contamination of precious water supplies.[9]

The 2018 estimate of households with access to safely managed sanitation was 7.4 per cent. This figure reflects numerous service failures and indicates how inadequate sanitation systems are discharging untreated waste to the environment. Such unsafe management contaminates already limited groundwater and surface water resources and rising temperatures may increase public health impacts of exposure to faecal waste.[8] The Government of Indonesia is committed to address this challenge through various existing sanitation policies and programs. These provide an opportunity to leapfrog directly to climate resilient sanitation, avoiding investments that may not be suited to the changing climatic conditions. However, wise investment is only possible if consideration is given to how sanitation systems and services will be impacted by climate change if these improvements to both infrastructure and management arrangements are to withstand the increasing and more intense climate hazards.

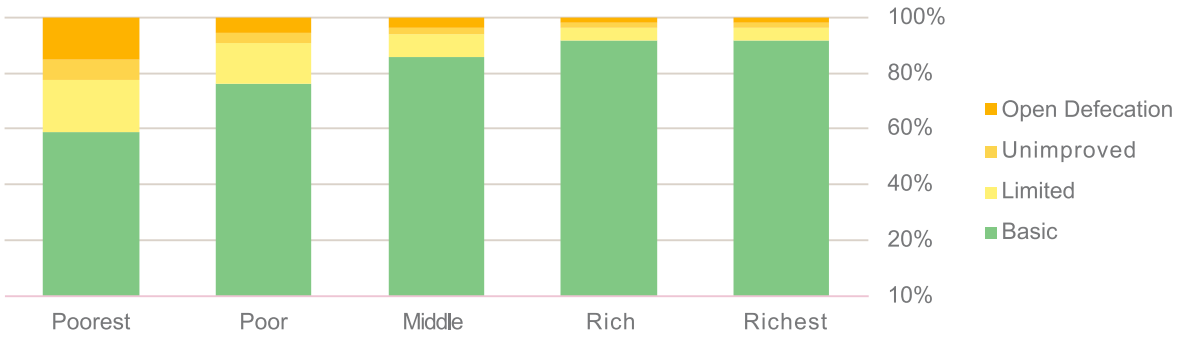

Figure 4 Indonesia urban household sanitation by wealth quintiles

1.2 Current policies, plans and programs relevant to climate and urban sanitation

Supporting the significant progress in improving sanitation in Indonesia have been a number of successful **sanitation programs, plans and policies.** Below is a summary of those relevant to urban sanitation. As is detailed, most do not explicitly include climate change adaptions, although the SSK does consider flooding in the risk assessment map.

- *National medium-term development plan (RPJMN) target of 0 per cent open defecation, 15 per cent safely managed water and sanitation by 2024*
- *City sanitation strategy (SSK)* implemented across Indonesia which includes an assessment of environmental health risk (EHRA) maps that considers flood prone areas and areas with poor sanitation to support planning.
- *Faecal sludge management (FSM) service improvements* in many cities and new or upgraded centralized and decentralized treatment plants. Wastewater treatment plant regulations include a requirement that gas generated should be reused, while plants should be situated out of flood zones.
- *Output based grants* to local government that support increased connections to sewer and improvements to on-site sanitation systems. No specific mention of climate events or impacts.

Several **climate change policies, programs and plans** have been developed in Indonesia however the climate sector has typically focused on mitigation and reducing greenhouse gas (GHG) emissions with primary focus on the water resources, agriculture, coastal and forestry sectors. The only inclusion of sanitation in the current policies or plans is the waste management target of the Nationally Determined Contributions (NDC), in which reducing emissions from sanitation is mentioned as an objective but the details of the target yet to be defined.

- *Climate Change Adaptation National Action Plan (RAN-API):* The RAN-API is a national action plan document on adaptation to the impacts of climate change that was then integrated into the National Medium-Term Development Plan.
- *Nationally Determined Contribution 2016:* Indonesia's submissions to the Paris Agreement in 2016. It pledged that Indonesia would reduce emissions by 26 per cent (41 per cent with international support) against BAU scenario by 2020
- *National medium-term development plan RPJMN 2020-2024:* First low-carbon development plan, includes two relevant agendas: **KP1. 5 Increase climate resilience of infrastructure and KP2.2 Increase climate resiliency of environment (water security protection).**
- *Climate Resilience Development Policy 2020-2045:* This set of policy guides the central and local government to execute the RPJMN 2020-2024 and beyond, with specific guidelines on (a) priority intervention areas for each region, (b) institutional framework, (c) financing and (d) monitoring, evaluation and reporting.
- *Climate Village Program "ProKlim":* Ministry of Environment and Forestry (KLHK) national program community-based climate change adaptation and mitigation activities.
- *Climate Healthy Village Program "Desa Desi":* Ministry of Health national activity to reduce risk of climate change specifically on community-based health and disease.
- *Climate Vulnerability Assessment:* Ministry of Environment and Forestry (KLHK) and National Disaster Management Agency (BNPB) vulnerability mapping for climate-related disasters.

1.3 Research Objectives

This action research project comes at a critical time to ensure on-site (including faecal sludge management), decentralized (communal) and off-site (sewer) urban sanitation services developed under RPJMN 2020-2024 are resilient to climate change and that the vulnerabilities of all population groups are reduced.

Climate predictions for Indonesia vary due to the diverse geographical and climate zones, making it is difficult to achieve certainty in the extent to which each hazard will occur in the future. Even with more precise modelling, uncertainties will remain, and it is unlikely that Indonesian cities will have detailed local estimates of the predicted changes to each climate hazards in the short term. Therefore, assessing the impacts and response of communities and systems to past and current climate hazards can inform how these systems may respond to future hazards.[7]

Diverse sanitation conditions across the research sites
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Data collection is vital to understand the context-specific impacts and requirements for climate change adaptations. The diverse environmental, social, institutional and sanitation conditions of the four cities in this research (**Makassar, Palu, Bekasi and Lombok Timur**) provide valuable information on challenges and opportunities applicable in Indonesia and elsewhere. Understanding the vulnerabilities and resilience of sanitation users, with a focus on low-income households, service providers and local government agencies to the recent climate events provides first-hand evidence to address the future challenges of climate change.

The key objectives of the study were:

- To identify key climate risks and responses to enable strengthened climate resilient safe sanitation services in four project sites, with a focus on low-income populations who are more vulnerable and likely less able to cope.
- To facilitate strengthened local and national engagement in climate resilient sanitation through an improved evidence base and stakeholder engagement.

2

METHODS

Seawater inundating households in Palu

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Figure 5 Case study locations

The four case study locations covered key climate hazards: sea-level rise, flooding, drought or water shortage and strong winds and included communal scale and onsite sanitation (but not city-wide sewerage). The four cities surveyed for this research were selected to cover the range of hazards expected for urban areas of Indonesia. Table 1 summarizes their current sanitation systems and climate hazards.

Table 1 Range of climate hazards and sanitation systems in four survey locations

	LOMBOK TIMUR REGENCY	MAKASSAR CITY	PALU CITY	BEKASI CITY
Demography	1.3 million (2020) 25% below poverty level	1.4 million (2020) 4.5% below poverty line	367,600 (2020) 6.8% below poverty line	3.08 million (2020) 4.4% below poverty line
Climate context	Semi-urban large regency frequently experiences drought and water shortages. Varied geography with coastal and inland hilly areas, also faces impacts from flooding and high tides or storm surge.	Major coastal low-lying city and economic centre crossed by major rivers that are also water sources. Flooding and drought experienced and predicted to increase. Small islands just off the coast face high climate risks.	Small coastal city. Recently experienced a major earthquake and tsunami which caused impacts that may be similar to climate hazards: prolonged flooding, high seawater, landslides.	Very dense inland city, adjacent to the capital Jakarta, crossed by major rivers and experiences frequent severe flooding.
Sanitation systems	Majority have private toilets discharging to tanks but over 14% still practice open defecation and 3% use communal toilets (2015). The old sludge treatment plant / disposal site does not function.	Mostly on-site sanitation with 1.3% open defecation (river and coast) and 9% use communal (decentralized) treatment systems (2016). Emptying by government and private trucks discharging to a sludge treatment plant. A centralized sewer system is planned.	Majority use improved toilets to on-site sanitation, 12% unimproved, 8% practice open defecation and 1% use communal treatment. Government emptying trucks dispose to a sludge treatment plant.	No open defecation, 90% using on-site sanitation 3% using communal toilets, 2% communal sanitation systems and 5% unimproved (2015). Private and government operators discharge to a sludge treatment plant with a new plant planned.

The research methods were as follows, adapted to comprise a mix of face-to-face and online engagement due to COVID:

- **National inception workshop** (41 participants) with representatives from relevant national ministries and development partners
- **City inception workshops** (total of 62 participants, 8-23 participants per city) to present the issue of climate and sanitation, inform data collection sites.
- **Household survey** (n = 412) on how households in the project cities experience and respond to climate impacts on sanitation. Criteria for site selection was communities with a high proportion of low-income residents and/or areas expected to be at increased risk from the four climate hazards assessed. The selection of locations was based on secondary city data and discussions with local government staff during the inception workshop. Three to four communities were selected in each city and households were randomly sampled from each community. These were conducted in person for all cities except Bekasi (n=74), where due to the Covid-19 situation throughout the survey period, interviews were conducted by phone.

- **Focus group discussions** (FGD) or in-depth interviews (5 participants per FGD group, separate male and female groups in Makassar, Lombok Timur and Palu; 4 male and 4 female participants via phone in Bekasi due to Covid-19). Participants were drawn from one of the household survey communities in each city.
- **Key informant interviews** (KII) with local government (23 participants). Participants included planning (Bappeda), environmental, health, public housing and public works agencies, as well as climate working group and sanitation working groups.
- **Key informant interviews with service providers** (12 participants): 4 treatment plant operators, 2 private emptiers, 5 decentralized treatment plant operators (IPALD communal), one communal toilet block (MCK) and three transect walks.
- **City climate response workshops** (10-14 participants per city) to validate findings, collaboratively assess priority risks and develop actions.
- **Consultation with relevant ministries** (3 ministries) were met at the project inception and/or prior to final workshop to review the results and policy and program recommendations.

3

CLIMATE IMPACTS ON SANITATION

A submerged septic tank connected to a raised house to anticipate flooding in Banjarmasin, South Kalimantan

3.1 Household experiences of climate hazards

Cities in Indonesia experience climate hazards to different degrees. In the four locations, dry spells and flooding were most frequently experienced (see Figure 5).[b]

- Water shortages due to periods without rain was the hazard most frequently reported by respondents from Lombok Timur (67 per cent of respondents)
- Flooding was most frequently reported by respondents in Palu (54 per cent of respondents)
- A high proportion of respondents in Makassar experienced flooding or dry spells (77 per cent and 62 per cent of respondents respectively)
- In Bekasi, nearly all respondents experienced flooding (97 per cent of respondents) and many experienced water shortages (55 per cent of respondents)

Responses to climate impacts should be tailored to the specific climate profile of a given city. These data are straightforward to collect through household surveys and can provide valuable information on the prevalence of climate hazards confronting sanitation users.

[b] Survey areas in each city were purposively chosen to survey respondents who likely have experienced climate impacts on sanitation, so these figures are not necessarily representative of their respective city.

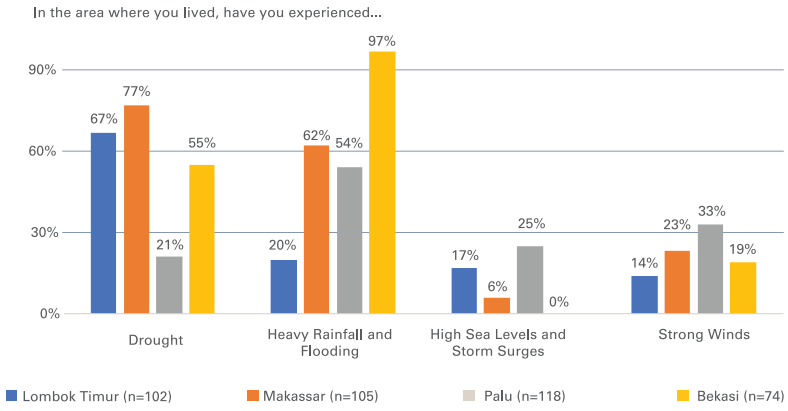

Figure 6 Proportions of respondents experiencing each climate hazard by city

- Strong winds - Strong winds that damage buildings
- Drought - Long periods without rain that causes your water supply to be limited or unavailable
- Flooding - Heavy/prolonged rainfall sometimes cause flooding, inundation, or rivers to overflow which affects public/ private property
- Storm Surges - High Sea levels and storm surges that impact your property, e.g. floods or problems with drainage.

3.2 Impacts of climate hazards on sanitation access, use and functionality

Climate hazards were found to strongly reduce sanitation access and use. Amongst respondents who had experienced impacts of climate hazards in their area, high proportions of respondents reported that they could not use or access their primary toilet due to a climate hazard at times (see Figure 7). Respondents who experienced water shortages due to droughts frequently reported that they were unable to use their primary toilet due to lack of water.

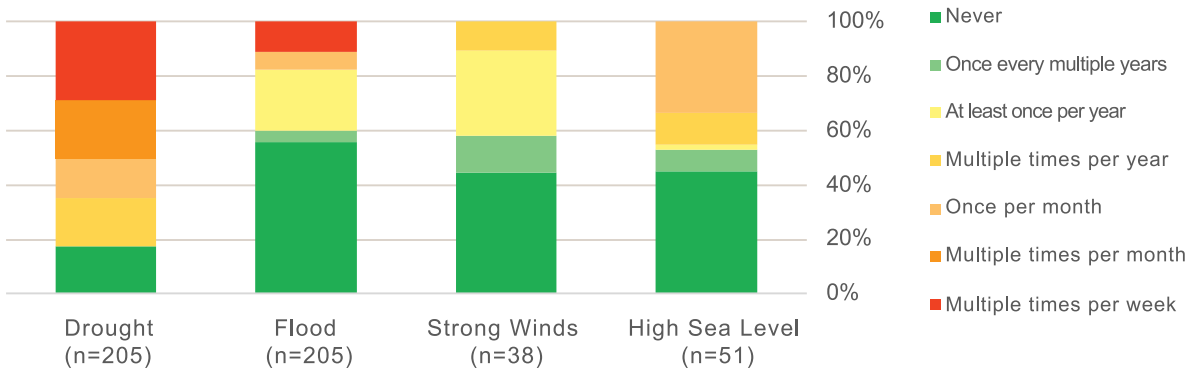

Figure 7 Frequency of lack of toilet access due to a climate hazard

Note: The flood results were asked only to households whose toilet was not inside the house. Also, the question for flooding was "difficulty accessing" whereas the other hazards the question was "unable to use".

Climate change is likely to increase the number of people losing sanitation access due to these climate hazards. Depending on the geographic area, climate change has potential to increase the prevalence and magnitude of certain climate hazards in cities in Indonesia. As more households become exposed to these hazards and to greater degrees due to climate change, the number of people unable to access or use their primary toilet will likely increase.

Different climate hazards create different forms of household sanitation access, use and functionality issues. These issues include insufficient quantities of water for using the toilet due to dry spells; floodwater or seawater inundating pits and tanks, toilets, or pathways to toilets due to heavy rainfall or high sea levels; and damage to latrine superstructures due to high winds.

