



**Climate adaptation in water,
sanitation and hygiene
(WASH) in humanitarian
crises: research and
innovation priorities**

elrha

Acknowledgements

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Foreword

By Shirin Maani (Head of the Humanitarian Innovation Fund)
and Kai Hopkins (Head of Research Initiatives)

The impact of climate change on water, sanitation and hygiene (WASH) responses in humanitarian crises is becoming increasingly evident, with rising global temperatures and unpredictable weather patterns presenting urgent challenges to the sector.

The escalating frequency of extreme weather events, droughts and floods is placing unprecedented strain on already vulnerable WASH services in crisis-affected regions. As humanitarian actors face these mounting challenges, the need for innovative, inclusive, evidence-informed and climate-adaptive solutions has never been stronger.

This report presents findings from an extensive global consultation that identifies critical research and innovation opportunities to strengthen humanitarian WASH systems against climate challenges. It draws on comprehensive literature reviews, insights from leading WASH practitioners worldwide and data from nine crisis-affected countries to pinpoint 11 actionable priorities.

These priorities focus on improving water security, strengthening sanitation infrastructure and enhancing public health responses in crisis-affected regions, where the consequences of climate change are felt most acutely.

Our findings reveal an urgent need for climate-resilient WASH solutions that both tackle immediate vulnerabilities and build community resilience against future climate shocks. Building on our previous [WASH gap analysis](#) and [WASH research agenda](#) reports, this study provides an important contribution to the broader climate adaptation conversation.

By highlighting the critical intersection between WASH, climate change and public health, we offer a clear agenda for research, collaboration and innovation.

The 11 priorities outlined here provide a comprehensive, evidence-based framework to guide the sector's response, ensuring that humanitarian WASH efforts are equipped to meet the demands of a rapidly changing climate while continuing to serve those most in need.

We urge researchers, innovators, practitioners and funders in the humanitarian WASH space to engage with these priorities and identify how they can contribute – because the climate crisis cannot wait.

Contents

Executive Summary 5

Introduction 14

Methodology 20

Literature review.....	21
Steering group consultation.....	23
Focus group discussions.....	24
Key informant interviews.....	25
Global survey	26
Steering Group prioritisation exercise	29
Constraints and limitations	30

Recommendations 32

Recommendations for research and innovation.....	34
1. Develop pragmatic, scalable solutions that conserve and reuse water in water-scarce regions.....	35
2. Map the pathways through which climate change disrupts WASH access for people affected by humanitarian crises	36
3. Identify the specific factors that motivate communities to embrace and sustain climate adaptation practices.....	38
4. Improve connections between disease surveillance, early warning systems and humanitarian WASH response	39

5. Identify and trial WASH management approaches that remain effective in resource-constrained, climate-affected environments.....	41
6. Understand and support community water use and coping strategies during extreme climate events such as drought and flood.....	43
7. Harness and integrate indigenous and local knowledge within humanitarian WASH programming.....	45
8. Evaluate the performance of existing WASH approaches in preventing infectious disease transmission in the context of climate change	46
9. Evaluate local hygiene practices, challenges and motivations in changing climate conditions and understand the factors leading to behaviour change.	48
10. Create simplified, low-cost watershed mapping tools and approaches tailored for humanitarian contexts	49
11. Develop low-cost desalination technologies that work at both household and community levels	51

Conclusion 55

Annexes	56
Annex 1 – Steering Group members	58
Annex 2 – Key informants	59
Annex 3 – Focus group discussion – facilitation guide	60
Annex 4 – Global survey questionnaire	72
Annex 5 – Global survey results.....	80
Annex 6 – References	82

Diagrams and figures

Figure 1: The funnel approach used to prioritise the research and innovation opportunities for climate adapting humanitarian WASH response	20
Figure 2: Percentage of respondents from the global survey in each focus area, disaggregated by country, regional and headquarter-level	26
Figure 3: Geographic focus of respondents from the global survey level.....	27

Acronyms

AI	Artificial Intelligence
CAR	Central African Republic
DRC	Democratic Republic of Congo
EU	European Union
FGDs	Focus group discussions
IFRC	International Federation of Red Cross/Crescent Societies
IMC	International Medical Corps
IPCC	Intergovernmental Panel on Climate Change
IRC	International Rescue Committee
IWRM	Integrated Water Resources Management
KII	Key informant interviews
LICs	Low-income countries
MENA	Middle East and North Africa
MSF	Médecins Sans Frontières
OXFAM	Oxford Committee for Famine Relief
ToR	Terms of Reference
USAID	United States Agency for International Development
WASH	Water, sanitation and hygiene
WHO	World Health Organization



Every drop of clean water counts.
© Amritanshu Sikdar/Unsplash



Executive Summary

Executive Summary

The climate crisis presents an urgent and expanding threat to humanitarian water, sanitation and hygiene (WASH) operations worldwide.

An estimated 3.6 billion people now live in areas highly vulnerable to climate impacts (IPCC 2023), with humanitarian contexts facing disproportionate risks. Humanitarian operations must prepare for both the direct consequences of climate change, such as increasingly severe flooding, storms, heatwaves and droughts, and the cascading secondary effects, including population displacement, food insecurity and conflict.

Water security stands at the forefront of these challenges. Half of the world's population already experience severe water scarcity for at least part of the year (IPCC 2023). Climate change will exacerbate this situation while simultaneously threatening water quality and creating significant public health risks for crisis-affected populations.

Climate change is fundamentally transforming the humanitarian WASH landscape through six key areas: diminishing water availability due to erratic rainfall and environmental degradation; compromising domestic water infrastructure through extreme weather events; degrading water quality with increased contamination and reduced natural purification; destroying sanitation systems through flooding and displacement pressures; accelerating disease propagation through warm, wet conditions; and disrupting essential hygiene behaviours, particularly among vulnerable populations. These interconnected challenges demand urgent, innovative responses as they compound existing humanitarian crises and threaten the health and dignity of millions worldwide.

Recognising that effective, focused research and innovation are essential to address these complex challenges, Elrha commissioned this study to identify specific opportunity areas where focused investment could transform humanitarian WASH response. We systematically identified the most pressing gaps in current practice.

This report presents our findings: 11 priority research and innovation opportunities that can significantly strengthen climate resilience in humanitarian WASH systems. These priorities, ranging from water recycling technologies to indigenous knowledge integration, provide clear direction for strategic investment and action.

By addressing these specific gaps, the sector can develop more effective research and innovation efforts to protect vulnerable populations from the escalating impacts of climate change on essential WASH services.



Overview of methodology

The study integrated multiple data streams to systematically identify and prioritise key research and innovation areas. These data sources contributed uniquely to refining the research preliminary focus areas:

Literature review: A structured rapid literature review of 80 documents was conducted to identify key climate change-related challenges faced by the humanitarian WASH sector for further research.

Focus group discussions: Face-to-face focus group discussions (FGDs) were held in Burkina Faso, Central African Republic (CAR), Democratic Republic of Congo (DRC), Kenya, Lebanon, Nepal, Somalia, South Sudan and Yemen. These engaged 310 WASH practitioners from 250 different agencies, including government representatives in several countries. Additional workshops included WASH Masters students at Cranfield University, UK, Oxfam teams covering the Middle East and North Africa (MENA) region, and Oxfam's global humanitarian WASH staff, bringing the total to 16 FGDs. Participants identified specific WASH challenges from climate change, current initiatives addressing these issues, and evidence gaps that research and innovation could address. This qualitative groundwork revealed the everyday operational and climatic obstacles in humanitarian WASH response.

Key informant interviews: Key informant interviews with 23 global WASH experts, academics and climate adaptation practitioners validated and expanded on the findings from the FGDs. The informants, leveraging their global WASH expertise and knowledge, offered an informed perspective on the evidence gaps highlighted by the FGDs, as well as additional areas where research and innovation could play a role. These interviews confirmed the importance of the identified challenges and provided expert recommendations for prioritising these based on what they perceived were critical evidence gaps and where research and innovation could have the greatest impact.

Global survey: A global survey was distributed through the Global WASH Cluster and other channels to prioritise the list of identified research and innovation topics from the focus groups and key informant interviews. There were 181 respondents to the survey, consisting primarily of WASH practitioners at country and regional levels, with the highest response rate from African regions. Participants were asked to rank and prioritise the list of research and innovation topics based on their field experiences and expertise. This data facilitated the narrowing of the longlist into a concise set of 11 prioritised research and innovation opportunities based on perceived urgency, the availability of existing initiatives and potential impact.

Expert Validation: Through a process combining input from focus group discussions, key informant interviews, and the global survey, 11 actionable research and innovation priorities were developed. Four meetings with the Steering Group (Annex 1) and three with the Global WASH Cluster Technical Working Group validated and prioritised these findings at each stage.

Priority climate adaptation research and innovation opportunities for humanitarian WASH

Our study reveals 11 critical areas where immediate research and innovation can strengthen humanitarian WASH response to climate change. These priorities reflect the experiences and realities of hundreds of practitioners across crisis contexts worldwide.



1.

Develop pragmatic, scalable solutions that conserve and reuse water in water-scarce regions.



2.

Map the pathways through which climate change disrupts WASH access for people affected by humanitarian crises.



3.

Identify the specific factors that motivate communities to embrace and sustain climate-adaptation practices.



4.

Improve connections between disease surveillance, early warning systems and WASH response.



5.

Identify and trial WASH management approaches that remain effective in resource-constrained, climate-affected environments.



6. Understand and support community water use and coping strategies during extreme climate events such as drought and flood.



7. Harness and integrate indigenous and local knowledge within humanitarian WASH programming.



8. Evaluate the performance of existing WASH approaches in preventing infectious disease transmission in the context of climate change.



9. Evaluate local hygiene practices, challenges and motivations in changing climate conditions and understand the factors leading to behaviour change.



10. Create simplified, low-cost watershed mapping tools and approaches tailored for humanitarian contexts.



11. Develop low-cost desalination technologies that work at both household and community levels.

These priorities address two fundamental needs: strengthening existing WASH interventions against climate impacts and developing new approaches for emerging challenges. We call on all stakeholders to use this framework to drive research and innovation that ensures humanitarian WASH response remains effective in our rapidly changing climate.

These priority research and innovation areas put the needs and problems of the sector at the centre and can help to ensure that humanitarian WASH response is fit-for-purpose, better able to tackle the effects of climate change and continues to reach people affected by crises.



Children at a public borehole fetching water for their families.
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Introduction

Introduction

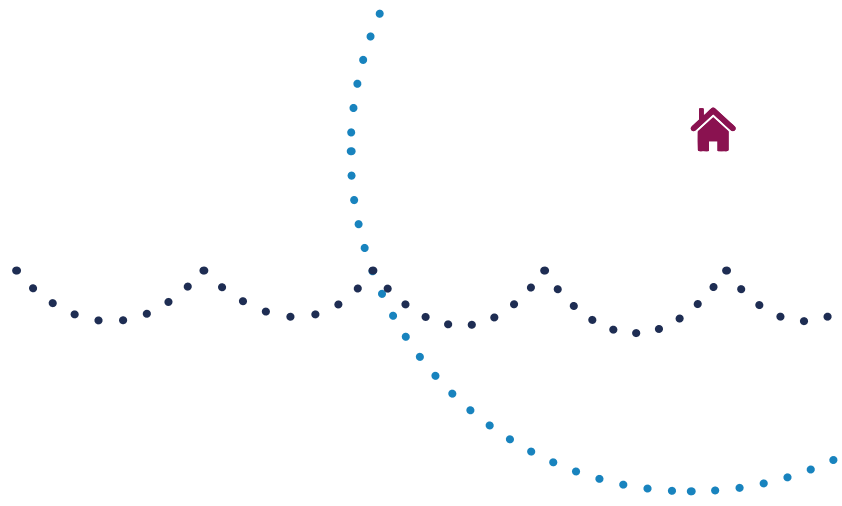
The climate crisis is a critical challenge facing the humanitarian WASH sector.

It is now estimated that 3.6 billion people live in areas highly susceptible to climate change, and that half the world's population currently experience severe water scarcity for at least part of the year. Climate change is expected to exacerbate this situation, with impacts on both the availability and quality of water (IPCC 2023). These impacts are likely to be felt disproportionately in humanitarian contexts, where the provision of adequate water and sanitation is already a challenge.

Climate change has far-reaching implications for water, sanitation and hygiene (WASH) systems, particularly in vulnerable regions. Changes in rainfall patterns, such as prolonged droughts and more intense but sporadic rainfall, disrupt water availability and exacerbate water scarcity in areas like sub-Saharan Africa, South Asia and the Middle East. Rising sea levels and saltwater intrusion affect coastal regions, reducing the availability of fresh water for drinking and irrigation. In addition, increasing water demand driven by population growth, urban migration and inefficient resource management places further strain on limited water supplies. Poorly integrated resource management and inadequate infrastructure amplify these challenges, making sustainable water extraction and allocation more difficult.

The effects of climate change on water quality are severe and multifaceted. Contamination of water sources due to increased runoff, flooding and pollution from agricultural chemicals and industrial waste jeopardises access to clean drinking water. Higher temperatures and reduced river flows exacerbate these issues by increasing pollutant concentrations and fostering conditions for harmful algal blooms. Groundwater, often more buffered against climate variability, is at risk from long-term contamination and over-extraction, with limited capacity for local communities to afford deeper wells or advanced treatment systems. As these challenges grow, the need for effective and affordable water treatment and storage becomes more pressing.

Sanitation systems are also increasingly vulnerable to climate-related disruptions. Flooding damages latrines, septic tanks and wastewater treatment facilities, causing sewage overflows that contaminate water sources and the environment. Droughts undermine the functionality of water-dependent sanitation infrastructure, while heat and extreme weather compromise the structural integrity of storage systems and treatment plants. Informal settlements and temporary camps created by climate-induced migration are particularly at risk, with overcrowding and inadequate facilities



accelerating the spread of waterborne diseases. Climate-resilient sanitation infrastructure remains financially out of reach for many low-income households, further entrenching vulnerabilities.

Climate change also intensifies public health risks by creating conditions conducive to disease propagation. Vector-borne diseases like malaria and dengue expand their ranges due to warming temperatures and increased stagnant water. Extreme weather events elevate the prevalence of waterborne diseases, while climate-related displacement often leads to overcrowding and unsafe sanitation practices.

Vulnerable groups are disproportionately affected, lacking the resources to adapt to these challenges or access clean water and sanitation. The compounding effects of stress, malnutrition and weakened immune systems make populations more susceptible to illnesses, underscoring the urgent need for adaptive strategies and equitable resource allocation to mitigate the impacts of climate change on WASH systems.

While climate change exacerbates existing challenges, it is also a new and emergent phenomenon. There is a lot that is not yet known about the impact of climate change on humanitarian WASH, and new WASH responses have not yet been developed.

As a result, research and innovation is essential to support the humanitarian WASH sector to respond to the challenges of the climate crisis. To help guide this, Oxfam, Elrha and the ADAPT Initiative worked together to identify opportunities for research and innovation in the climate adaptation of humanitarian WASH response.



A young girl accesses clean water at a community tap in a refugee settlement. © Khaled/Pexels



A woman draws water from a manual pump in rural Africa. © Adobe Stock



A mother bathes her child using limited water resources. © Ahmed Akacha/Pexels



The research objectives were:

- 1. Identifying challenges and public health impacts.** Establish the key challenges that an increase in extreme weather events may bring to humanitarian WASH response in the next 10 to 20 years and the possible associated public health risks.
- 2. Identifying research and innovation opportunities.** Evaluate these challenges to identify those that may represent good opportunities for research and innovation.

The study started in February 2024 and ended in February 2025. It involved a structured literature review to scope the challenges of climate change for humanitarian WASH and the possible public health impacts, and included feedback gathered from in-country focus group discussions, key informant interviews and a global WASH and climate change-focused survey.