Water shortages prevented toilet use. Amongst respondents that experienced water shortages in their area, half reported that they experienced insufficient quantities of water for using the toilet at least multiple times per month during the dry season and more than one-quarter (29 per cent) reported insufficient quantities of water multiple times per week[c]

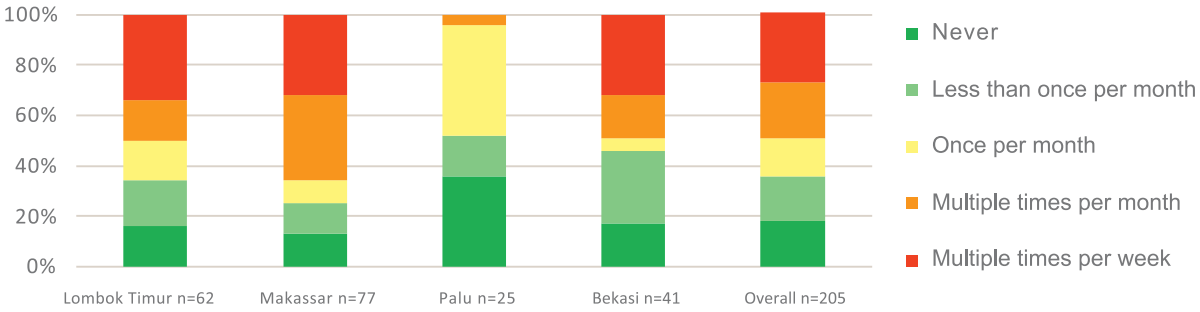

Figure 8 Frequency of insufficient quantities of water available for using the toilet during the dry season


Access difficulties after heavy rainfall in Lombok
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Floodwaters commonly covered toilets, preventing access. Amongst respondents that experienced flooding in their area before, floodwater covering the toilet was the most frequently reported issue affecting access, use or functionality in Makassar, Palu and Bekasi. In Lombok Timur, pit or tank overflow was the most frequently reported issue.

Floods give opportunity for households to wash out pits and tanks. 6 per cent of respondents that used a septic tank or pit and had experienced flooding in their area before reported that the owner opens the pit or tank during flooding to allow contents to be washed out. Although this represents a small proportion of all users, even a small number of households deliberately allowing floodwaters to wash out the contents of pits and septic tanks represents a substantial public health risk.

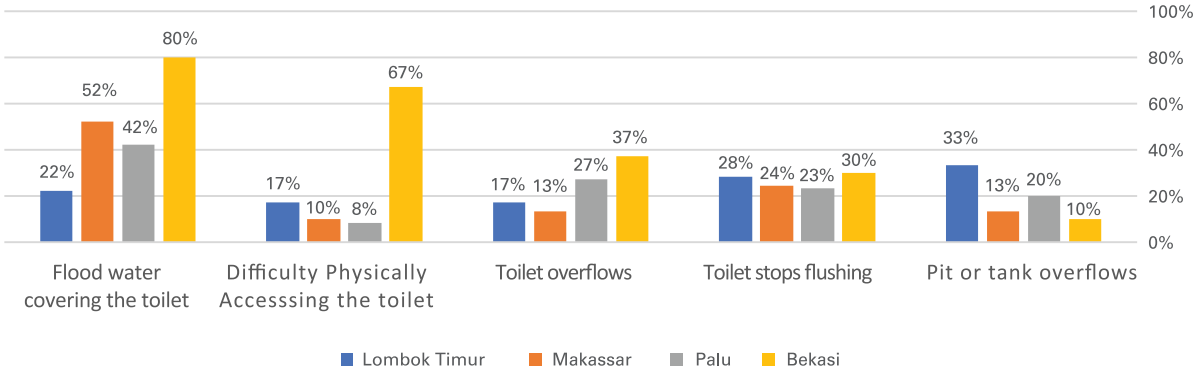

Figure 9 Proportions of respondents that experienced flooding that experienced issues with toilet access, use or functionality

[c] It should be noted that water shortages can be created by a range of issues (poor maintenance, rising demand, etc.) and respondents may not always have known the cause of water shortages they experienced

In coastal areas, high-sea level and storm surges caused water to enter toilet facilities and drains to back up. Data on impacts of high sea levels were only collected from Lombok Timur, Palu and Makassar because Bekasi is not located along the coast. A total of 50 respondents – 29 from Palu, 15 from Lombok Timur and 6 from Makassar – reported that high sea levels from either storm surges or high tides have affected their toilet facility. Amongst the 51 respondents that experienced impacts from high sea levels on sanitation, seawater entering the toilet facility was the most frequently reported issue.

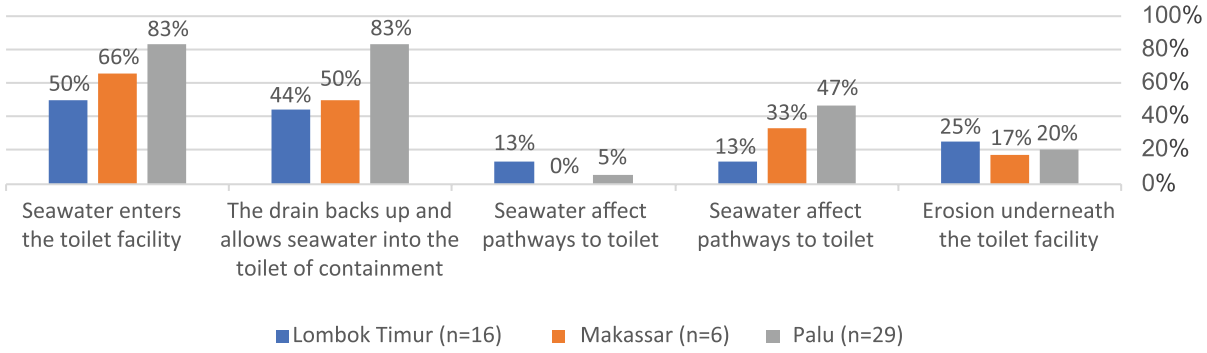

Figure 10 Proportions of sanitation facilities with access, use or functionality issues when exposed high sea levels

Strong winds did not frequently impact sanitation facilities, but when they do, they create privacy concerns. Damage to toilet facilities due to strong winds was relatively less common therefore are presented as combined results across the four cities. Amongst respondents who reported wind damage occurring in their area (n=88), the majority (59 per cent) reported strong winds never damaged their sanitation facility. Of the 36 respondents that reported experiencing wind damage to their sanitation facility, 22 reported that this resulted in privacy concerns

Table 2 Frequency of sanitation facilities damaged by strong winds in areas where wind has damaged buildings

Results from all cities	Multiple times per year	Once per year	Once every two years or less	Never
Sanitation facility damaged by strong winds (n=87)	9%	17%	15%	59%

3.2.1 Alternatives used if primary toilet facility was unavailable

Households chose from a variety of alternatives, including open defecation. If their primary toilet facility could not be accessed or used due to an impact of a climate hazard, the alternatives chosen by households varied across the four cities (see Figure 10 and Figure 11 for drought and flooding respectively):

- Using a neighbour, family member or friend's toilet overall was the most common alternative.
- Higher rates of poverty in Lombok Timur and lower levels of access to sanitation may partially drive the high rate of return to open defecation compared to other cities.
- In Palu, communal toilets may be more widely available as a result of the emergency response to the 2018 Sulawesi earthquake and tsunami.
- Respondents in coastal areas were more likely to resort to open defecation than those in low-lying non-coastal areas during both drought and flood periods.

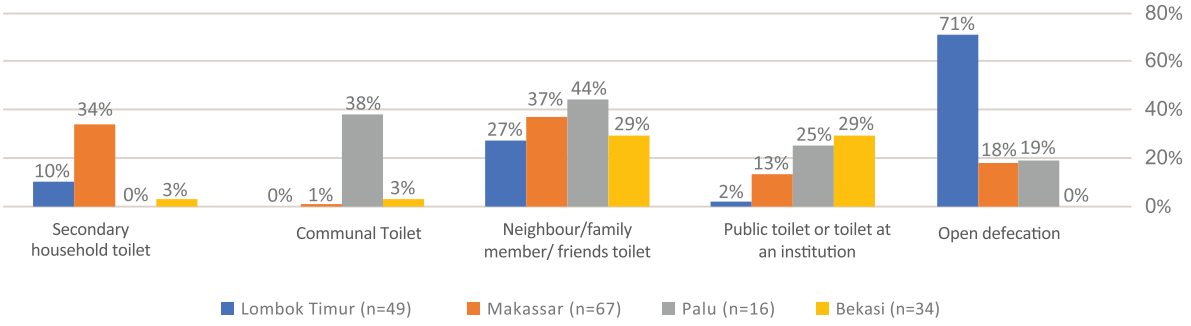

Figure 11 Alternatives used if primary toilet is unavailable due to a drought

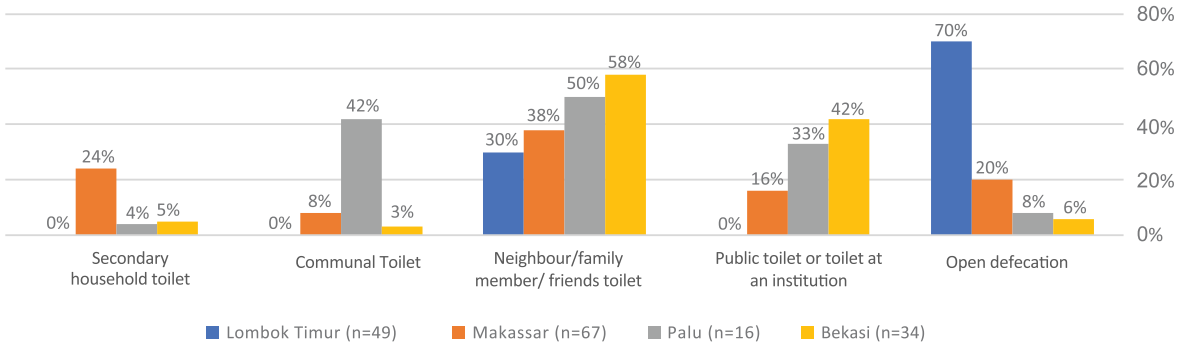

Figure 12 Alternatives used if primary toilet is unavailable due to flooding/heavy rainfall

3.2.2 Changed ease or distress in meeting defecation needs

Respondents overall felt less comfortable and more stressed about meeting their defecation needs when they experienced a climate hazard. All climate hazards studied caused respondents overall across the four cities to report an increase in discomfort in meeting defecation needs. High sea levels caused the greatest increase in discomfort (not comfortable or less comfortable). Floods caused the greatest increase in respondents feeling not comfortable, mild stress or anxiety when meeting defecation needs compared to the other hazards.

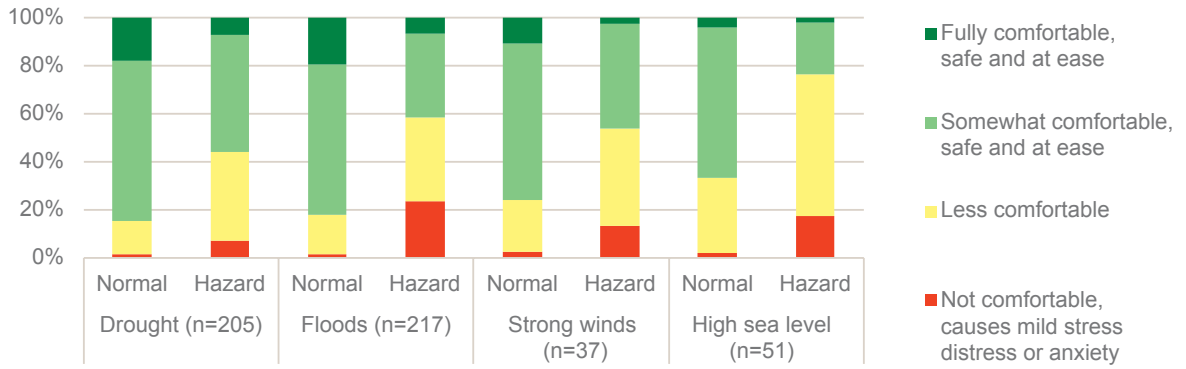

Figure 13 Levels of comfort meeting defecation needs in normal periods versus during periods of climate hazards

3.3 Impacts of climate hazards on containment infrastructure

The type of containment affects the extent of functionality issues faced. Amongst respondents who have experienced flooding, a higher proportion of users of toilets with no containment reported issues with toilet overflow or inability to flush compared to users of toilets with containment. Also, these functionality issues were less frequently reported by users of toilets flushing to sewers or a two chamber septic tank compared to toilets flushing to a one/unknown chamber septic tank.

Table 3 Proportions of sanitation facilities that overflow or stop flushing when exposed to flooding or heavy rainfall

Sanitation facility type	Flush to piped sewer	Flush to septic tank (two-chamber)	Flush to septic tank (one-chamber or don't know)	Flush to single pit	Flush to drain, canal, pond, lake or other
	n=28	n=49	n=100	n=5	n=26
Proportion that overflows or stop flushing	21%	29%	43%	60%	65%

Note: The question whether the sanitation facilities overflow or stop flushing was asked to several households with different sanitation facility types.

Reduced acceptability and problematic quality issues like clogging of toilets and pipes occurred in the dry season. Respondents were asked about acceptability and quality issues that they experienced due to effects of the dry season. Across the four cities, the most frequently reported issues were worse smells than usual around the toilet (n=43), worse smells around drains than usual (n=40) and more flies than usual (n=33). Clogging of the sewer in the street (n=16), clogging of the toilet or pipes in the house (n=4) and difficulty emptying the septic tank (n=2) were also reported. The low number of respondents reporting issues with emptying the septic tank in the dry season contrasts with reports from service providers ((sub-title 3.5 Impacts on emptying services). This may be due to a lack of awareness from households about the status of their septic tanks.

Pit latrines and sewered systems had the worst issues in dry season. Acceptability and quality issues in the dry season were most frequently reported by users of pit latrines and systems that flush to piped sewers. Pit latrines may generally have acceptability issues, for example smells, due to their design. Low flowrates in the dry season may cause pipes to clog or liquids to stagnate in pipes in flush to sewer systems.

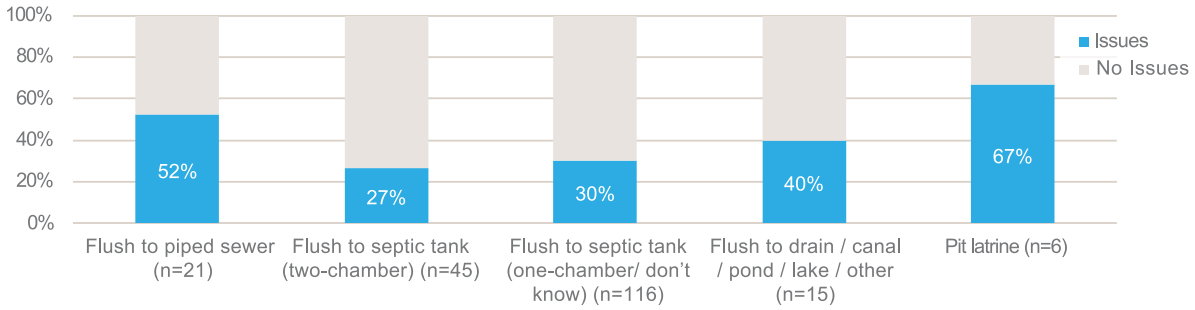

Figure 14 Proportion of respondents reporting acceptability/quality issues in the dry season by containment type

Worse smells in toilets and drains occurred in the wet season. Respondents were also asked about acceptability and quality issues experienced due to the wet season. Across the four cities, the most frequently reported issues were worse smells than usual around the toilet (n=63), worse smells around drains than usual (n=57), clogging of the sewer in the street (n=56)[d], clogging of the toilet or pipes in the house (n=45), more flies than usual (n=32), inside of the latrine getting muddy/dirty (n=25), roof leaks (n=18), septic tank needs emptying (n=15) and electricity/lighting problems (n=13).

Toilets flushing to two-chamber septic tanks performed better on acceptability and quality issues compared with other containment types. Acceptability and quality issues in the wet season were reported by most users of most containment types. Users of flush to septic tank systems reported acceptability and quality issues less frequently than users of other containment types.

> **Most people use septic that are not watertight. Gradually this issue can become urgent as it can affect the availability of groundwater in the future which is consumed by the community every day.**
> Makassar – Slum-less city program (KOTAKU)

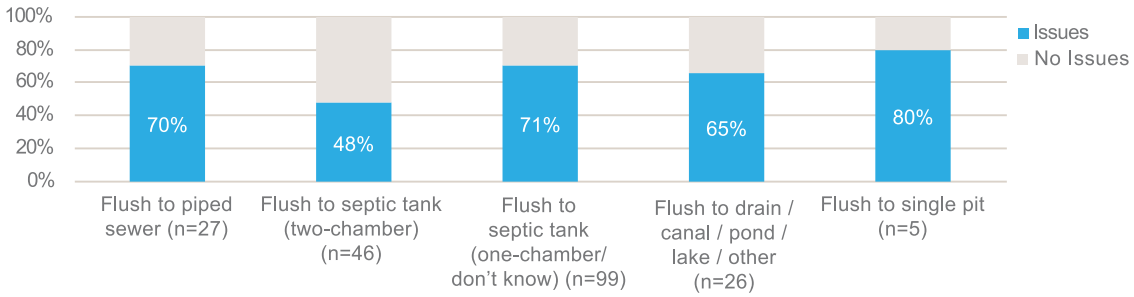

Figure 15 Proportion of respondents reporting acceptability/quality issues in the wet season by containment type

[d] Some respondents may have interpreted clogging of sewers as clogging of drains in the street

BOX 1 **Climate hazards increase risks to the urban water cycle**

The interactions between sanitation systems, urban water supply and drainage were even more evident with climate change and consideration of the integrated water cycle will become increasingly important. This research found limited water supplies and blocked or inadequate drainage impact sanitation. While two key issues with sanitation, particularly containment, impact water supplies and drains:

- Containments or toilets that connect or overflow to drains, contaminants that are flushed out in floodwaters or children's feces thrown or rinsed into waterways release high concentrations of pathogens into waterways. The risk of exposure is high due to children playing in drains, people washing or cleaning in canals and exacerbated by flooding which further spreads waste.
- Unsealed containments are common in many Indonesian cities and depending on soil and groundwater conditions risk contaminating drinking water supplies. This will increase in both high rainfall periods as the groundwater level rises and in drought due to increased extraction that leak to soil in areas that at risk to groundwater contamination.

> **When the septic tank overflows it is certain that the feces will go everywhere and risks that fecal-related diseases will contaminate the water, it is definitely a risk to the family and the surrounding population.**
> Palu- Public Health Office

3.4 Inequalities in access to and use of sanitation systems

3.4.1 Impact on open defecation

Increased open defecation is a risk given climate change impacts. Given the national and global priority to reduce open defecation (OD), understanding how climate change may impact these efforts is important. Many government staff reported that achieving ODF is their focus and climate was perceived as secondary or following this objective. However, the study findings highlight that climate hazards currently impact OD and must be considered, particularly as those with inadequate sanitation are often in areas at heightened risk for climate change.

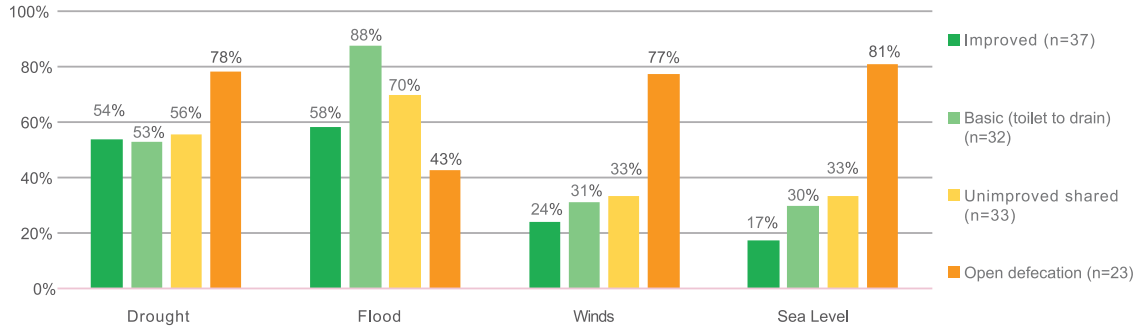

Figure 16 Respondents experiencing climate impacts by sanitation type

The study showed close connections between open defecation and climate impacts. Of the surveyed respondents, noting that they were sampled from low-income, hazard-prone areas, 15 percent of respondents in Lombok Timur and 5 per cent of respondents in Makassar practiced open defecation. Respondents practicing open defecation (n=23) were more likely to experience the impacts of drought, wind and high sea levels than respondents using other forms of sanitation. Although fewer respondents were impacted by flooding, 44 per cent of those practicing OD affected by flooding must change their location of practice of OD during the flood, compared with only 5-6 percent changing during other hazards.

Combining open defecation and climate hazards creates significant health risks. Households practicing open defecation were more likely to have increased cases of diarrhoea during climate hazards than households that had santiation facilties. In flood conditions, 55 per cent of households practicing open defecation were more likely to have family members experience diarrhoea compared with 25 per cent in households with sanitation facilities, similarly this was 39 per cent vs 16 per cent for drought periods. Perceptions of comfort, stress, distress and anxiety varied with sanitation type and conditions. For dry conditions those with no facility/unimproved systems were most impacted in comfort meeting defecation needs during climate hazards, but basic and improved were also impacted. For wet conditions, those without a facility had a worse base level comfort but didn't change due to flooding, however those with a basic system reported the greatest decrease in change in comfort. However, it should be noted that the sample sizes for no facility, unimproved and basic facilities were small therefore we cannot confidently conclude there are correlations between facility type, comfort and hazard.

> **When the seawater overflows the septic tanks cannot be used, the community will do open defecation again and it is difficult to reach ODF.**
> Palu- Public Health Office

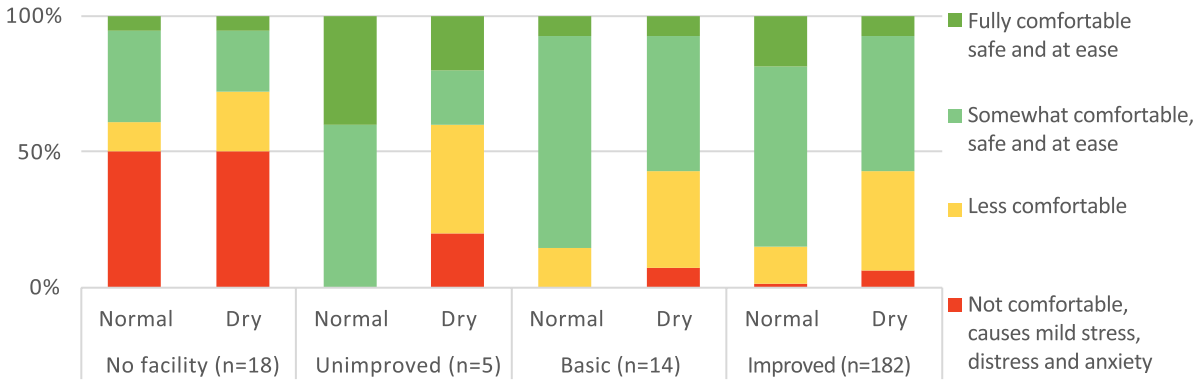

Figure 17 Change in comfort meeting defecation needs in normal conditions versus in dry season

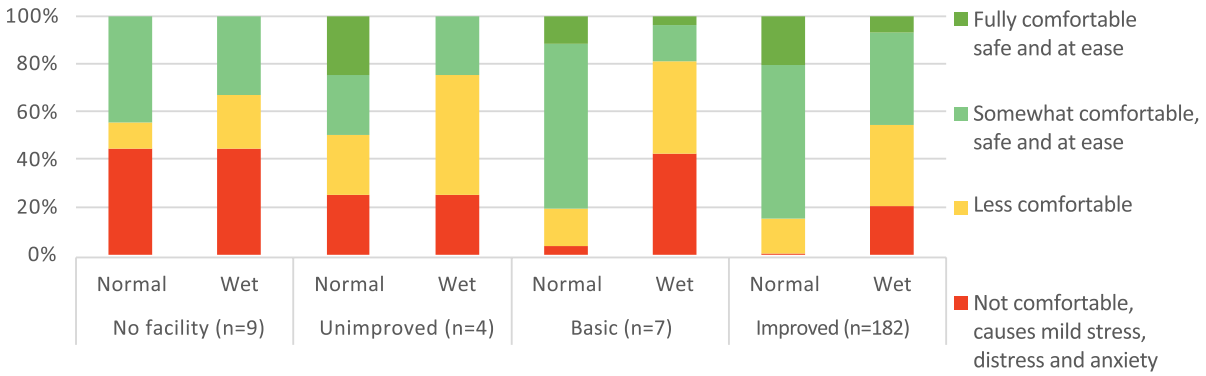

Figure 18 Change in comfort meeting defecation needs in normal conditions versus in wet season

BOX 2 **Impacts of water shortages due to drought on open defecation in Lombok Timur**

Of the four cities, rates of open defecation were highest in Lombok Timur: 15% in this survey (targeting low-income areas) and 14% based on local survey data (EHRA 2015). Lombok Timur also had the highest proportion of child faeces thrown into the environment (37%). The households practicing open defecation were mostly on the coast, often with houses over the beach. Greywater and litter were also reportedly disposed directly into the sea. Respondents reported that faecal waste spread and smelt during high tide and they were exposed to this pollution during drought periods when they must bathe in the ocean.

Sea water as an option for daily needs during water shortages due to climate hazards

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> **"During water shortages we "bathe with sea water and rinse with well water (brackish water). Although it is shameful, there is no other option because the price of water is expensive".**
>
> Lombok- Female FGD participant

3.4.2 Gender disaggregated impacts

The study showed differences in the gendered impacts of climate change on sanitation, which can be used in designing climate responses and adaptations that meet both women and men's needs.

Women noticed and experienced issues with sanitation different than men. In dry conditions women reported more frequent occurrence of insufficient water for using the toilet than men, with 32 per cent reporting it occurred multiple times per week compared with only 20 per cent for men[e]. After long dry periods women were more likely than men to report issues of worse smell around the toilet and more flies. In contrast female respondents (52 per cent) were less likely to experience impacts of flooding than male respondents (63 per cent). Relating to the specific impacts, such as floodwater covering or causing overflow of their toilet or containment, females also reported fewer impacts (average 36 per cent for female vs 48 per cent for male respondents).

Men were more likely to return to open defecation than women when there was insufficient water for toilet use: For households that had insufficient water to flush the toilet in dry season, women were more likely to use a neighbour's, friend's or family's toilet (44 per cent) than practice open defecation (40 per cent), for male respondents it was the reverse (30 per cent open defecation, 25 per cent family/friend/neighbours' toilet). Subsequent options of using an alternative household toilet (23 per cent) or buying/finding alternative water supplies (20 per cent) occurred equally between respondents.

During flooding, women preferred alternatives of neighbours and family whereas men preferred public or communal toilets. While most respondents can continue to use their toilet during flooding (45 per cent), female respondents that needed to use an alternative toilet were more likely to use a neighbour's/family's toilet (37 per cent) than males (25 per cent), in contrast male respondents were most likely to use public/communal toilets (28 per cent) than females (16 per cent). Compared to dry spells, open defecation was less common (11 per cent).

High sea levels created more distress in meeting defecation needs for women than men. There was little difference between genders in the levels of comfort or distress in using sanitation systems during climate events, except for sea-level rise where 24 per cent females were not comfortable vs 9 per cent males.

Meeting menstrual hygiene needs during drought created shame and embarrassment for women. Drought impacts on sanitation were most acutely felt by the FGD participants from Lombok Timur. FGD participants in Lombok Timur explained how people needed to meet personal hygiene needs, including menstrual hygiene management, with seawater or well water during water shortages, which was shameful and embarrassing. When toilets could not be used due to insufficient water, they also stated that they would stay with family members, especially to ensure the wellbeing of their children.

> **"During menstruation, participants will rinse clothes and bathe on the beach, which is embarrassing and uncomfortable but because of the circumstances and the cost of buying water, they were forced to do it."**
>
> Lombok- Female FGD participant

[e] Note that most respondents were female (73%), likely due to the surveys being conducted during daytime hours when men were away from the home working. The level of access and type of sanitation was similar between male and female respondents

Men reported higher investment and willingness to invest in sanitation improvements than women: An equal proportion of women and men reported upgrading their toilet in the past (20 per cent of respondents), however male respondents reported spending twice the amount of female respondents on these upgrades (2.6 million IDR vs 1.3 million). Similarly, in the past year male respondents reported spending more than female respondents due to damage to the toilet facility following climate hazards (1 million IDR vs 717,000), a higher proportion of female respondents reported spending no money on repairs compared to men (68 per cent vs 56 per cent). Male adults were only slightly more likely to be responsible for repairs and maintenance of sanitation facilities (48 per cent) than women (43 per cent). While genders were equally likely to invest to increase resilience of sanitation (about 50 per cent), men were willing to spend more.

3.4.3 Impacts on children

The majority (75 per cent) of respondents had at least one child under the age of 5 living with them and 48 per cent had at least one child aged 5-17 living with them. 75 per cent of children aged 5-17 (n=146) used the same sanitation facility as their parents, including 50 per cent of children whose parents practice open defecation (n=7) and all whose parents use unimproved or hanging latrines or public/neighbour's toilets (n=4).

Some child faeces disposal patterns may create problems given climate hazards. For respondents with children under 5, 19 per cent reported they disposed children's faeces by throwing or rinsing them into the open waterways (drain, river, sea), in uncovered garbage or left in open, all of which present issues that could be made worse given climate hazards. Fortunately, most of the waste is disposed of in a covered garbage (43 per cent), followed by children using the toilet (23 per cent), washing/rinsing into the toilet (11 per cent).

Children experienced reduced ease in meeting their defecation needs during climate hazards. Like adults, the perceived impact on children's comfort or distress involved in defecation during climate hazards was worse than in general periods.