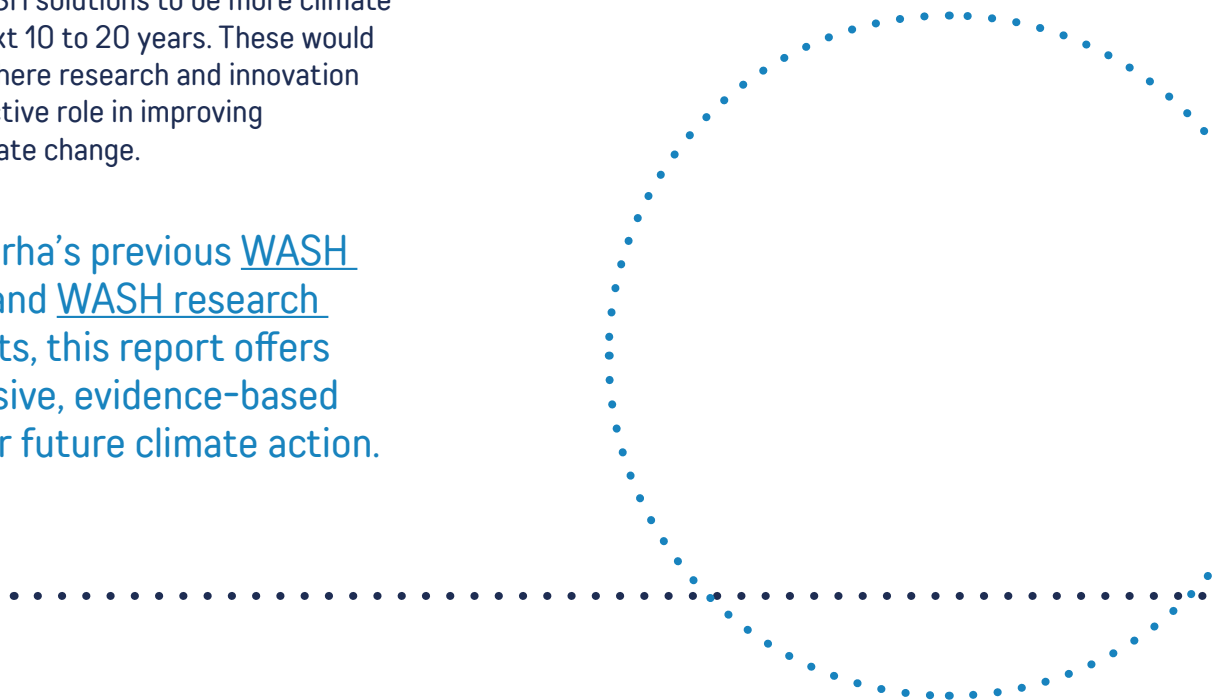
The aim of the study was to identify priority areas where research and innovation could have a significant impact on adapting existing humanitarian WASH solutions to be more climate resilient in the next 10 to 20 years. These would ideally be areas where research and innovation could play a collective role in improving responses to climate change.

[Building on Elrha’s previous WASH gap analysis and WASH research agenda reports](#), this report offers a comprehensive, evidence-based framework for future climate action.

For the purpose of the study, ‘research’ was understood to be a detailed and methodical study of a subject carried out to discover new information or to reach a new understanding. ‘Innovation’ was understood to be an iterative process to identify, adjust and diffuse ideas for improving humanitarian action.

This study identifies 11 actionable research and innovation opportunities ready for implementation. These areas provide a foundation to inform future problem-led research and innovation challenges or call designs.

The study benefited from an expert Steering Group (see Annex 1) consisting of global and local agency WASH practitioners and specialists, climate change specialists, and academic researchers involved in climate change and WASH issues.





Joy in access to clean water. © Sansy/Pexels



Methodology

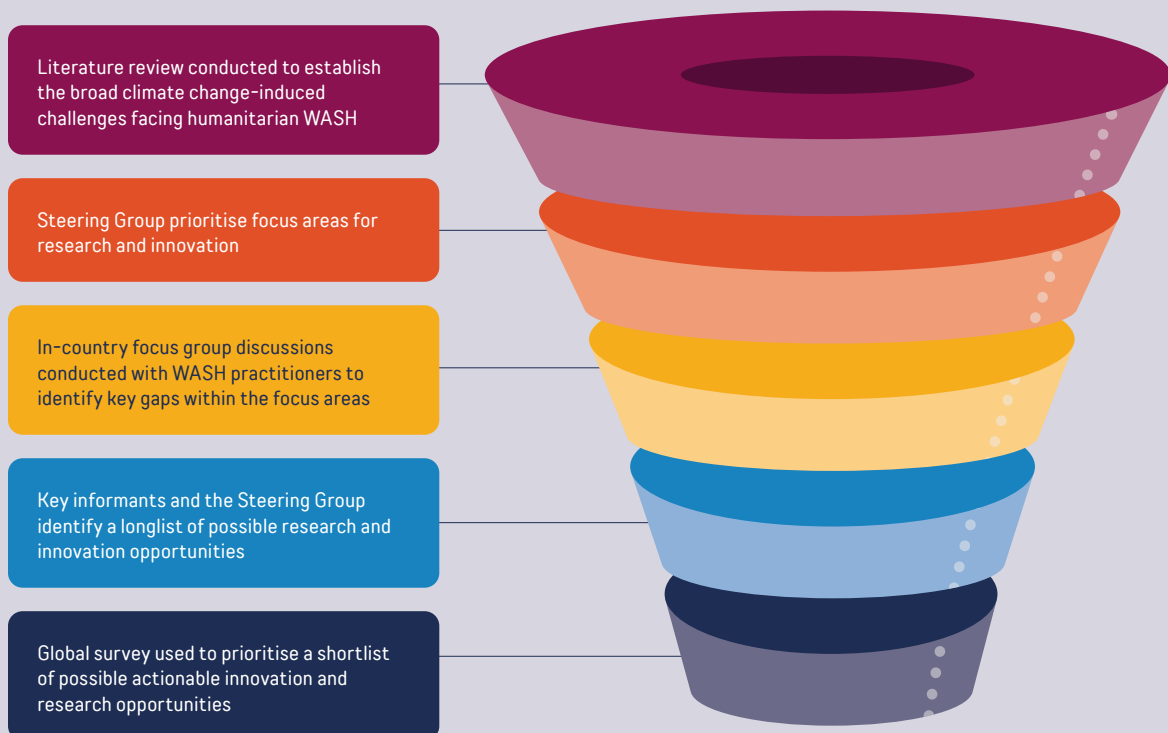
Methodology

The study used a ‘funnel’ approach to identify the key challenges for humanitarian WASH response in the context of climate change, as well as prioritise a final actionable shortlist of research and innovation opportunities.

The process started with a literature review to identify a broad list of challenges faced by the humanitarian WASH sector, gradually narrowing these down through a global consultative process to identify the challenges most likely to benefit from research and innovation.

This process included gathering feedback from the Steering Group, in-country focus group discussions (FGDs), key informant interviews (KIIs) and a global survey.

Figure 1: The funnel approach used to prioritise the research and innovation opportunities for climate adapting humanitarian WASH response.





Literature review

The purpose of the literature review was to identify the broad challenges to humanitarian WASH response caused by climate change, and how these challenges might develop over time.

The literature review also aimed, where possible, to identify challenges that were already being addressed, and which types of actors were addressing them.

The research team selected Google Scholar as the primary source for reference documents. Two Google searches were considered with the following key words: 1) “water”, “sanitation” and “climate change”; 2) “public health” and “climate change”. Two other sources of documentation were also selected: 3) the database produced by the Global WASH Cluster Climate Change Technical Working Group, and 4) documentation shared by the research team’s wider network.

The first search yielded 495,000 results and the second search 4,260,000 results. In each case the first 200 documents were reviewed against the following inclusion criteria:

- **Focus:** The focus or a section of the document is on WASH and climate change in low-income countries.
- **Types of population/countries:** The document refers to more than one country or region.
- **Types of studies:** Document is peer reviewed or (for grey literature) includes statement of methodology. All study designs were considered.
- **Content:** Document includes clear statement of challenges and/or description or assessment of how challenges are being addressed.
- **Date:** Published after 2010.