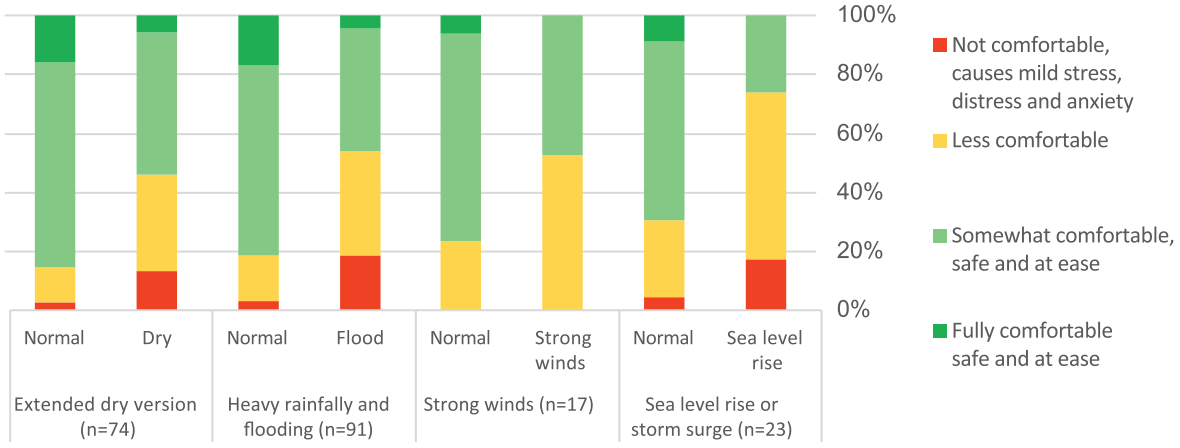

Figure 19 Perceived change in comfort meeting child's sanitation needs with climate hazards

Climate hazards can cause children to also return to open defecation. From the FGDs households in Lombok Timur reported evacuating to family member's house due to the need to access to sanitation facilities for women and children. Lombok Timur also had the highest proportion of respondents that experienced flooding reporting that children cannot access the toilet when there is heavy rain. During dry periods when there was insufficient water to use the toilet, children predominately practiced open defecation (13 per cent) or used a neighbour or family's toilet (12 per cent), yet this varied by city. In Palu it was predominantly community toilet, in Lombok Timur predominately open defecation, in Makassar a secondary household toilet.

3.4.4 Impacts on people with a disability and ethnic minorities

This section presents the analysis of inequalities for households with a member with a physical disability and households from a minority ethnic group. There were insufficient respondents from different religious groups to report on differences.

Respondents with a family member with a disability experienced less ease both generally and during climate hazards than other respondents. Physical difficulties faced by members of the households were captured, with 20 per cent of households having someone with some difficulty seeing, 11 per cent with some difficulty walking and 8 per cent with difficulty hearing and 8 per cent with difficulty with memory, although less than 2 per cent reported to be facing a lot of difficulty. Households with one member with some or a lot of difficulties were most common in Palu (50 per cent of households) compared with Lombok Timur (29 per cent) and Makassar (20 per cent). It was not assessed in Bekasi as the interview was shortened to accommodate it being conducted by phone. For both current conditions and during climate hazards, households with someone who experiences physical difficulties were less comfortable with their sanitation use than other households. This difference was most notable for current and drought conditions.

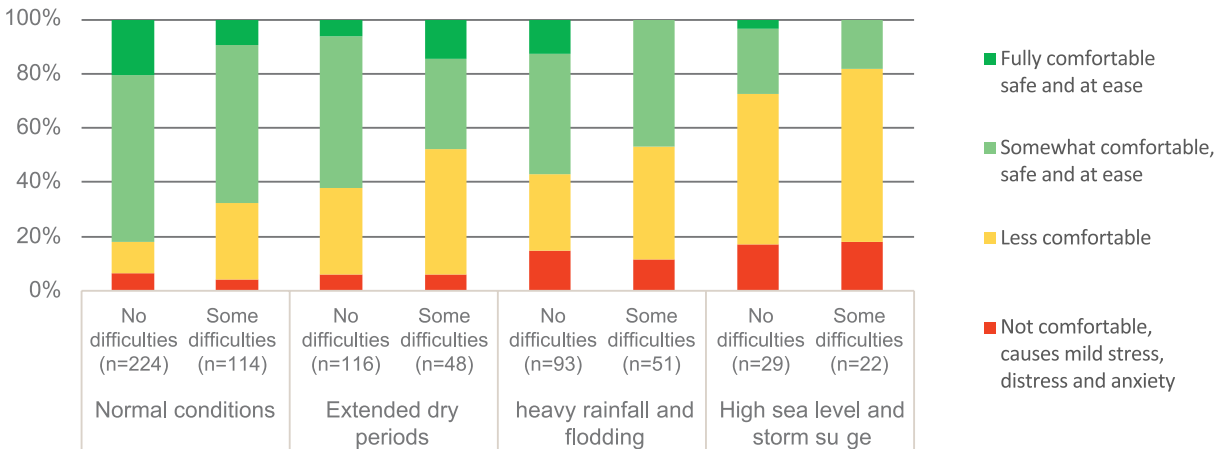

Figure 20 Change in comfort with hazard and family members with some or no physical difficulties

Minority ethnic groups were more likely to experience climate hazards. Ethnic groups were assigned majority vs minority depending on the major groups in each city. People from minority ethnic groups in each city were more likely to experience climate hazards than households from majority

ethnic groups. This ranged from over 70 per cent more likely to experience sea level rise and strong winds, 33 per cent for dry conditions and 10 per cent for flooding.

There was no clear trend in the comfort between ethnic minorities across all hazards, but they had a greater level of discomfort for general conditions and dry compared with majority groups.

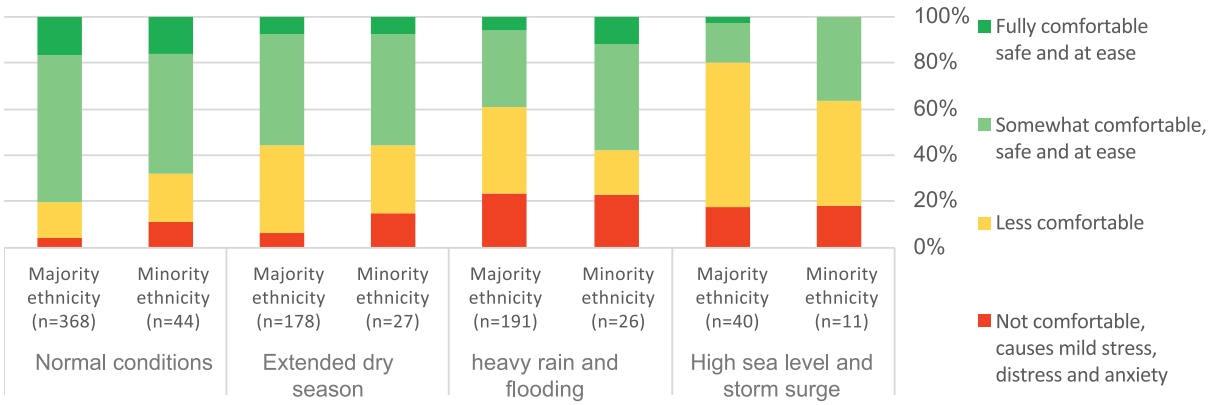

Figure 21 Levels of comfort between ethnic groups and hazards

3.5 Impacts on emptying services

Demand for emptying increased during flooding. The key climate hazard impacting the two operators interviewed in Makassar and Bekasi was flooding. This had wide ranging impacts and the most reported being the increase in demand for emptying during the wet season. Containments were reported to be more difficult to empty due to silts and sands entering during flooding and solidifying if not emptied quickly. These sands also caused problems at the treatment plant in Makassar.

Restrictions in access caused problems for service providers during floods. Other impacts included floodwaters inundating the garage and therefore restricting maintenance, flooding making roads impassable or risked damaging truck engines and creating difficulty accessing containments.

Emptying was more difficult during dry season or when containments have not been emptied for long periods. The dry season also caused issues with emptying since containments that had not been emptied for a long time were often too dry and difficult to empty with the pump. Water is used to assist pumping sludge, particularly drier or older systems, however it is less available in dry season and may require that tanks be manually emptied or if unable to be emptied, households to build new containments.

3.6 Impacts on sludge treatment plants

Resilient sludge treatment plants are critical to functioning of the whole sanitation chain. Faecal sludge treatment plays an important role in ensuring safely managed sanitation. When treatment plants do not function well, sludge is not adequately treated, trucks may not dispose there and instead directly into waterways or fields and the lack of safe treatment limits government's ability to promote improved containment and emptying services. This has flow-on effects to resilient sanitation due

to the impacts of infrequent emptying stated above, the delays in much needed containment improvement if emptying and treatment services cannot be provided and the potential environmental and health impacts of poorly performing treatment.

Even under normal climate conditions, some sludge treatment plants are not operational. In one city the treatment was considered non-operational by the government staff who noted they had requested national funding for a new plant. In two cities the treatment operator reported that the systems were not functioning well, although still received sludge, however these issues were not widely known by government departments.

Covered sludge storage area in Makassar (top), dry vegetation poses a fire risk at Palu (bottom)

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Flooding causes both physical damage to treatment plants and management issues for operators. The Bekasi treatment plant was operating well but faced several impacts due to flooding:

- Increased demand for emptying in wet season causes staff to work overtime to keep up.
- Flood damage to treatment systems, particularly systems with electrical equipment that are shut down prior to floods to protect it from damage, resulting in period of no treatment and a delay as the plant re-starts.
- Damage from flooding is also possible because many are in low-lying areas or discharge to rivers.
- Access to the treatment plant was occasionally limited due to flooded access roads, particularly for treatment plants located far from the city.

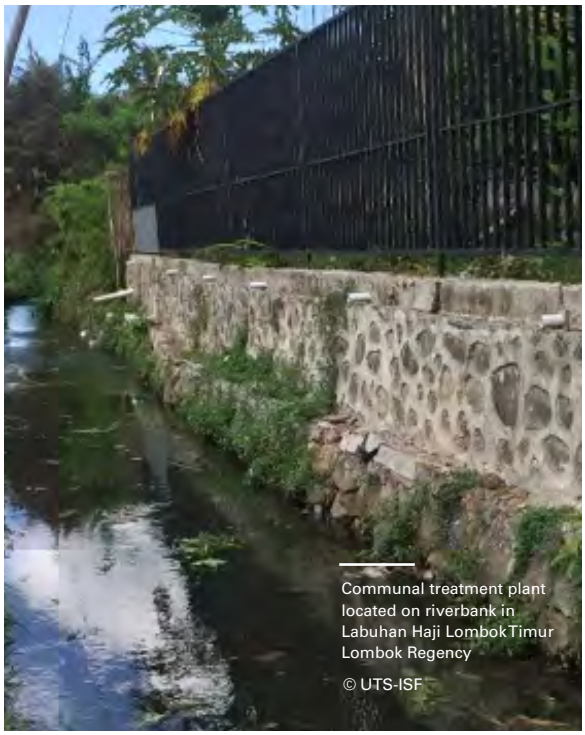
Drought also negatively impacted treatment plant operation. Other operators reported challenges with drier conditions, which also coupled with lower demand in dry season. Impacts included increase drying which causes blockage in the initial settling chamber; limiting availability of water on-site which is required for cleaning; and grass fires were a risk at one site due to overgrowth of vegetation and hot and dry conditions.

3.7 Impacts on decentralized sanitation systems

Decentralized treatment systems, referred to as IPALD communal or SANIMAS in Indonesia, were assessed in each city as these are a common community scale sanitation solution in Indonesia. They typically serve around 50 households and consist of small sewers discharging wastewater to an anaerobic baffle reactor, occasionally with a filter chamber and discharge to drains or waterways. As none of the cities assessed had a centralized sewage network, some of the impacts experienced by these systems, particularly for the sewer network, may be indicative of impacts to centralized systems.

To date, four of the five of the observed systems had not been significantly negatively impacted by climate hazards and no climate adaptation actions have taken place. However, the following impact to other systems in the cities and potential risks were identified in the assessment and through local government interviews.

High sea-level risk was problematic for decentralized systems located on the coast. One system assessed in Palu has stopped functioning due to high sea level blocking the outlet pipe, which is a very long narrow and flat pipe from the system discharging to the sea. The Palu government noted that decentralized gravity flow systems are not suitable in these flat areas and will look to build individual systems instead.



Communal treatment plant located on riverbank in Labuhan Haji Lombok Timur Lombok Regency

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Heavy rainfall and floods are a risk to decentralized treatment systems located adjacent to rivers and canals. In Indonesia it is common for these systems to be located on riverbanks and discharging to canals or rivers as this is often the low point for these gravity-based systems. Assessed systems were at risk of damage and scour from high river flows, particularly those on larger canals or rivers or floodwaters enter the systems through opening or cracks. This was reported to have occurred to systems following either heavy rainfall and/or high sea-level and affected function, including backflow and occasionally restricting household toilet use.

The systems were also at risk to very dry conditions, with some reports of pipes becoming blocked due to low water flows. As the receiving waterways often have low flows in extended dry periods, there will be a greater impact of the discharged effluent since dilution capacity of the receiving waterways are reduced.

3.8 Impacts on urban water cycle

The interactions between water supply, sanitation and drainage become even more apparent due to climate hazards including risks environment and public health and could also undermine progress on safely managed water. Integrated urban water cycle management will require a different set of actors and different focus to current sanitation or climate working groups.

- Impacts from climate hazards on the urban water cycle affects the use and function of sanitation. Insufficient water during dry periods was the most reported hazard and occurred in all four cities. This is a concern for sanitation use, as Indonesians typically use water flush toilets and water for cleansing. Inadequate or blocked drainage infrastructure was a reported contributor to the frequent flooding during heavy rain or high tides, with many individual and community sanitation facilities, as well as access to sanitation services, affected by flooding.

- Impacts from climate hazards on sanitation facilities and services increase the risk that untreated faecal waste is discharged to urban waters. Water scarcity due to climate change is predicted, therefore contamination from inundated or overflowing sanitation systems poses a threat to maintaining safe water supplies, including both groundwater and surface water sources. During periods of heavy rain, flooding and high sea-levels, water enters the toilet or containment, causing overflow or stopped functioning since the facility cannot drain. This restricts toilet use and also risks faecal waste being spread in the floodwaters. For toilets exposed to flooding, the lower quality sanitation systems (direct to drain, unimproved toilets) were twice as affected as toilets discharging to (communal) sewers or septic tanks. Some households also reported flushing out containments into flood waters. Contamination of drains and surface water is more likely to spread during increased flooding and potentially increased interaction.

4

CAPACITY TO PREPARE AND RESPOND

A triggering session with households and facilitators to raise awareness

© UNICEF WASH team

This section summarizes the findings from interviews, workshops and discussions with households, local government officers and service providers the awareness, priority and current actions to prepare for or respond to climate change. Comparison of the current capacity to act with the capacity needed for required climate resilience and adaption can inform suitable actions and support required to meet capacity gaps.

4.1 Household resilience and adaptive capacity

Households' awareness about climate change varied but was generally low. Some respondents demonstrated knowledge (e.g. in Palu) and others offering related ideas such as mentioning the La Nina/El Nino climate effect, whilst many needed interviewers to make reference to the specific hazards (flooding, sea level rise and dry conditions) to reflect on its impacts. The youth and disability groups involved in the final national workshop also had difficulty with the technical climate language and required explanation of key climate concepts and terminology.

The community awareness about climate change and impacts on sanitation was reported by the government in workshops to be low and was perceived to contribute to increased impacts of climate on sanitation systems. Key areas noted by the local government where there was a lack of awareness was about the importance of constructing a standard sanitation system in homes, the need to empty onsite systems and options for reducing water use or reusing water. From the findings negative responses to climate change included reverting to open defecation when toilets were inaccessible or some households flushing out their containments into floodwaters. Local government officers commonly reported that households were a key contributor to the pollution and solid waste

blocking drains that in turn contributes to flooding and that greater awareness and campaigns are needed to highlight the widespread impact of their actions. However, in Makassar communities already participate in regular cleaning of waterways, organized by the community leader and informed through women's groups.

Households relied on the dug well in a mosque during drought

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Households were already employing some coping mechanisms for climate events: Survey respondents identified a range of coping actions to meet sanitation needs when climate hazards occurred, which varied by city (see Table 4). Many actions were applicable across a range of hazards and numerous were management or behavioural actions rather than new infrastructure. Storing water was the most common coping action for most hazards and all areas. Various water management actions such as seeking alternative sources and using less water were reported for all hazards, not only during extended dry periods. Accessing an alternative toilet was also common, especially in response to heavy rainfall or flooding. Other reported actions to respond to floods that were not in the top three included raising toilets higher, installing extra drains and increasing the height of the septic tank ventilation pipe.

The role of the community leaders or community groups in raising climate awareness or providing support post climate hazards varied. Some FGD participants in Lombok Timur reported that they had not received any information or warning from the village regarding impending disasters and noted that in dealing with disasters it was the "business of each household to overcome it". At the same time some participants indicated they expected the community or local government to reduce climate impacts through financial support to improve toilets, water supply and drainage.

Table 4 Most frequently reported coping actions for responding to climate hazards to meet sanitation needs

Top three (1, 2, 3) reported coping actions for responding to climate hazard in each city	Drought				Heavy rainfall / flooding				Strong winds			High sea levels		
	Lombok Timur	Makassar	Palu	Bekasi	Lombok Timur	Makassar	Palu	Bekasi	Lombok Timur	Makassar	Palu	Lombok Timur	Makassar	Palu
Store water	1	1	1	1	2	2	2			2	1	1	2	2
Find alternative source of water	2	3	3	2	1							2		
Use less water to flush	3	2	2	3		3							1	
Use an alternative toilet					3		1	3	2			3		1
Unblock/clean pipes						1	3	2						
Clean more regularly								1						
Modify latrine superstructure									1	1	2			
Wait until seawater recedes to use toilet														3

Other key findings about household capacity to prepare for and respond to climate hazards were:

- **Need for early warning to households about climate events:** Almost no warning was received by households before climate hazards, except for Bekasi where 86 per cent of households received a warning before flooding.
- **Repairing sanitation systems was shared between women and men:** There was relatively equal responsibility for conducting repairs and maintenance of the toilet between men (48 per cent) and women (43 per cent), while a few children were reported to be responsible (2 per cent male and 1 per cent female children).
- **Emptying practices were not yet in place in response to flooding:** Increased emptying was reported by service providers and local government but was not directly reported by households and was not one of their key coping actions to deal with impacts of flooding on sanitation systems.
- **Households made requests for government to address drainage systems and for more reliable water supply to reduce climate impacts on sanitation:** To reduce the impacts of climate change, households suggested that further government support was needed to improve local infrastructure and services – predominately improving drainage and improving water supply reliability.
- **Households were willing to invest in more climate resilient sanitation facilities:** As described in box 3, households, particularly men, had already invested in making their toilets more resilient and were willing to invest more.

BOX 3 **Household finance to repair or improve sanitation in response to climate hazards**

The survey asked households about the spending on sanitation following hazards and willingness to invest in more resilient sanitation systems

- Between 15-30% of households spent money on repairing their toilet, median 300,000 IDR
- 8-23% have invested in upgrading to ensure it works in bad weather, spending median 500,000 IDR

43% of households reported they were willing to invest 1million to make their toilet more climate resilient. Further analysis on willingness to invest is recommended as the local government questioned the high amount and strategies to mobilize investment needed.

Local government officers were uncertain whether the existing on-site sanitation grant criteria could serve the households most vulnerable to climate change.

> **"Septic tank upgrade grants are not available to households without toilets in the most vulnerable areas. Grants are very important because sanitation risks to climate resilience are most vulnerable to low-income communities and slum areas. Areas that are at risk of being vulnerable to flooding, drought, and environmental pollution must have an impact on the area and the surrounding environment"**
>
> Bappeda Makassar

4.2 Local government institutional adaptive capacity

Capacity of local government institutions and staff in the four cities to prepare and respond to climate change was assessed through the lens of capacity defined as "the ability to perform functions, solve problems and set and achieve objectives".[f]

4.2.1 Adaptive capacity

The first lens the local government capacity was assessed was the ability of departments and staff to perform functions and solve problems. In performing their functions, local government agencies were found to have undertaken a mix of initiatives to solve problems related to climate hazards and sanitation across the four cities. Examples included:

- **Climate resilient infrastructure:** Grants to improve on-site sanitation are part of a national program, in Makassar PVC and Bekasi watertight containment tanks were installed, designed to be resilient to flooding.
- **Pro-active emptying:** In Bekasi government supports emptying during periods of flooding for a limited number of households in high-risk areas.
- **Rapid flood response:** Bekasi and Makassar have rapid flood response teams that use pumps to reduce flooding. River dredging and community drain cleaning activities also aim to reduce flooding.
- **Mapping and resource protection:** In Lombok Timur ProKlim/DLHK have a program to protect water sources, maps of drought prone areas to inform water distribution and a program to build community deep wells.
- **Awareness raising:** Pokja Iklim in Makassar, situated in the Department of Environment, have a project to raise awareness about climate change in a select number of villages supported by ADB and Monash University.
- **Planning:** Lombok Timur and Makassar City preparing a regional action plan (RAP) for climate change building from the recently developed action plans at the provincial level. Palu plans to update their city sanitation strategy (SSK) to consider disaster risk reduction and will consider to also include climate risks.

[f] Fukuda-Parr, S., Lopes, C. & Malik K., 2002, "Overview: Institutional Innovations for Capacity Development", in Capacity for Development, New Solutions to Old Problems, UNDP-Earthscan.

BOX 4 **Individual septic tank (SPALD-S) Improvement program**

The Bekasi government has a local domestic wastewater management system (SPALD-S) program which installs individual household septic tank systems throughout Bekasi. The Bekasi government installed 560 SPALD-S systems in 2019, 600 in 2020, and plans to install 1600 more in 2021. The SPALD-S system comprises a prefabricated septic tank that contains a biofilter for treating waste. Effluent from the tank should be discharged to an infiltration well, but in practice some systems discharge to a simple pit that also receives greywater.

Sanitary risks from heavy rainfall and flooding are less if the system is well designed with a proper infiltration gallery for treating effluent.

Several key challenges were identified:

Unclear responsibility for climate resilient sanitation: The responsibility for climate resilient sanitation was not clear in most cities. While climate change working groups existed in Makassar and Lombok Timur, these groups did not see sanitation as part of their agenda, particularly the Lombok Timur group which was funded by an agriculture and economic project. The sanitation working group also didn't consider climate to be part of their agenda, mostly due to lack of expertise and also since there was no National guidance or policy requiring this. While the public works department was responsible for sanitation infrastructure and health department supported the ODF campaigns, neither of these groups felt responsible for climate change.

Limited expertise in climate resilient sanitation: Only Makassar had staff with climate and sanitation expertise, built through a current climate resilient slum upgrade project. Other cities mentioned that expertise existed in one part of the agency (e.g. climate or environment division) but this expertise wasn't shared across departments.

Gaps between disaster response and long-term repairs: The unclear transition of responsibility between disaster response and longer-term repairs was a challenge. For example, whether the repairs of a treatment system damaged during an extreme event are managed and financed by disaster response or part of annual budget.

Unconsolidated data to understand vulnerability and risk: While agencies were able to list the existence of different data sets or climate relevant information (flood maps, historical drought or rainfall data, air quality, disaster response plans), this information was spread across different agencies and not known or accessible to all. Improved data specific to the city was a key request from local government staff to enable integration of climate considerations into planning and infrastructure design. However, it is unlikely that climate predictions can be generated at this granular level and scale due to the uncertainties, particularly in Indonesia which faces multiple hazards. In its place, data to identify high risks areas for climate change and details of current sanitation, as was collected in this research, was also seen to be valuable to inform prioritisation of investment, particularly as such data meets criteria for the national on-site sanitation improvement grants.

The second lens to assess institutional capacity is the ability to set and achieve objectives in relation to climate change and sanitation. At present there is little or no priority setting in this domain and such processes were impacted by the following challenges:

- **Low awareness and priority of climate change impacts on sanitation:** While most local government staff were aware of climate change, very few had considered the potential climate impacts on sanitation. Nor that climate resilience should be considered in sanitation programs and investment.

The exception was in Makassar where new containments are designed to be resilient to flooding. In the inception workshops there was widespread low prioritisation of climate change and sanitation due to the lack of evidence.

> **Right now, the impact of climate change on sanitation is not apparent enough. At least not like how climate change has impacted the agriculture sector**
>
> Bappeda Lombok Timur

> **Our main priority is providing safe sanitation. I think we are not there yet for climate change**
>
> Pokja Sanitasi Bekasi

> **If climate change becomes a hindering factor to achieve 0% open defecation, maybe we will put it into consideration**
>
> Bappeda Lombok Timur

A poll in the climate response workshops conducted near the end of this study indicated that participants felt their understanding and concern of the potential impacts of climate change on sanitation increased yet slightly less their ability to act.

- **Budgets for sanitation were insufficient and disaster funds were also insufficient to meet needs:** Finance was the most reported barrier to considering climate in urban sanitation. It was perceived that climate resilient sanitation was an additional step and most respondents reported insufficient funding is allocated to current sanitation services and that makes investing in climate change a low priority. While there is some local budget for disasters or emergency response, the budget is difficult to estimate and multiple extreme events mean the allocated budget is typically insufficient. When disasters occur, budgets are typically reallocated from elsewhere to cover the expenses and was limited to minor repairs as major repairs required requests in the following years' budget. National finance is often made available for major disasters.
- **Financial resource considerations were focused on disaster response and not yet on proactive investment in resilience:** In this study, all discussions on finance and budgeting focused on response to hazards, with no focus or discussion about budget to prepare for disasters or increase resilience.
- **Unknown climate resilient technical sanitation options:** Lack of available sanitation technical options or modification to increase climate resilience was a key gap in local governments ability to support or progress resilience. Officers did not know what options or actions were suitable for the different climatic conditions and requested further guidance and physical examples of these options.[g]
- **Demand for national guidance on climate change and sanitation:** The lack of a national or local government policy or program on climate change and sanitation was noted as a key gap by local government staff. Such a policy or program was reported to be expected to help departments to prioritize the allocation of budget as it would align with a specific budget policy.

[g] Response actions were presented to local government during the response workshops with participants identifying feasible actions for their organization. Some of these are included below under potential response actions

4.2.2 Required support to local government to progress action

During the inception and climate response workshops the government were asked what they needed to be able to take action on climate resilient sanitation. Their responses fell into the following categories:

Data to inform risk and vulnerability assessment: A frequent request from government staff was for more detail on climate predictions for their city, rather than national estimates. For instance, data on future sea or flood levels or maps that show the most flood and drought prone areas. However, due to uncertainties in future climate modelling at local scales, it is difficult to develop these maps. In lieu of maps that show precisely where future hazards will occur, existing data can be made available to all and maps indicating potential hazards developed based on historical data, such as flood and high tide levels. Considering the climate predictions alongside existing hazard mapping could guide assessments of priority climate risk areas or selection of locations for important sanitation infrastructure.

Technical support on climate resilient sanitation infrastructure: Technical support including appropriate technology for improving latrines and technical improvements such as additional water supply, communal latrines for emergency, climate resilient septic tanks or decentralized systems.

Additional financial resources for user awareness, Infrastructure and management improvements: Finance is needed to conducting the community socialization activities and to provide assistance to the infrastructure improvements such as new water supplies, communal or public toilets, improved operation of treatment plant so they can promote regular emptying,

Greater coordination between central, regional, provincial, NGO and others working on either sanitation or climate change. Dissemination of the link between climate and sanitation must go beyond the core group and also include other related sectors (e.g. Building Permit) and district and regional working units.

Options for climate resilient sanitation finance were needed, including clarity or polices to inform and permit local budget allocation. Strategies are needed to mobilize household willingness to invest and criteria for existing sanitation grants needs to be adapted to suit vulnerable populations.

Increase awareness raising amongst community: Awareness raising for general public and decentralized treatment operators (community volunteers) on potential climate impacts on sanitation, the importance of improved sanitation (standard septic tanks, regular emptying, not polluting drains) to reduce climate risks.

4.3 Service provider adaptive capacity

Overall, this research found low adaptive capacity amongst service providers and treatment plant operators, pointing to clear needs to build such capacity and access to resources.

To date the private emptying operators interviewed in this study had implemented a limited number of adaptive actions:

- Not allowing trucks to operate in deep floodwaters to avoid damaging the engine (Makassar)
- Considering moving the garage for emptying trucks to a low-flood risk area to reduce the risk of further inundation and blockage of the garage (Makassar)
- Planned training of staff about climate risks by the operator (Makassar)
- Request to local government to promote construction of improved (rather than basic) sanitation facilities and regular emptying, as this would make the physical act of emptying easier and help reduce the peak demand in wet season (Makassar)
- Government provides emptying to households following flooding, but this was limited to one neighbourhood since the treatment plant cannot accommodate a larger volume of sludge if it has been shut off due to flood risks (Bekasi)

The sludge treatment plant operator in Bekasi demonstrated various adaptive actions:

- Building a flood barrier out of available on-site materials (including dried sludge); shutting off electrical equipment to prevent damage (Bekasi)
- Limiting trucks disposal due to reduced plant capacity (Bekasi)
- Planning a duplicate treatment plant that will be raised to reduce flood risk, with the old system to remain in place to provide backup capacity during flood periods (Bekasi)
- Although not mentioned by the manager, it is probable that the emptying trucks that couldn't discharge to the treatment plant disposed waste into the environment, particularly given the high demand for emptying (Bekasi)

However, the other treatment plant operators had low capacity to perform current function, including fixing or adapting operation of plant to keep it functioning. The low capacity of these staff to operate the systems under current conditions questions their ability to practice adaptive management needed to be more responsive to future climate hazards. It is not just the operators but also the systems that are not flexible to operate in the range of conditions, for example modular systems that can cope with the low summer inflow and high winter flows or bypass damaged systems but maintain operation.

Makeshift retaining wall to protecting the Bekasi sludge treatment plant from floodwaters

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The community-based operators of the communal treatment plants faced reduced motivation and difficulties operating the systems after climate hazards, particularly in Palu. As noted by previous research on communal scale sanitation, these systems can easily become a burden for the low-income community groups managing them and some level of government responsibility is needed to ensure sustainable operation (ISF-UTS 2018). Many of the respondents knew little technical information about the system or about potential climate risks. Therefore, their capacity to adapt the treatment systems to cope with future hazards is unlikely. In addition, the absence of even minor operating funds makes major repairs out of reach and clearer processes were needed to financially support the repairs of these systems following climate hazards.

> **Every time the Fecal Sludge Treatment Plant (IPLT) closes, it can take up to 4-6 days to gradually restart. In one day, the treatment plant can accommodate 60 households, therefore if it does not operate for 6 days, the impact is almost 360 houses not served. This is despite the much-increased demand for emptying during rainy season. Private trucks will queue up, but we cannot dispose of them. Given the warning from the Meteorology Climatology and Geophysics Council/ BMKG about increasing bad weather, maybe the IPLT will be closed even longer, which could result in up to 1000 unserved households.**
>
> Head of the Bekasi Wastewater Treatment Area Technical Implementation Unit

Service providers and treatment plant operators requested the following support from local government:

- Information before climate disaster so they can prepare
- Enforcement of standards for proper septic tank design
- Regular maintenance of drainage system to reduce flooding of roads, particularly of roads to emptying providers or the treatment plant.
- Functioning and repair of decentralized treatment systems and greater support to community operators of communal scale systems.