The same criteria for selection were applied to the two other sources of documents which contained 150 and 32 documents respectively.

A total of 80 documents from the pool of 582 considered documents met the inclusion criteria and were retained for the literature review. This consisted of 30 documents from source 1 (Google Scholar search of water and sanitation), 22 from source 2 (Google Scholar search of public health), 22 from source 3 (Global WASH Cluster Climate Change Technical Working Group database) and six from source 4 (shared from the research team’s wider network).

Coding was done using MAXQDA using a mix of inductive and deductive coding, starting from the most recent documents. Inductive codes were used as a framework to organise deductive coding identified through the examination of literature. The inductive coding framework was developed before any document was coded through an initial brainstorming within the research team with known facts about WASH and climate change. The framework included two sections:

1. A set of codes relative to climate change direct impacts and the response these impacts induced in people and the environment,
2. A set of codes describing the main elements of the WASH systems impacted and aggravated by climate change.

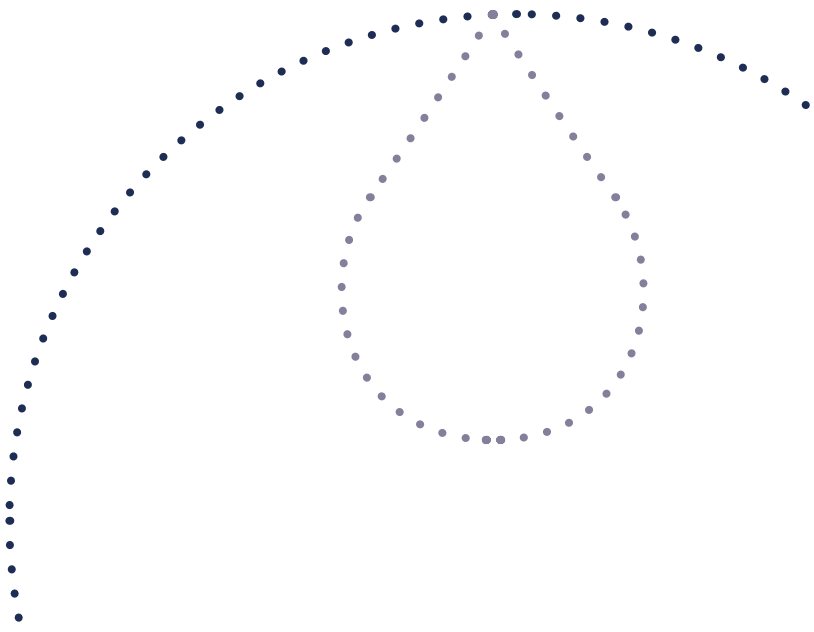


Water transportation by foot and bicycle highlights daily access challenges. © Gyan Shahane/Unsplash

An initial set of documents, based on the date of publication, were coded (all documents from 2022 to 2024). Additional documents were only then coded where their abstracts or introductions suggested that they outlined new challenges or covered new aspects of challenges that had already been identified. In total, 30 documents were coded.

The results of the literature review (code headings) were then laid out in a table of 168 challenges which were then aggregated into 21 broad challenge areas.

In grouping and developing these broad challenge statements, the team excluded those not specifically relevant to humanitarian contexts, not clearly related to WASH activities, or not suitable for research or innovation (such as challenges where effective responses existed but lacked funding).





Steering Group consultation

From the broad challenges identified by the literature review, the purpose of the Steering Group consultation was to identify the challenges that should be considered as preliminary focus areas for further investigation.

The Steering Group were asked to consider the 21 broad challenges identified by the literature review, and score them against five criteria:

- Does the challenge apply to the humanitarian context?
- Does the challenge present a clear problem statement?
- Is the problem exacerbated (directly or indirectly) by climate change?
- Does it affect multi-countries or multi-regions?
- Can it be addressed by research and innovation?

The project team consequently ranked the results on the basis of the scores. The Steering Group discussed the ranking, considering the priorities produced by the exercise, as well as the relative severity and scale of the challenges and the degree to which each challenge was already being addressed.

This analysis led to the selection of seven preliminary focus areas where research and innovation could play a role:

1. Increased infectious disease burden resulting from climate change aggravated by migration and displacement.
2. Unequal access to WASH services that is exacerbated by climate change (such as climate change affecting people's capacity to maintain hygiene at the household level).
3. Increased water demand induced by climate change, combined with a lack of water use management, leading to water scarcity.
4. Extreme weather events increasing the pollution of domestic water supply.
5. Understanding the behavioural enablers and barriers to disease transmission in the context of climate change.
6. The effects of climate change on both surface and groundwater availability.
7. Uncertainty about future climate conditions impacting the capacity of households, communities and WASH practitioners to take decisions to invest in climate adaptation.

Part of the role of both the Steering Group and the Global WASH Cluster Climate Change Technical Working Group was not only to discuss and validate the findings at each stage of the project, but to also ensure that there was no duplication with other agency activities.

Focus group discussions

The purpose of the focus group discussions was to assess the preliminary focus areas based on whether they addressed critical knowledge and practice gaps. The outcome was to identify areas where research and innovation could have the largest impact.

Face-to-face FGDs were held in Burkina Faso, CAR, DRC, Kenya, Lebanon, Nepal, Somalia, South Sudan and Yemen. In most cases these were organised by the National WASH Cluster Coordinators and in-country Oxfam staff members. These workshops covered approximately 270 WASH practitioners from 250 WASH agencies, including government representatives in some countries. Other workshops were held with: WASH Masters University students at Cranfield University, UK, Oxfam teams covering the MENA region, and Oxfam's global humanitarian WASH staff. Overall, there were 16 FGDs with 310 participants in total.

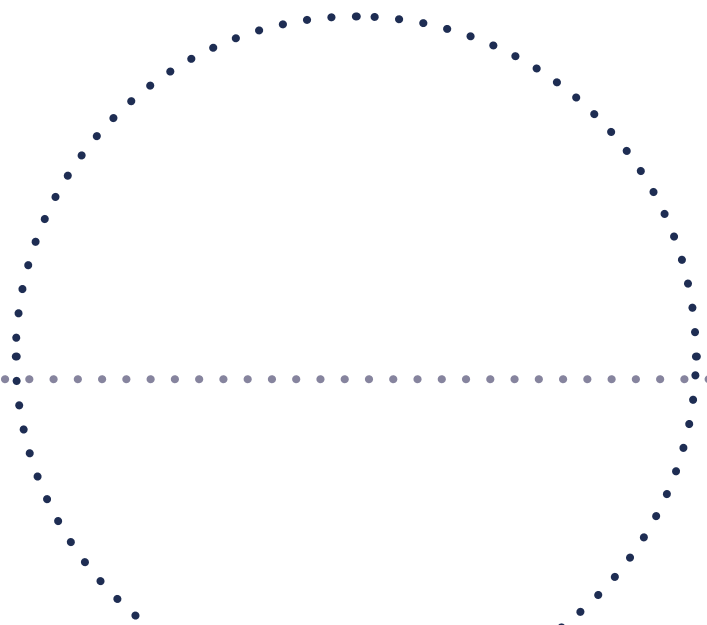
Focus groups were asked to split into smaller groups, one for each of the seven preliminary focus areas that emerged from the Steering Group. For each preliminary focus area, they were asked to consider:

- How the preliminary focus area manifested in that context (for example, whether and how climate change was leading to the increase of specific infectious diseases in a given context).
- Specific challenges encountered by humanitarian practitioners related to this preliminary focus area.

- Innovations, research or guidance that they could suggest that would help address these challenges.
- Ongoing activities in the area of research and innovation that were currently addressing these challenges.

The research team reviewed the suggestions made by all focus groups. Similarly themed suggestions were merged together, whereas suggestions where the team was aware that the issue was already receiving significant research and innovation investment were removed.

This resulted in a longlist of 96 specific evidence gaps where research and innovation could play a role across the seven preliminary focus areas.