5

WHAT DOES A RESILIENT SANITATION SYSTEM LOOK LIKE?

A water storage and toilet built over water, withstanding flooding, in Medan, North Sumatera

The Intergovernmental Panel on Climate Change (IPCC) defines resilience as: "*The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation*".[12] In other words, to cope with the floods, droughts, storms and sea level rise that climate change is worsening, sanitation systems, comprising infrastructure, services and people, must be able to respond and reorganize to continue delivering sanitation's essential service to protect human and environmental health. The people governing and managing sanitation systems must also develop capacity to learn about changes in the environment and capacity to adapt or transform sanitation systems.

A key unanswered question across the sanitation sector at the time of documenting this research, is what a holistic resilient sanitation system looks like. Such an ideal is required to provide a destination to aim for and take steps toward, both in Indonesia and elsewhere. The authors' previous research identified seven areas of focus to guide the development of climate resilient urban sanitation systems.[13] In this research, we have adapted these categories towards describing an ideal 'climate resilient sanitation system' (Figure 22) and used these to guide climate response workshops with local governments, as well as key areas for action and recommendations going forward.

Institutions, governance, and services

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

Financing

Sustainable and responsive financing for both preventive measures and disaster responses

User and societal engagement

Creative, strength-based user and societal engagement and awareness

Infrastructure

Robust and repairable sanitation infrastructure options

Figure 22 Dimensions of a climate resilient sanitation system

A raised wall pit latrine in Aceh
© UTS-ISF/Freya Mills

The terminology of a 'climate resilient sanitation system' describes the overall social, technical and environmental system, rather than narrowly referring to sanitation infrastructure, which is sometimes denoted by this term. Four main dimensions are included: (i) Institutions, governance and services; (ii) financing; (iii) user and societal engagement; and (iv) infrastructure. Such dimensions are fundamental to and aligned with achieving city-wide inclusive sanitation (CWIS), where all inhabitants have access to services (whether onsite, decentralized or offsite) and institutional arrangements and incentives for the full-service chain are considered (see Box 5). Below we have elaborated on the four dimensions in relation to key resilience characteristics, such as consideration of risk, vulnerability, flexibility, responsiveness, robustness and adaptation.

BOX 5 Climate resilience within Citywide Inclusive Sanitation (CWIS)

Citywide inclusive sanitation is being pursued in many cities to achieve safe, equitable and sustainable sanitation for all (SDG 6.2), irrespective of where people live within the city or what technologies are used to serve them. To date there has been little discussion about how climate change is considered in the CWIS approach or how climate resilient sanitation can be integrated.

Table 5 Citywide Inclusive Sanitation service framework (Schrecongost, et al. 2020)

OUTCOMES	**Equity**	**Safety**	**Sustainability**
	Services reflect fairness in distribution and prioritization of service quality, prices, deployment of public finance/ subsidies	Services safeguard customers, workers and communities from safety and health risks by reaching everyone with safe sanitation	Services are reliably and continually delivered based on effective management of human, financial and natural resources
FUNCTIONS	**Responsibility**	**Accountability**	**Resource Management/ Planning**
	Authority(s) execute a clear public mandate to ensure safe, equitable and sustainable, sanitation services for all	Authority's(ies') performance against mandate is monitored and managed with data, transparency and incentives	Resources–human, financial, natural, assets–are effectively managed to support execution of mandate across time/space

The CWIS service framework (above) identifies core outcomes and functions for public service delivery of sanitation, relevant across diverse city contexts.14 There are many parallels between the objectives of CWIS and the framework of climate resilient sanitation.

- **CWIS Outcomes:** Equity is integral to climate resilient sanitation with risk-based planning supporting prioritization of those most vulnerable to climate change and targeted engagement with societal groups to identifying the needs and support engagement of vulnerable populations. Sustainability is central to robust infrastructure and flexible services to ensure they are resilient to the varied and uncertain future climate hazards. Coordinated management of the urban water cycle aims to protect natural resources as well as reducing public health risks. Monitoring and warning systems aim to increases preparedness for hazards while risk-based planning across the service chain considers safety for users, community and service providers.
- **CWIS Functions:** The core functions are designed to achieve the outcomes and play a similar central role to the institutional, governance and services dimension identified for climate resilient sanitation. Clarifying responsibilities for climate resilient sanitation requires mandates to be integrated within an existing structure. At the same time an integrated approach is needed to plan, share data, build capacity and implement actions as climate change actions span many departments. The monitoring described in the framework focused on how data can inform resource and service planning and management, yet can also provide accountability of progress, particularly if indicators of climate resilience are developed and tracked.

Further analysis is needed to understand how cities are currently implementing the CWIS framework and identify actions that are most suitable to integrate the components of climate resilient sanitation. This is critical to ensure that the CWIS outcomes will be achieved under changing future climate conditions.

5.1 Institutional, governance and services

5.1.1 Clear institutional responsibilities and flexible management and service delivery arrangements

An officer from a desludging service provider consulting a customer. Service providers play an important in being available although in emergency situations.

© UPTD PALD Kota Bekasi

Responsibility for climate resilient sanitation needs to be clearly allocated to a lead ministry at national level and a lead agency at local level. Cross-agency climate working groups and cross-agency sanitation working groups can provide valuable support and are important given the complexity and cross-cutting nature of both climate change and of sanitation service delivery. But without a clear lead, it will likely be difficult to prioritize and implement resilient sanitation systems.

A major factor of building resilience is to be adaptable to the uncertain conditions and flexible to a range of climate scenarios. To be flexible, management arrangements for different parts of the sanitation chain need to have multiple options that allow them to function under different hazards and conditions. For instance:

- At the user-interface, households in high-risk areas need access to safe, well-managed facilities at times when their own facilities are unusable. Provision of alternatives such as robust resilient public or institutional toilets (e.g. in schools), can enable people to have a back-up option if their household toilet fails due to climate events.
- For emptying of onsite systems, if only a single provider exists for delivering a particular sanitation service (e.g. emptying pits and tanks, or repairing damaged sanitation infrastructure), that service could disappear if the provider is unable to operate (e.g. if their trucks are damaged by a flood, or their access is blocked). Ensuring that multiple providers are available throughout the city will make it more likely that communities will still have a service available to them after an extreme weather event occurs.
- For treatment plants, flexible management could include decentralized systems that may not all be impacted by the one hazard, systems that are designed to cope with low and high inflows with contingency options and operators must have the required skills and climate information to adapt operations under different climatic conditions. This is linked to the below dimension on the importance of monitoring for adaptable operation of services to be resilient to varied hazards and uncertain future conditions.

A meeting program at the local level. A climate resilient sanitaiton system incorporates risk asssessments into planning and decision-making.

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5.1.2 Risk- and vulnerability- informed planning and decision-making

A climate resilient sanitation system incorporates risk assessments into planning and decision-making at local and national level. As obtaining detailed and accurate predictions of future climate change at a local scale remains challenging, the use and analysis of existing data on historical and current climate hazards are an effective starting point. Developing risk maps by overlaying information from different sources and systematically prioritising risks based on expected likelihood and consequence are common risk management approaches that need to be adopted in sanitation planning and decision-making. Current risks and future climate scenarios are combined with vulnerability assessments, that consider socio-economic and other criteria, to inform priority risk areas and the future conditions to consider in the development or upgraded of sanitation infrastructure and services. These assessments need to consider not just households and their toilet facilities, but also all stages of the sanitation chain and the life cycle, including operation, maintenance and repairs.

5.1.3 Maintaining capacity for continual adaptation through monitoring, evaluation and learning

Resilience is not a static, final state, but an evolving, responsive dynamic one. As such, adaptations continue to be required as climate change conditions and impacts evolve. Feedback loops that support learning are fundamental to continued adaptations in a resilient sanitation system. An obvious starting point is continual monitoring of weather forecasts and climate change projections by service providers and service authorities to inform sanitation management and governance decisions. For example, service providers need to be supported to monitor weather conditions and have strategies for adjusting their operations based on the conditions. In the context of a treatment facility, this could be a strategy for dealing with an expected increase in sludge or sewage inflow when heavy rainfall periods are forecasted. This is linked to the above dimensions, as adapting operation requires that flexibility in systems or services is considered in the initial investment decisions.

Depending on the hazard and ability to predict, development of early warning systems for alerting the public and service providers when extreme weather is coming help to prepare their facilities for impacts and prepare for adapting or responding afterwards. Mechanisms to communicate this information depend on the local context, community engagement is considered in the dimension below.

Evaluation of the status of current sanitation services and systems and assessment of their vulnerability to climate hazards, such as was done in this study, supports service providers and government identify how to build resilience of the existing system before hazards occur. Post-disasters, evaluation of the impacts on infrastructure should be conducted within local government systems, rather than external disaster relief efforts. This allows for clarity of short- and long-term repair plans, informs how operation or infrastructure upgrades could reduce future impacts and provides evidence to inform government's future budget or infrastructure decisions.

5.1.4 Integrated action on the whole water cycle to protect services, environment and public health

Houses and sanitation systems at the riverbank. The sanitation system has a strong relationship to the urban water cycle

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The strong inter-relationships of sanitation systems and the urban water cycle require integrated action across drainage, sanitation and water supply. Such interdependencies include potential for overflowing or leaking sanitation systems to pollute surface and ground water supply sources; overflow or waste dumped to drains and waterways that is re-suspended and spread during flooding or concentrated during dry season; and the impacts from flooding or insufficient water on the access and function of sanitation systems. These sectors are often managed independently, yet a climate resilient sanitation system achieves coordination action across the relevant ministries to ensure that cross-dependencies are noticed and planned for.

As indicated below in the infrastructure dimension, there may also be the case for effort to decouple sanitation from the wider water cycle, particularly in urban areas. For instance, dry sanitation systems may be at lower risk of resulting in widespread environmental contamination during flood events and can be used during droughts and times of water shortage. Greywater reuse for toilet flushing, low-flush toilets or demand reduction education could also be considered and build from coping mechanisms identified by the households. Social acceptance and suitability of alternatives to the local context must be considered.

A domestic wastewater treatment plant. A proper treatment plant prevents public health risks during potential hazards like floods or sea level rise.

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The risks posed to the urban water cycle from impacts of climate hazards on sanitation are considered in in environmental and public health impact assessments. For example, an environmental impact assessment of a new treatment facility considers the potential for climate change to reduce water flows in receiving water bodies reducing dilution potential or the public health risks if the system is inundated with floodwaters. Monitoring and mapping of diarrhoeal disease outbreaks, particularly during droughts or flood periods, could indicate areas where addressing the interconnection of poor drainage, sanitation or water supply are a priority. Assessments of public health risks from poor sanitation in the city not only considers the current risks that poor sanitation poses to communities, but also the potential for hazards like floods or sea level rise or drought resulting in use of secondary water sources (shallow wells, surface water) or alternative sanitation options (e.g. open defecation) to worsen those risks in the future.

5.2 Financing

5.2.1 Sustainable and responsive financing for both adaptive measures and disaster response

An officer from the Bekasi Sanitation Department, processes a payment from local resident, for emptying the septic tank at her home, for transport to the city's Domestic Wastewater Management Site.

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Advocacy for higher budget prioritisation at both local and national levels is fundamental to strengthening sanitation resilience and improving recovery after extreme climate events, not only for increasing toilet access which is often already programmed in post-disaster recovery, but also for emptying and treatment services. Sanitation itself is an under-funded sector and building towards a more climate resilient sanitation system may be even more costly to implement for initial investment. However resilient systems may have reduced operation and maintenance costs as they will be less impacted by climate hazards which, due to increasing frequency and severity, are likely to increase the operation and maintenance costs for non-resilient systems. As such, there must be stronger advocacy for resilient sanitation system needs, including in applying for climate finance and better articulate the value of the losses associated with climate-impacted sanitation services. To access climate finance (see Box 6), further efforts are needed to define sanitation vulnerability indicators and draw evidence-based links with co-benefits related to economic, livelihoods and social resilience as well as ecosystem and landscape resilience.

5.2.2 Two main types of investment are needed, in adaptive measures and for disaster response.

Household digital payment for desludging services can be means for alternative sanitation investment

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Proactive, preventive investment in appropriate infrastructure options and support for flexible management practices will serve to avoid large costs associated with damage from climate events. This is true for any part of the sanitation chain, so applies to household investments in toilet facilities and containment systems, as well as transport and treatment options. As detailed above, preventative investment to increase adaptive management could include retrofitting systems to operate in a range of climate conditions, providing warning systems and educating service providers and public how to prepare and respond to climate hazards. Attaining the right balance in weighing up uncertain climate events with making such proactive investments requires analysis of the likely scenarios and careful consideration of costs and benefits.

Disaster response funds continue to be required and are a necessary part of a resilient sanitation system. Not every climate event can be planned for and impacts avoided. As such, the need for responsive financing mechanisms to repair or rebuild damaged infrastructure are needed. Such funding must be available both at household level (either from households themselves, or through subsidized funds, particularly for low-income or disadvantaged communities) and for community-scale and city-scale infrastructure and assets. Given the differential impacts of climate change on vulnerable and disadvantaged populations, specific financing is needed to ensure their health and safety.

BOX 6 **Applying for international climate financing for sanitation**

Climate financing (funding for climate change mitigation or adaptation projects) can come from many sources including multilateral climate funds such as the Green Climate Fund (GCF), the Adaptation Fund (AF) and the Global Environment Facility (GEF). Every donor has its own criteria for what it expects from a climate resilience proposal. For example, the GCF criteria for adaptation/resilience projects include.[20]

- **Impact indicators:** The expected change in loss of lives, value of physical assets, livelihoods and/or environmental or social losses due to the impact of extreme climate-related disasters and climate change in the geographical area of the GCF intervention.
- **Necessary conditions indicator:** How the proposed project can catalyse impact beyond a one-off investment.
- **Co-benefits indicator:** An associated indicator and baseline and target values, disaggregated for men and women, that shows how the project creates economic (e.g. job creation), social (e.g. health and safety), environmental (e.g. water quality) or gender empowerment benefits in addition to adapting to climate change.
- **Barriers to climate-related finance:** The country's financial, economic, social and institutional needs and the barriers to accessing domestic (public), private and other international sources of climate-related finance.
- **Country ownership:** Alignment of the project with the country's nationally determined contributions (NDCs) and relevant national climate change policies, plans and strategies. Proposals must also outline how they were developed with relevant stakeholders- engagement with national designated authorities is required.
- **Efficiency and effectiveness:** Projects should provide an estimate of the expected economic internal rate of return and/or financial internal rate of return. Projects should describe how the proposal applies and builds on the best practices in the sector.

5.3 User and societal engagement

5.3.1 Creative, strengths-based user and societal engagement and awareness

A triggering session packed in a creative way, encouraging users to participate in order to engage and raise awareness.

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Effective communication of climate risks requires careful messaging and approaches, both to catch attention and to avoid scaring or disempowering people. Communication campaigns that support people to mobilize their own capacities and knowledge to undertake 'doable' adaptive actions are more likely to achieve influence and change than negatively framed 'doom and gloom' messages about future uncertainties. Creative approaches to communication have been effective in other sanitation behaviour change campaigns and are likely to also be effective in relation to climate resilient sanitation. Engaging users prior to disasters through regular forums or collection dialogues, as occurs for ODF campaigns, can support sanitation users sharing issues, experiences and obstacles dealing with disasters and build awareness of options and capacity to respond. Ideally, messaging is based on sound assessment of local climate risks such that it matches the local context and likely severity of climate impacts on sanitation and is presented in simple terms (e.g. less rainfall in the dry season, more rainfall in the wet season).

Targeted action to engage vulnerable groups given the increased risk and reduced capacity to respond to climate change. Different groups, including youth, women's, disability, ethnic minority groups, may require different means of communicating climate change awareness or disaster warning messages as mainstream challenges or language may not be appropriate. Engagement and awareness activities require consideration of the different needs of vulnerable groups and approaches to build their capacity and resilience to climate change. Considering their strengths and potentials, these groups could also deliver the message in improving the awareness of climate change.

5.4 Infrastructure

5.4.1 Robust or repairable infrastructure options

Toilet in Lombok with resilient slab and latrine but repairable superstructure

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A resilient sanitation system employs sanitation technologies that are robust to resist impacts of a range of climate hazards, or, in some cases, are designed to be easily rebuilt at low cost. While sanitation infrastructure is often designed to meet standards and conditions over a medium to long lifespan, due to the uncertainty of how climate change will affect these conditions, resilient systems should be robust to sustain the range of scenarios or flexible to adapt (described above). Robust systems and infrastructure, as defined by engineering resilience, are those that can endure greater stresses, bounce back after stress and are less disturbed by a given amount of stress.[15] Understanding what aspects limit sanitation use or have damaged systems during previous climate hazards can inform decisions on what parts can be robust (yet more costly upfront) or rebuildable (but may take time to repair). Easy to rebuild or repair solutions must ensure that sanitation markets remain available post disasters and financial support available for vulnerable households. They must also account for people being unable to access or use the infrastructure while it is under repair and must ensure that the infrastructure does not create health or environmental risks while it is under repair. For example, a resilient containment and toilet that doesn't discharge waste when impacted by climate hazards yet a lower cost superstructure that could be rebuilt and later upgraded with a range of locally available materials.

Making every sanitation system resilient may be neither required nor justified. It is important to assess the system vulnerabilities to identify critical elements for prioritizing, those most at risk or those with the greatest consequences to the environment and public health. A resilient sanitation system distinguishes different requirements based on topography and climate conditions, the risk mapping detailed in the above dimension could identify which assets are most likely to be affected by different hazards and the potential consequences of failure. Such mapping should also include dependent infrastructure and services such as roads or bridges that lead to treatment facilities.

Households practicing open defecation are often in the most climate prone areas. Improving sanitation in these households provides an opportunity to leap-frog directly to more climate resilient systems. Sanitation campaigns, such as open defecation free programs, can include climate resilience in awareness raising and proposed sanitation improvement options. For example, poorly constructed pits or septic tanks may be more likely to leak or overflow during floods and to dry out during the dry season (making them harder to empty). Regularly emptied septic tanks and those with proper infiltration systems, rather than discharging to drains, are less likely to have function issues during

Wastewater is treated by workers at the Domestic Wastewater Management Site of the City of Bekasi (TPST).

heavy rainfall. New technologies, like prefabricated plastic septic tanks, may be more resilient to climate extremes and need to be incorporated into markets and mainstream choices. Improvements to one part of the service chain must consider the flow-on implications and service upgrade needs, for example the prefabricated tanks demand more frequent emptying than larger, often unsealed systems.

6

STEPS TOWARDS CLIMATE RESILIENT SANITATION IN INDONESIA

Workers build a sewage system in Candimulyo village, Central Java province, Indonesia.

Having laid out what a 'resilient sanitation system' might look like, this section focuses on incremental, feasible steps at local and national level in Indonesia towards achievement of that state. The actions described at local level were developed by local government staff as part of the research process, following their own assessment of the highest-priority impacts and risks in their local context. The actions proposed at national level are key recommendations arising from this research. Overall, three key priorities are:

- Development of a policy framework to support climate resilient sanitation services including clarification of institutional responsibilities, strengthened coordination across the urban water cycle and provision of capacity building on climate resilience for local governments
- Approaches to identify locations at-risk from climate hazards both nationally and at local scale, integration of these into existing sanitation planning processes and on this basis, development of responsive financing frameworks for adaptation actions and disaster response.
- Increased user-awareness of climate change building on existing coping mechanisms and ensuring access to support for those most vulnerable.

6.1 Local government actions

In each of the four cities, government participants identified actions that their agencies could take to address the climate-related issues affecting sanitation in their city. The table below is a compilation of ideas generated across the four cities that has been mapped to the areas of focus for climate resilient sanitation described in the previous section. In addition, further suggestions have been added based on this research process.

Table 6 Local government workshop participant suggestions for strengthening climate resilient sanitation in their city with additional suggestions based on findings of this research process

ST = Short-term, MT = Medium-term, LT = Long-term

INSTITUTIONS, GOVERNANCE AND SERVICES

Clear institutional responsibilities and flexible management and service delivery arrangements

- Plan for scheduled desludging at the beginning of the wet season [Lombok Timur and Bekasi] (ST)
- Greater coordination between central, regional, provincial, NGO and other organizations working in sanitation and/or climate change (MT)
- Arrange for installation and management of large public toilets with large reservoir tanks [Lombok Timur] (MT)

Additional suggestions from research team:

- Include climate-relevant stakeholders in sanitation working groups and encourage sanitation actors to engage with cross-cutting sectors (e.g., emergency response, water resources, flood management) (ST)
- Clarify responsibilities between sanitation service delivery authorities versus disaster response authorities when it comes to preparing for and responding to climate impacts on sanitation (ST)
- Request training from national level to build capacity of local government sanitation stakeholders on climate change impacts and possible response options (ST)
- Establish regional climate working groups as a centre for climate knowledge, data and support. Ensure their scope includes sanitation and its interlinkages with other sectors (MT)
- Ensure there are climate resilient/robust communal facilities (e.g. MCK, schools, public places) for the public to access if their household toilets fail due to climate hazards and a management plan for how these facilities would be managed if a large number of people are using them (MT)

Risk- and vulnerability- informed planning and decision-making

- Consider climate risk in ongoing review of current SSK by Pokja Sanitasi [Bekasi] (ST)
- Increased sharing and access to data between agencies that can inform risk and vulnerability assessments (ST)
- Inclusion of sanitation in Local Provincial Action Plans for Climate Change Adaptation (RAD-API) which will then be integrated into the RPJMN [Lombok Timur and Makassar] (ST)
- When mobilizing resources to repair homes damaged from climate events, consider sanitation facilities as well as the dwelling itself [Makassar] (ST)
- Update city sanitation strategy for disasters, considering also including climate change [Palu] (MT)
- Explore the feasibility of having a functioning toilet in each household in slums [Makassar] (MT)

- Restrict building and sanitation construction in areas prone to high sea levels [Palu] (MT)
- Adapt building permits to require that that buildings and sanitation facilities are raised above average flood levels [Makassar] (MT)

Additional suggestions from research team:

- Identify any existing datasets/information (and/or new data requirements) to better understand likely climate hazards (rainfall, flood or drought risk areas, sea-level rise and encroachment) and possible hazards in given city (ST)
- Map at-risk sanitation infrastructure exposed to climate hazards and integrate assessments of climate vulnerability and sanitation risks into all city sanitation strategies (SSK) (MT)[h]
- If there is a regional action plan for climate change, integrate sanitation into climate action priorities (MT)
- Identify priority areas that are at high risk from climate hazards for improving sanitation infrastructure and services (MT)

Maintaining capacity for continual adaptation through monitoring evaluation and learning

- Coordinate with Environmental Agency / KLHK for desludging if there are reports of overflowing [Lombok Timur] (ST)

Additional suggestions from research team:

- Strengthen knowledge, awareness and capacity for climate resilient sanitation systems with support of national authorities (ST)
- Support service providers to monitor weather conditions so they can prepare their services accordingly (ST)
- Monitor incidences of diarrhoea and the practice of open defecation following extreme weather events (ST)
- Conduct periodic reviews of sanitation infrastructure (e.g. IPALDs, public toilet facilities) to learn how they are affected by climate hazards (MT)
- Develop a database of on-site sanitation facilities to identify priority on-site improvement in high-risk locations and facilitate pro-active or preventative emptying (MT)
- Evaluate the effectiveness and cost efficiency of new interventions to strengthen climate resilience in the sanitation sector (LT)

Integrated action on the whole water cycle to protect services, environment and public health

- Develop new water sources, for example boreholes, so that water supply for sanitation is sufficient [Makassar and Lombok Timur] (MT)
- Provision large water tanks for sanitation use in each region [Makassar and Lombok Timur] (MT)
- Sanitation/STBM teams carry out more specific triggers related to sanitation and climate change [Lombok Timur] (MT)
- Dredge rivers periodically to prevent them from overflowing [Bekasi] (MT)
- Plant trees to promote groundwater recharge [Makassar] (MT)

Additional suggestions from research team:

- Promote emptying services to households to prevent overflow or practices of washout during flood (ST)
- Consider climate risks (e.g. reduced flows of water bodies receiving treated wastewater) when carrying out environmental impact assessments for new sanitation infrastructure (MT)
- Carry out Sanitation Safety Planning risk assessments in areas facing existing climate hazards or at increased vulnerability to climate hazards or sanitation exposure to minimize the risk posed to public health from climate hazards (MT)
- Regular water quality monitoring of water supplies and recreational water bodies during high and low rainfall periods to identify critical sanitation/water interaction and assess the influence of climate on treatment and disposal services (LT)

[h] There are not yet specific tools or guidelines to support sanitation and climate risk mapping however the following documents could support this: Sanitation Safety Planning (WHO 2015), Climate Sanitation and Health (WHO 2019); A Guide for Assessing Climate Change Risk (Urban Land Institute, 2015); Assessing Physical (Asset) Resilience (ADB Sanitation Dialogue 2021) on the use of GIS to map risks

FINANCING

Sustainable and responsive financing for both preventive measures and disaster response
Encourage collaborative programs and funding between villages to provinces [Lombok Timur].

Additional suggestions from research team:

- Request clarifications to the national on-site sanitation grant program as it is perceived to exclude households without piped water supply (an issue for drought prone areas in Lombok that rely on non-piped supplies) or households without an existing toilet (misses the most vulnerable).
- Incorporate funding required for recovery from extreme weather into annual budgets. (ST)
- Consider the existing sources (e.g. DAK, BOK, ZAKAT) and additional funding needs to prepare for and respond to climate impacts and ensure it is available to vulnerable populations most exposed to climate change (ST)
- Identify whether slum upgrade funding (Kotaku) or PU grants can support climate resilient sanitation in vulnerable or low-income areas. (ST)
- Consider options to mobilize households' willingness to invest in climate resilient sanitation (MT)
- Consider higher operation and maintenance financial needs in system design, sizing and business models. (MT)
- Advocate for increased funding for climate resilient sanitation in regional mid-term development planning. (MT)
- Development of a disaster preparedness plan that can inform proactive investment in resilience. (MT)

USER AND SOCIETAL ENGAGEMENT

Creative, strengths-based user and societal engagement and awareness

- Provide information to people about the threat of disease and epidemics – and how sanitation and climate interacts with these threats [Makassar]. (ST)
- Encourage community members to use water that is not suitable for consumption (e.g. water from shallow wells) for flushing toilets [Makassar]. (ST)
- Socialize the numbers for contacting desludging services [Bekasi, Palu, also applicable other cities]. (ST)
- Socialize the construction of quality and resilient septic tanks [Palu, Bekasi, also applicable other cities]. (MT)
- Encourage communities to continue to prepare water storage tanks to accommodate water distributed by the local government [Makassar]. (MT)

Additional suggestions from research team:

- Alert the public about incoming extreme weather through locally suitable communication channels, paying attention to reach vulnerable or marginal groups (ST)
- Engage and collaborate with local community or societal groups (women's, disability, religious, youth groups, etc.) to identify specific risks faced by their communities and mechanisms for engaging them in climate change awareness raising and support activities (ST).
- Conduct formative research to determine the barriers and potential solutions to better household preparation for climate impacts on sanitation (MT)
- Incentivize households to build and maintain a proper septic tank (e.g. through rebates) and emptying their tanks (particularly prior to wet season) to increase resilience and reduce impacts from climate hazards (MT)
- Improve climate change literacy of the public by raising awareness on climate change impacts and their implications for sanitation using language and examples suitable to the local context (MT)
- Include climate change awareness into programs and training of sanitarians and ODF facilitators (MT).

INFRASTRUCTURE

Robust or repairable sanitation infrastructure options

- Make technical information on climate resilient sanitation options available, including pilots of examples. (ST)
- Rehabilitate or build new faecal sludge treatment plant, lack of which is limiting other sanitation improvements [Lombok Timur]. (ST)
- Add pumps in flood-prone areas to remove floodwater [Bekasi]. (ST)
- Provide portable emergency toilets in flooded areas [Makassar, Palu and Bekasi]. (ST)
- Arrange a 'Certificate of Acceptability of Function' to certify that certain sanitation technologies (e.g. IPALD) are working properly [Makassar]. (MT)
- Promote raised toilets and septic tanks in area prone to flooding from heavy rainfall or high sea levels [Makassar, Lombok Timur and Palu] (MT)
- Promote construction of watertight septic tanks and enforce standards for construction [Makassar, Lombok Timur and Palu]. (MT)

Additional suggestions from research team:

- Ensure existing ODF/STBM campaigns focus on improvement options are climate resilient. This is particularly important as the hardest to reach are often in areas most exposed to climate risk (ST)
- Support sanitation service providers, such as emptying providers or treatment plant operators, to develop operational plans for extremely wet and extremely dry conditions (ST)
- Engagement with private sector or local research institutes to identify options for sanitation that consider local climate hazards in their design or construction, such as stronger super-structure for coastal facilities affected by high winds or prefabricated septic tanks in flood prone areas. Include these in ODF/STBM materials (ST)
- Investigate options for new technologies for on-site sanitation, such as prefabricated tanks for flood prone areas, low-flush toilets, greywater reuse in toilets, non-return valves on flood prone septic tanks or communal treatment systems to prevent inundation and overflow (MT)
- Put in place mechanisms to endorse sanitation projects based on climate resilience criteria (MT)
- Review whether the 'building permit' (IMB) includes adequate requirements that septic tanks are climate resilient, for example considering height relative to floodwater and sea level. At the same time increasing enforcement of standard septic tank construction and monitoring existing tanks for compliance (sealed lids, not discharging to drains, regular emptying) (MT)

BOX 7 Green Climate Fund's (GCF) consideration of sanitation in water security projects proposals

Many of the actions proposed in Table 6 to increase climate resilient sanitation are included in the GCF's recent guidance for proposals for water security projects.[23] Water security encompasses the sectors of: Integrated water resources management; **Climate resilient WASH;** Integrated drought management; and Integrated flood management. The following interventions could form part of a Simplified Approval Process (SAP) proposal in the water sector, including our assessment of which example activities included in the document could relate to sanitation. This list is not exhaustive, see the document for further details. These actions and potential for finance further highlight the importance of considering the integrated management of sanitation, water and drainage.