Key informant interviews

The purpose of the key informant interviews (KIIs) was to validate the information emerging from the focus groups.

These interviews specifically asked informants to describe the evidence gaps in more detail, gather feedback on the degree to which they felt the identified gaps were amenable to being addressed by research and innovation, and identify any known existing humanitarian WASH initiatives or research and innovation activities in these areas.

In total, 23 global key informants were interviewed consisting of WASH experts and public health experts – both academic researchers and WASH practitioners. Most informants gave their views on the longlist of research and innovation suggestions under the seven preliminary focus areas.

However, some focused interviews were held where the expert was asked about a specific area, or subset of an area. Health and hygiene areas had more targeted interviews to redress the balance as most informants provided more generalised WASH feedback (Annex 2).

For public health-related areas, the analysis was supplemented with additional literature due to the broad range of topics identified by focus groups and limited response from potential key informants. This literature served the same purpose as the KIIs – validating that the challenges identified were consistent with research and expert opinion and giving more specificity and detail on the nature of the challenges.

Several specific evidence gaps were removed from the list based on feedback from key informants that these challenges either were already receiving significant research and innovation attention or could not be adequately addressed through research or innovation.

Global survey

The purpose of the global survey was to enlist the expertise and experience of the global WASH sector to prioritise the most pressing areas where research and innovation could play a role from the challenges emerging from the consultative process.

The survey asked respondents to prioritise the research and innovation opportunities within each of the seven preliminary focus areas. Each area included 10 potential opportunities for consideration. Respondents were encouraged to

focus only on areas matching their experience and expertise, which resulted in few participants completing the prioritisation exercise across all seven preliminary focus areas.

Figure 2: Percentage of respondents from the global survey in each focus area, disaggregated by country, regional and headquarter-level

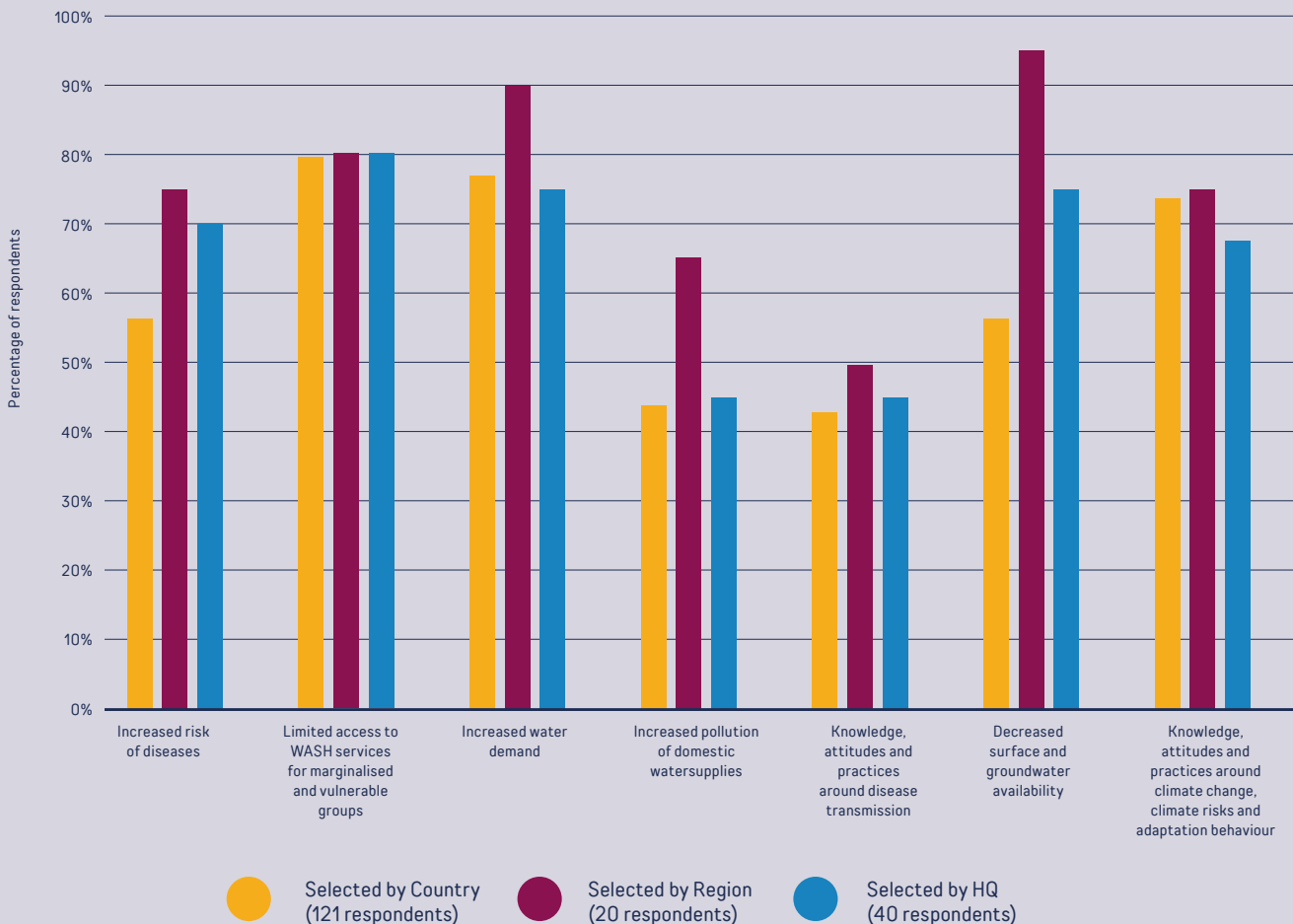
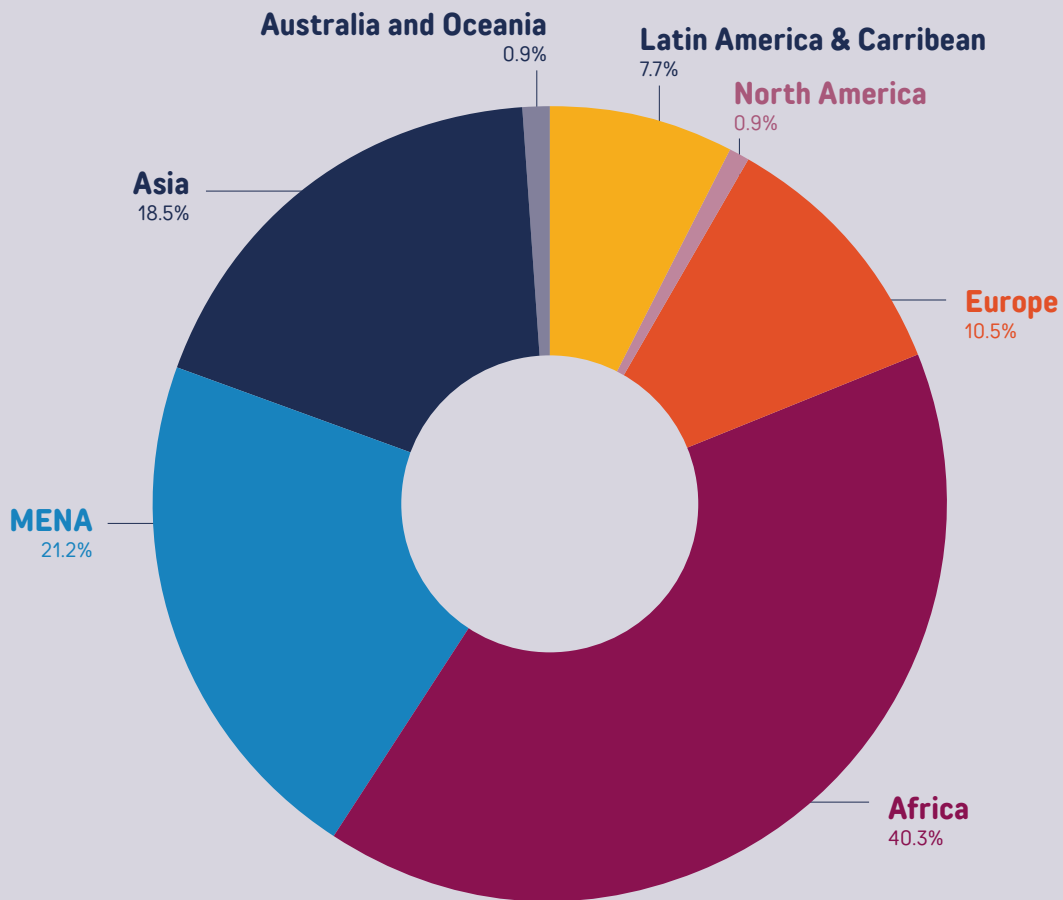




Figure 3: Geographic focus of respondents from the global survey.