Table 7 GCF guidance of sample activities and indicators for water security project proposals (GCF 2020)

Sub-sector	Sample activity and sample indicators
Climate resilient water supply, sanitation and hygiene	Sanitation specific • Climate-proofing water supply and sanitation infrastructure. Indicators: Number of water supply and sanitation structures that include climate considerations in their (re)design; Reduction in incidence of water-borne diseases Sanitation related • Water use efficiency in households, public and commercial buildings (No- or low-flush toilets, low flow showerheads). Indicators: Volume and value of water saved by reducing wastage. • Construction or rehabilitation of rainwater harvesting and storage systems. Indicators: Extent of improvement in existing rainwater harvesting system, Number of additional (new) rainwater harvesting and storage systems for communities • Communal hand pumps or motorized boreholes. Indicators: Number of hand pumps or motorized boreholes constructed, Percentage increase in availability of water for vulnerable communities
Integrated water resources management	Sanitation related • Water resources monitoring and information systems. Indicator: Level of understanding of climate responsive water policies and plans and the related stakeholder perceptions • Water policy review, IWRM planning or incorporation of climate change adaptation into existing IWRM plans. Indicator: Extent of application of water resources information in water infrastructure operation and disaster management

Sub-sector	Sample activity and sample indicators
Integrated flood management	Sanitation specific • Flood-proofing household water and sanitation structures (e.g. wells, latrines). Indicators: number of sanitary latrines with climate-proof designs, meeting relevant standards Sanitation related • Clearing of blocked waterways to prevent flooding (removal of invasive plant species and excess silt). Indicator: Length of waterways cleared to prevent flooding • Flood hazard mapping, zoning and land development restrictions. Indicator: Reduction of population, livelihood activities or infrastructure constructed in floodplains
Integrated drought management	Sanitation related • Greywater recycling at household level. Indicator: Percentage reduction in demand for water from the water supply system

Note: Not included as sample activities due to potentially averse environmental and/or social risks are urban wastewater treatment works, structural barriers to flooding (earthen barriers accepted) and upgrades to urban drainage and waterways.

'Paradigm shift potential' is a criterion against which every GCF funding proposal is assessed to ensure the impact beyond a one-off project investment, through replicability and scalability, to bring about systemic change. The approach ensures water security by enabling the water supply and (waste)water treatment cycle to withstand multiple climatic threats or adapt to various climate scenarios. Additionally, this approach ensures multiple benefits to society and ecosystems, such as disease reduction related to water-borne vectors, prevention of economic losses, conservation of aquifers, amongst others.

Capitalising on the **mitigation as well as adaption potential** of every project is another important paradigm shift. To do this it will be important to consider the contribution a climate resilient sanitation system might make to mitigation. Emerging evidence on onsite systems suggests that emissions from containment and treatment systems may be the dominant source of greenhouse gas (GHG) emissions from sanitation and as such, extended anaerobic conditions are to be avoided. Actions central to climate resilient sanitation services such as proactive management (e.g. timely, regular desludging) therefore can contribute both to resilience as well as to mitigation. A further connection to mitigation is flooding leading to inundation, which is problematic both for mitigation since it may increase methane production due to anaerobic conditions In addition, for sewerage systems, actions can be taken to support energy efficiency (e.g. using more energy efficient pumps) and methane capture and energy generation at wastewater treatment plants. Where such efforts also reduce costs, they also represent win-win solutions for both climate resilience and mitigation. Through these pathways, there is possibility for **climate resilient sanitation to contribute to NDC's,** however quantification of such contributions is yet to be undertaken and further scientific research to clarify emissions from on-site systems is needed.

6.2 National level recommendations

With diverse and existing climate hazards and predictions of Increasing frequency, severity and variability due to climate change, Indonesia provides a valuable case study for assessing the climate impacts on sanitation.

The assessment of how key climate hazards have impacted sanitation for households, service provision and institutions justify immediate action. Restricted sanitation access causing household to revert to open defecation and the health risks of untreated faecal waste released to the environment across the sanitation service chain are a concern for all sectors.

Sanitation was typically absent from climate change programs and policies and most government agencies were unaware of the potential impacts of climate hazards on sanitation. Climate policies should include sanitation as a priority sector given:

1. All climate hazards cause frequent difficulty for households to access sanitation, a basic human right
2. Damaged or malfunctioning sanitation systems discharge pathogens into the living environment - creating an environmental and public health hazard and into groundwater- contaminating an increasingly precious water resource

Eliminating open defecation and achieving safely managed sanitation are local government priorities, driven by national and global targets. Government staff initially perceived climate change as additional or future consideration that they currently did not have capacity or finance to prioritize while focusing on the ODF objective. Given the evidence that households are reverting to OD due to climate hazards and that the "last mile" households are often located in challenging environments most prone to climate hazards, the ODF campaign must integrate climate resilient sanitation communication and options. Similarly, it is evident that many sanitation services are not coping with current climate hazards and if new systems are to be sustainable and available during increasing climate events, consideration of climate risks is needed in their planning, design and finance.

Other countries have started to take steps forward on such issues. There are examples in Bangladesh of cyclone resistant toilets in schools provided as a backup when communities lose access to their household toilet facilities.[20] In Lusaka detailed mapping of flooding and sanitation infrastructure provides a basis to decide on priority areas for upgrading and emptying.[21]

For Indonesia to take such concrete steps forward as are being undertaken elsewhere, Indonesia must create an enabling institutional environment that mainstreams and integrates climate change into the activities of relevant ministries. The following recommendations present options for how climate impacts and climate resilient sanitation can be integrated into programs and policies. Government is the primary duty bearer for ensuring sanitation services are provided under climate change and therefore are the focus of the recommendations below. However, non-government actors that comprise not-for-profit organizations, research institutions and private sector also all have valuable roles to support their implementation.

Table 8 Recommendations for national level actors to develop climate resilient sanitation systems [i]

INSTITUTIONS, GOVERNANCE AND SERVICES

Clear institutional responsibilities and flexible management and service delivery arrangements

- Ministry of Environment (KLHK) to include sanitation more explicitly in the National Action Plan (NAP) and national guidelines, identifying sanitation's linkages to economic resilience, livelihoods and social resilience and ecosystem and landscape resilience, given sanitation's importance to NAP action areas of public health, settlement, infrastructure and urban areas (ST)
- KLHK, PU and Kemenkes to provide guidance on the integration of sanitation into Regional Action Plans (RAPs) (ST)
- MOHA and Bappenas to clarify and communicate the central role of Pokja sanitasi to address climate resilience in sanitation, with support from Pokja Iklim to ensure information on climate prediction and risks are addressed appropriately (ST)
- Bappenas to increase coordination in PPAS (Housing, Settlement, Water and Sanitation working group) on climate change and sanitation, including bringing together additional stakeholders relevant to climate change and disasters (BNPB, BMKG etc.) (ST)
- KLHK to explicitly include household sanitation in the Climate Village program, in addition to wastewater management (which is already covered as a mitigation activity) (ST)
- Identify regional champions to support horizontal learning (ST)
- Bappenas, Kemenkes and PU to develop training materials to build local government capacity on climate resilience sanitation services, focused on planning, STBM and infrastructure aspects respectively (MT)
- Ensuring the principle of inclusivity in guidelines for sanitation and climate planning, financing and implementation (MT)
- PU team for climate change to promote a coordinated approach to urban water cycle management that supports climate response – across water supply, sanitation and drainage (MT)

Risk- and vulnerability- informed planning and decision-making

- Kemenkes to develop and socialize new health regulations on adaptation to climate change (under development) and technical guidance on the health sector's role in the NAP/RAN-API 2020-2030 including in relation to climate adaptation actions in sanitation/ STBM (ST)
- Kemenkes to provide guidance on how ODF roadmaps can integrate climate risk assessment and provide examples of resilient sanitation options. Climate resilience could be included as an STBM-related criterion for Kabupaten/Kota Sehat (ST)
- Ministry of Public Works and Housing (PU) to develop a protocol to assess climate risks when prioritising locations and designs for new or upgraded major infrastructure[j] (ST)
- Develop national level and sub-national mapping of locations at risk of climate hazards (ST)
- KLHK to set and develop a roadmap for the Waste Management sector target in the Nationally Determined Contribution (NDC) that promotes improved sanitation, resource re-use and energy production (MT)
- Bappenas to develop Guidance to integrate climate resilience into City Sanitation Plans (SSK), with BPBD and KLHK supporting development of methods to map risks and identify priority areas due to climate hazards and sanitation conditions.[k] (MT)
- Bappenas to integrate climate resilience into the roadmap for safely managed sanitation, e.g. SDG6.2 plans and operationalisation of the mid-term development plan (RPJMN) (MT)
- KLHK to coordinate with Kemenkes and PU to define a suitable 'sanitation vulnerability indicator' to be used to identify priority locations where there is vulnerability of sanitation systems (based on water, sea-level rise, elevation, socio-economic characteristics etc.) and a 'minimum standard for sanitation resilience' (MT)

[i] Indonesian Ministries: Ministry of Planning (Bappenas), Ministry of Home Affairs (MOHA), Ministry of Public Works and Public Housing (PU), Ministry of Health (Kemenkes), Ministry of Environment and Forestry (KLHK), Indonesian National Board for Disaster Management (BNPB), Meteorology, Climatology, and Geophysical Agency (BMKG).

[j] For example, building from existing resources: World Bank's Confronting Climate Uncertainty in Water Resources Planning and Project Design The Decision Tree Framework (2015) https://openknowledge.worldbank.org/handle/10986/22544actions

Maintaining capacity for continual adaptation through monitoring evaluation and learning

- Bappenas to develop standardized approach to support cities to undertake rapid assessment sanitation as similar to that conducted in this research project (household surveys, identification of areas vulnerable to climate hazards, engagement with service providers), as an input to SSK (MT)
- Kemenkes to combine data related to diseases and climate change (including diarrhoea) in a common portal, including data from different sources (BNPB) and analyse this data to identify priority locations for interventions (MT)
- Develop monitoring and evaluation criteria to assess climate resilience of sanitation within existing monitoring systems, such as EHRA and STBM monitoring (MT)
- Develop capacity building modules and training of Local Government service providers on climate resilient sanitation services (MT)
- MoE to monitor status and progress on climate resilience against sanitation vulnerability indicators (detailed above) (LT)

Integrated action on the whole water cycle to protect services, environment and public health

- PU and Bappenas to support strengthened coordination of different parts of the total urban water cycle, such that planning and investments in water supply, onsite, communal-scale and offsite wastewater management and sludge treatment and related interlinkages, including under climate change scenarios, are given attention (MT)
- PU provide guidance on household water reuse options, particularly for drought prone areas. Including guidance on all aspects of implementation: awareness raising and acceptance, range of technical options, risk mitigation and financing (MT)

FINANCING

Sustainable and responsive financing for both preventive measures and disaster response

- Bappenas, MoE and MOF to coordinate further discussions on the use of existing finance (BOK, Village Fund, ZAKAT, APBN, KPBU) and accessing external finance (e.g. Foreign grants, Multi-lateral and bilateral cooperation, GCF, Private sector) for building climate resilience of sanitation (ST)
- PU to review readiness criteria for sanitation grants to ensure accessibility to vulnerable households facing climate risks (e.g. in areas unsuitable for piped water supply) without compromising the long-term benefit of the output. Such grants should integrate co-financing by non-poor households in high-risk areas to upgrade to resilient sanitation systems (ST)
- Provide additional financial support for climate resilient interventions in locations at risk of climate hazards (ST)
- PU and MoF to provide guidance on estimating operation and finance budgets for predicted increased damage and cost of adaptions required to address climate change impacts on sanitation, as well as how this is related to changes in service tariffs (MT)
- PU to increase flexibility in sanitation grant programs so LGs have more flexibility to respond to climate change and provide guidance to LG on relevant investment options to improve resilience (MT)
- MoF to coordinate with KLHK and BMKG to develop climate finance proposals for selected priority locations with evidence of extreme vulnerability to climate impacts on sanitation (based on robust risk analysis) and proposed adaptation solutions (LT)

[k] There are not yet specific tools or guidelines to support sanitation and climate risk mapping however the following documents could support this: Sanitation Safety Planning (WHO 2015), Climate Sanitation and Health (WHO 2019); A Guide for Assessing Climate Change Risk (Urban Land Institute, 2015); Assessing Physical (Asset) Resilience (ADB Sanitation Dialogue 2021) on the use of GIS to map risks.

USER AND SOCIETAL ENGAGEMENT

Creative, strengths-based user engagement and awareness

- Kemenkes to integrate climate resilience into ODF campaign- recognising the last mile ODF likely to be households most at risk from climate and target existing cash transfer village sanitation grants to priority locations vulnerable to climate change (ST)
- Kemenkes to ensure language in communication materials about climate change is understandable to the public with adaptions to local contexts or languages (ST)
- Kemenkes to monitor diarrhoea and OD practices after climate risks (e.g. flooding) to make visible the health impacts of climate change on sanitation (MT)
- Kemenkes to socialize updated STBM materials, guidance and training on health risks and responses for climate change with local governments (MT)
- Targeted engagement and collaboration with ministries responsible for different societal groups to identify specific risks faced by their communities and mechanisms for engaging them in climate change awareness raising and support activities Groups include disability, women's, children (with the Ministry of Women Empowerment and Child Protection), religious, youth groups (with the Indonesian Ministry of Youth & Sports), etc. (ST)

INFRASTRUCTURE

Robust or repairable sanitation infrastructure options

- PU to develop guidance or standards for climate resilient sanitation technologies robust for a range of climate hazards, particularly household toilets and containment systems, public/communal/institution toilets and (faecal sludge) treatment plants (ST)
- PU to explore climate resilient technology options suitable for people with disabilities or elderly (e.g. raised toilet for flooding pose accessibility challenges) (ST)
- Make special funding available to enable existing facilities in locals at risk of climate hazards to be climate resilient (ST)
- PU to engage with private sector, academia and research institutions to stimulate innovations and the market for climate resilient sanitation systems and services, including the pilots of options to suit the different conditions across Indonesia (MT)
- PU to develop more flexible IPLT designs to deal with different climate conditions (high demand/wet conditions, low demand/dry conditions) (MT)
- PU to develop and socialize standard operating procedures (SOPs) that support flexible, appropriate operation of existing IPTL/IPALD etc. during different weather conditions and events (MT)

6.3 Implications for global level actors

Indonesia is a country that already experiences significant climate hazards and impacts on sanitation and hence provides important learning ground for how the broader global sanitation sector tackles climate change. This research demonstrates the importance of integrating climate change into sanitation planning, programs and policies. Some key areas for sectoral action include the following:

Continue to evolve urban sanitation policy and service delivery frameworks to define key characteristics of a climate resilient sanitation system covering institutional, operational, technical, financial, social and environmental aspects. The framework provided in this report provides a starting point for such efforts.

Develop strengthened sanitation vulnerability indicators that can be used to justify investment in sanitation as part of wider climate adaptation efforts and to track progress in addressing vulnerabilities.

Develop common methods for risk and vulnerability assessments, prioritisation and options for sanitation investment projects, from household level through to city and national government investments

Develop, pilot and evaluate climate resilient sanitation infrastructure and service options for all steps of service chain, including the methods to encourage uptake, market development and financing

Provide training to support government to identify and access external finance for climate and sanitation. Raise awareness of available funding, support preparation of proposals and other processes for accessing finance

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A boy washes his face in front of his home. Access to safe sanitation even in times of climate harzards is vital to health, child development and social and economic progress.

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A raised communal sanitation system by the sea. Designed to withstand sea level rise.

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