The survey was disseminated through the Global WASH Cluster, in-country WASH Coordinators, the ProWASH newsletter, the Global WASH Cluster Climate Change Technical Working Group, the Interagency Emergency WASH Group and Cranfield University's alumni group.

The aim was to capture adequate responses from humanitarian WASH actors over a diverse range of geographical areas and contexts.

Most responses received were from Africa (40.3%), followed by MENA (21.2%) and Asia (18.5%). In total, there were 181 survey respondents, of which 121 were at country level (67%), 20 at regional level (11%) and 40 at headquarter level (22%) (Annex 5). As some respondents worked in multiple regions, the regional percentages do not add up to 100.



A facilitator leads a community consultation session on local priorities. © Adobe Stock



Steering Group prioritisation exercise

In total, 28 research and innovation opportunities across the preliminary focus areas were identified as being priorities for the sector from the global survey.

The Oxfam research team prioritised 15 of these opportunities based on the number of respondents that had prioritised the opportunity, the feasibility of being able to address the challenge through research and innovation, and whether there were already existing initiatives addressing these challenges based on knowledge gained from the study.

Some of the challenges that were prioritised in the survey were removed because they were not closely enough aligned to WASH or were general issues that were not specific to humanitarian response.

The Steering Group was presented with the list of 28 research and innovation opportunities, which also highlighted the 15 suggested by the research team.

They were asked to validate and prioritise this list into a critical and actionable shortlist, to which 11 research and innovation priorities were finally selected. There were no contentious issues that were difficult to resolve.



Constraints and limitations

The research approach outlined above included several constraints and limitations.

The literature review was relatively limited in coverage, due to the lack of documents at the time dealing specifically with WASH and climate change and the limited amount of time allocated to this element of the research. There were a number of climate change-related issues that the team would have expected, from their own experience, to be addressed in the literature that did not appear.

To a degree, this limitation was addressed by a research design that did not rely exclusively on the literature review to identify potential gaps – that is, by not taking the original 168 challenges identified in the literature review as the basis of the following stages, but instead combining them into 21 areas, and prioritising seven of these

areas based on a global consultative process. This enabled focus groups and key informants to include key challenges faced by frontline humanitarian actors, such as the integration of humanitarian WASH response within integrated water resources management (IWRM) approaches and systems, effective water testing and treatment approaches, community beliefs and attitudes regarding grey water reuse, and community-based surveillance systems.

The scope of the research – looking for key areas where research and innovation could improve humanitarian WASH response to climate change – proved challenging. Many existing WASH responses already address weather hazards such as droughts and flooding. This created challenges



Refugee camp housing displaced Syrian families.
© Adobe Stock

in distinguishing between routine emergency preparedness and response programming versus initiatives specifically designed for climate change adaptation. In most cases, the research team determined that, as these challenges would increase in scale and frequency as a result of climate change, gaps related to these responses were within the scope of this research.

In other cases, it could be difficult to determine whether a particular challenge was specific to, or particularly relevant for, humanitarian contexts, or whether it occurred more broadly in low-income countries. In these cases, the research team prioritised those challenges that were humanitarian context-specific, with the rationale that they were priorities for humanitarian funding. In general, challenges of scope were addressed by the research team at each stage of the study and by removing suggestions that seemed to be out of scope with assistance from the Steering Group.

Mapping the actors currently engaged in WASH climate-adaptation activities proved challenging due to the vague area between normal humanitarian response (e.g. responding to floods and droughts) and specific responses to climate adaptation, as well as the large number of potential actors involved. Many agencies are

only starting to plan activities to address climate change, and there is the risk that any actor-mapping efforts would be outdated before it was finished. The Global WASH Cluster Climate Change Technical Working Group is attempting to list projects on an ongoing basis.

The research team addressed this limitation by asking focus groups, key informants and the Steering Group to identify and remove challenges where climate-adaptation activities were already being conducted. While this does not provide a mapping of current research and innovation activities, it should ensure that the areas selected for research and innovation are real 'gaps' that are not currently being addressed.

While consultations with field WASH practitioners were a central part of the research, affected populations were not consulted due to the limited time and scope allowed for this project. Affected populations were consulted in depth for the [2021 Global Humanitarian Gap Analysis](#) and many community responses focused on insufficient service provision from responding humanitarian agencies.



Collaboration is vital for stronger WASH solutions.
© Adobe Stock



Recommendations

Recommendations for research and innovation

This section presents 11 priority climate adaptation research and innovation opportunities in humanitarian WASH response, identified through our global consultative process.

Gender considerations received strong support from both survey respondents and the Steering Group. Rather than creating a separate research area, the Steering Group recommended incorporating gender and inclusion as an expectation in the terms of reference for all research and innovation activities. Each recommendation below should therefore include a specific gender and inclusion perspective.

Similarly, the FGDs and KIIs highlighted the need to improve monitoring and evaluation of WASH approaches, technologies and processes. Rather than suggesting this as a separate research and innovation area, we recommend integrating monitoring considerations into all research and innovation activities. Each initiative should clearly address how the results of new knowledge, technologies, processes or approaches can be effectively monitored.



1.

Develop pragmatic, scalable solutions that conserve and reuse water in water-scarce regions.

The literature review identified increased water scarcity as a key impact of climate change in many areas. Greywater recycling is one approach to respond to this challenge.

Greywater recycling is the process of collecting, treating and reusing wastewater generated from household activities such as bathing, laundry, washing dishes and any spillage from tap stands and boreholes. Greywater, unlike black water (wastewater from toilets), contains fewer contaminants and can be treated to a safe level for non-potable purposes, such as irrigation and toilet flushing.

This issue was flagged a number of times in FGDs conducted in MENA and Africa. The main challenge highlighted was the removal of grease from water, especially from bathing and clothes-washing areas. Groups explained that if the grease trap or membrane was not cleaned out regularly, bad odours could rapidly occur and could cause blockages.

Many of the key informants confirmed the issue of greywater recycling as an important evidence gap. There are currently no easy low-cost ways of recycling greywater. Kils mentioned that there have been a few examples of higher-tech, higher-cost devices such as modular greywater treatment systems, but these are not appropriate for humanitarian situations due to their high capital and operational cost.

This challenge received a high number of votes in the global survey. The benefits are clear in terms of water conservation and protecting the environment, but greywater recycling does not happen as a standard response in humanitarian emergencies. Apart from drainage trenches from showers or tap stands to small market gardens, it is extremely unusual to find a functioning low-cost greywater recycling system.

Recommendation

Since there is not enough evidence on greywater recycling technologies and practices in humanitarian settings, research and innovation efforts should focus on mapping the available options for low-cost greywater recycling in different contexts, as well as explore the acceptability of greywater reuse by different communities. Innovative greywater recycling approaches and technologies could also be piloted to build the evidence base of what works and what does not work in different humanitarian contexts.



2.

Map the pathways through which climate change disrupts WASH access for people affected by humanitarian crises.

The literature review emphasised that people's socio-economic status influences their access to WASH services and their capacity to adapt to climate change hazards.

For example, women often lack financial access and decision-making power within the household to influence which adaptation measures can be implemented. People with disabilities have fewer employment capabilities and therefore less capacity to invest in climate-proof, disability-adapted sanitation facilities which cost more than a standard sanitation facility.

FGDs homed in on displacement as a specific source of vulnerability and a key driver of exclusion. Climate change hazards are often associated with sudden and large population movements to zones lacking capacity to absorb additional needs. The parameters used for WASH infrastructure design do not usually include future risks or sudden increased demand. Consequently, infrastructure design in areas receiving displaced people is often not adapted to a sudden increase in demand, and those with the fewest resources (financial, social or political) are likely to be excluded.

KIIs suggested that WASH actors need to be more aware of the impacts of climate change on those that are already marginalised due to socioeconomic or cultural reasons. As climate-proofing all WASH services is not realistic in the short term, they suggested to focus particularly on adaptations that would maintain access to WASH services for vulnerable groups.

The KIIs also highlighted that, currently, the choice of technology is often determined by what has worked in other contexts and therefore does not take into account context-specific constraints (and specifically constraints to access by vulnerable groups). They also pointed out that the monitoring and evaluation of WASH responses may overlook issues affecting vulnerable groups within the community. To improve access monitoring, they suggested we need better understanding of the specific risks and vulnerabilities facing different population groups.

While there is existing data on climate change risks to WASH services and their impacts, and there are also existing definitions and typologies of “vulnerable populations” in humanitarian contexts, there is a lack of understanding and research on how these two types of information overlap. As highlighted in one of the KIIs, there is a research gap in “understanding more about people living in (those) overlap zones” and how they are affected according to their status. Examples given were women walking increasing distances to fetch water during droughts and so being exposed to increased gender-based violence (GBV) risks and heat exposure, or children having to take cattle further for grazing and having to miss school.



Recommendation

Humanitarian WASH response aims to put in place operational and good-quality WASH services and infrastructures to meet the needs of crisis-affected communities. For this to happen, an understanding is needed of the factors associated with success and failure to identify the types of WASH services and infrastructures that operate best in different contexts and for specific community groups, such as vulnerable groups.

Given that research and innovation efforts on WASH access for crisis-affected populations affected by climate change is limited, we recommend further research to build the evidence base and map the pathways through which climate change disrupts WASH access for people affected by humanitarian crises, as well as to better understand the types of WASH interventions that can work in increasing access to WASH services for vulnerable groups. There is also a need to develop and pilot key indicators and metrics to measure the effectiveness of WASH interventions in these settings.

Piloting different innovative approaches to increase access to WASH services in the face of climate change are also needed, and particularly if they have potential to be transferred to other contexts.

3.

Identify the specific factors that motivate communities to embrace and sustain climate adaptation practices.

The literature review demonstrated that many communities, households and WASH practitioners are not engaging in climate adaptation activities around WASH due to several factors, including a lack of knowledge around climate change.

FGDs acknowledged that there was a lack of information on the effectiveness of climate adaptation projects within the WASH sector – including information on what motivated people to engage with these projects. Practitioners during some FGDs highlighted examples where communities appeared to lack motivation to act on adaptation plans but said that they were not aware of the reasons behind this lack of motivation. Some possible reasons that were raised include:

affected communities and other stakeholders not explicitly relating the difficulties they encountered with climate change, not being aware of actions they could take to adapt, proposed adaptation recommendations being too different to what people were already doing, and uncertainty around the cost benefit of adopting new technologies.

Recommendation

More research exploring the enablers and barriers in decision-making processes related to climate change adaptation is needed. This should consider the voices of various stakeholders – such as community members, local authorities and private sector actors – and should explore the motivation for these stakeholders to participate and actively contribute to and implement action plans. The research would need to be conducted in multiple locations, to identify common and non-context specific trends and factors that motivate individuals and communities to take action on climate adaptation around WASH in humanitarian contexts.

This knowledge could support the development of innovative tools to assist humanitarian WASH practitioners in designing and implementing relevant community-based climate-change adaptation programmes or initiatives.

4.

Improve connections between disease surveillance, early warning systems and humanitarian WASH response.

The literature review identified the increased prevalence of infectious diseases in humanitarian contexts being a result of climate change due to a number of factors, such as altering disease vector habitats, extending transmission seasons, and intensifying extreme weather events like floods and droughts.

These disruptions lead to overcrowded living conditions, contaminated water supplies and food insecurity, all of which exacerbate the spread of vector-borne and waterborne diseases such as malaria and cholera. Additionally, forced migration, weakened healthcare systems and malnutrition make affected populations more vulnerable to infections.

Given this, the FGDs identified the importance of improving early warning or forecasting systems to predict disease outbreaks (including for new or emerging diseases) and better linking these systems to WASH responses, and improving surveillance systems, and the use of surveillance systems by WASH actors, to identify disease outbreaks.

These two areas are connected through their focus on providing health information in humanitarian contexts to enable effective and timely action to prevent or mitigate against infectious disease outbreaks.

The key difference lies in timescale – forecasting delivers predictive information before an outbreak occurs, while surveillance provides descriptive information during an outbreak, ideally at its earliest stages.

There are many types of forecasts, ranging from those that predict a situation years in advance (such as forecasts of the geographical

occurrence of vectors by the end of the century) to those that predict a situation months, days, or hours in advance (Knox Clarke 2022). The former are more likely to be used for long-term strategic planning, the latter to initiate operational humanitarian activities. These short-term forecasts can be thought of as early warning activities.

Similarly, a wide variety of surveillance systems exist, particularly for vector-borne diseases (Otmani del Barrio 2018) (Fournet 2018).

Forecasting and early warning

The KII and literature review suggested that there is already significant innovation and development activity in the health sector related to forecasting and early warning. Much of this work involves using meteorological data to forecast areas at risk of disease outbreaks (Oxfam & MSF 2021). These systems are at various levels of complexity: some essentially forecast hydrometeorological disasters and assume that associated diseases will follow, others use multiple indicators (including weather information), mathematical models and, in some cases, artificial intelligence to forecast specific outbreaks.

The main constraints to progress in improved forecasting and early warning in most humanitarian contexts is a lack of historical public health data to show when outbreaks

occurred and their related climatic conditions (Oxfam & MSF 2021), as well as the need for highly context-specific approaches. Both the availability of data and the relationship between climatic conditions and disease outbreaks is local and highly context specific.

There are also significant challenges around organisational and inter-organisational processes in getting early warning information used.

Surveillance

In terms of current practice, there is a gap around surveillance for the malaria vector *An. Stephensi* in urban areas (UNICEF & WHO 2024).

The main challenges with surveillance systems tend to be around the process, rather than around evidence or technology that could be produced by research or innovation. The Klls and literature review identified, in particular, challenges related to the skills of health workers on case definition and diagnosis (Fournet 2018); engagement of decision makers to respond to surveillance (Fournet 2018); and the ability and resources of medical staff to respond (Fournet 2018) (Otmani del Barrio 2018).

The main suggested areas for improvement identified by the study were around process, and particularly inter-organisational coordination processes (Fournet 2018) (Otmani del Barrio 2018). These could be addressed, to a degree, by technical innovations that speed up the analysis of information from multiple sites and systems, and the flow of information from primary sites to central decision makers (Fournet 2018) (Otmani del Barrio 2018). Research and innovation activities should focus on both the technical and the organisational aspects of surveillance systems.

Innovation is also required to produce rapid diagnostic tests, particularly for differentiating Zika virus, dengue and chikungunya from other common febrile illnesses (Otmani del Barrio 2018) (Wilder-Smith 2017) and for identification of Chagas disease, filariasis, leptospirosis, enteric fever, human African trypanosomiasis, schistosomiasis and cholera (Otmani del Barrio 2018).

Recommendation

The main area for research and/or innovation related to humanitarian WASH would appear to be in developing processes that integrate WASH actors more effectively into infectious disease early warning and surveillance systems – potentially through improved sharing of information between health and WASH actors, and through (joint) planning of WASH activities that support public health actions when early warnings are received. As this work aligns with the growing trend for Anticipatory Action in humanitarian contexts, humanitarian actors should collaborate with other actors like the Risk Informed Early Action Partnership (REAP) and the Anticipation Hub, to avoid duplication of efforts.

In the survey, respondents also suggested that there would be value in research and innovation related to technological or mobile solutions to speed up the collection, analysis and flow of information from primary healthcare sites to decision makers. However, while important, this does not seem to be primarily a WASH sectoral responsibility, nor specific to humanitarian contexts. Significant work seems to be already occurring in this area. Any work on technological innovations should also include a strong utilisation or process focus and explore how the technology is being used to improve coordination between organisations.

5.

Identify and trial WASH management approaches that remain effective in resource-constrained, climate-affected environments.

The literature review outlined the multiple constraints that climate change puts on the provision of WASH services, and the importance of robust management of these services to ensure resilience.

Access to WASH services in low-resource contexts often depends heavily on the type of management model used, as well as on robust approaches for long-term system maintenance. In humanitarian contexts it is challenging to keep facilities running due to a range of factors such as lack of funding, capital investment in infrastructure, capacity and climate change, which is exacerbating existing problems and making it essential to develop management models that are better able to withstand future climate change shocks to the system. This issue came up multiple times in FGDs and also received significant support in the global survey as an area that would benefit from research and innovation.

The KIs highlighted that there had been quite a lot done in this area in the development sector but very little within humanitarian settings. They also articulated the broad management models currently being used in humanitarian settings:

a. Community-Based Management (CBM): In community-based models, local community members are trained to manage, operate and maintain WASH infrastructure. This model can struggle with a lack of technical expertise and revenue collection, which can lead to breakdowns and reduced access if community funds are insufficient or management capabilities are weak. Another model of Professionalised CBM – where some individuals with business experience are

part of the management – goes some way to addressing some of the shortfalls of this approach.

b. Private Sector Management: Under this model, private entities manage WASH services, often on a cost-recovery or profit basis. Affordability for users often becomes an issue, limiting access for the poorest households if services are priced above what they can afford. Additionally, private providers may focus on areas with higher returns, potentially not providing services to remote or low-income areas or to informal settlements.

c. Public Sector Management: Here the government takes responsibility for the planning, installation and maintenance of WASH systems. In low-resource contexts, governments often lack the budget or administrative capacity to maintain consistent service quality and coverage, especially in rural or informal urban areas.

d. Public-Private Partnerships (PPPs): PPPs combine public oversight with private management. This model requires strong governance and regulatory oversight to ensure quality which is rarely present in humanitarian settings.



Recommendation

This challenge can be addressed by research and innovation efforts by investigating examples of management models that have been successful in humanitarian contexts affected by climate change, and – critically – the factors that contribute to their success to determine whether it is possible to replicate these factors in other countries and regions. Innovative models could be piloted that can both withstand the impacts of climate change and be sustainable in a low-resource, low government authority or capacity setting.

6.

Understand and support community water use and coping strategies during extreme climate events such as drought and flood.

The literature review identified extreme weather resulting from climate change – particularly droughts and floods – as a key driver of water insecurity.

It also demonstrated that communities have several ways of managing water resources and adapting their practices in response to these events. These approaches are increasingly under pressure because of the increased scale, frequency and duration of extreme weather.

The FGDs discussed access to WASH services, water demand and water availability, and further elaborated this challenge, suggesting that there is a need for tools to support communities and field practitioners in developing and using water resources more efficiently in times of drought and flood.

Key informants agreed that this was a gap that needed more research and innovation, and further broke this challenge down into a number of related needs:

1. Understanding Water Use Patterns:

- a. Investigating how communities access water during normal and extreme conditions.
- b. Studying seasonal variations, agricultural/livestock needs and domestic consumption.

2. Coping Strategies:

- a. Examining traditional and modern techniques communities use to adapt to water scarcity or surplus.
- b. Assessing short-term responses like rationing, and long-term strategies like rainwater harvesting and flood prevention measures.

3. The Impact of Social and Environmental Factors:

- a. Exploring how socioeconomic status, geography and infrastructure influence water management and resilience.
- b. Considering cultural practices and community-based approaches to water stewardship.

4. Barriers to Effective Adaptation:

- a. Identifying gaps in knowledge, resource availability or policy that hinder efficient coping strategies.
- b. Understanding how misinformation or lack of engagement can exacerbate crises.

This issue was ranked very highly in the global survey. Comments in the survey suggested that specific areas for consideration (which had not occurred in the KIIs) should include methods for increasing water infiltration recharge rates and the sustainability of extraction practices.



Recommendation

Research efforts are needed to build the evidence base across a number of different countries and contexts to create innovative tools that can support communities and field practitioners in developing and using water resources more efficiently in times of drought and flood, and that could be applicable in a wide variety of humanitarian situations. There is a need to identify current practices and processes which can realistically address the information needs outlined above as part of humanitarian WASH programme designs, and which could include a range of community engagement techniques.

7.

Harness and integrate indigenous and local knowledge within humanitarian WASH programming

Our literature review confirmed the importance of recognising and incorporating diverse knowledge in climate adaptation activities.

WASH practitioners and community members develop knowledge in different ways. Practitioners tend to default to scientific knowledge – based on testing and replication, whilst community members may use knowledge based on observations over long periods of time which can span generations.

The literature review pointed out the importance of indigenous knowledge from community members as a source of information to support adaptation and resilience to climate change. This theme also emerged in several FGDs, which identified specific indigenous adaptation activities (such as methods for rainwater harvesting) as useful sources of information to develop further climate change adaptations. Other examples include community knowledge of the most reliable sources of water in periods of drought, water conservation techniques and flood mitigation.

Key informants pointed out that the use of indigenous knowledge can also contribute to increased community ownership of the various activities/intervention. They also suggested that projects based on indigenous approaches are more likely to be successful, as the approaches have already been shown to work in that specific context. However, challenges can arise when the different types of knowledge are not trusted by the different actors – and even when there is an intent to use both external and local knowledge, integrating the two in project design can be difficult.

With respect to specific gaps, the KIs suggested that there were often difficulties in recognising existing knowledge and solutions during assessment and design, and in understanding how to integrate indigenous and scientific knowledge to co-construct an adaptation plan.

Recommendation

More research is needed to identify the best practices and success factors for better integrating indigenous knowledge into WASH processes and programme designs and implementation. This could be conducted as action research, trialling and reporting on processes to identify and incorporate indigenous knowledge. Such research efforts may be most effective when conducted across multiple sectors. Building the evidence base in this area also requires the testing and adaptation of innovative approaches to better integrate indigenous knowledge into humanitarian WASH service design and delivery.

8.

Evaluate the performance of existing WASH approaches in preventing infectious disease transmission in the context of climate change

The literature review identified increased prevalence of infectious diseases because of climate change as a key concern for humanitarian WASH.

To address this challenge, the FGDs suggested two broad areas of research that focused on better understanding how climate change is influencing or forecast to influence the prevalence of diseases in humanitarian contexts, including a better understanding of the behaviour and persistence of certain pathogens and vectors, and of transmission pathways. They also highlighted more research efforts to better understand the effectiveness of existing WASH activities in preventing infectious disease transmission in different contexts.

In discussing these approaches with key informants, it became clear that the majority of current research on climate change and health concerns the first of these two areas: the influence of climate change on the prevalence of specific diseases such as malaria and dengue (IFRC 2021) (Fogarty International Center 2024) (Otmani del Barrio 2018).

Climate change produces varied effects across different geographical areas with some regions becoming wetter, others drier. Disease transmission pathways also differ significantly based on factors including health and WASH service availability, local knowledge and practices. This makes research results highly location specific.

The majority of research has occurred predominantly in G20 states and there is much less research available for low-income countries (IFRC 2021) (Degroote 2018) (Otmani del Barrio 2018) (Simane 2016) (McIver L 2024), although there has been an increase in research in recent years.

The KIIs and literature review also suggested that there is much less research occurring on adaptation activities, including on programmatic responses to climate change and infectious diseases, and that this should be a priority area (IFRC 2021) (Issa 2023) (Bigmore 2024) (Palmeiro-Silva 2023).



Recommendation

The main areas for research and innovation should be on the effectiveness of humanitarian WASH activities in preventing infectious disease occurrence or transmission in the context of a changing climate, and on the potential to transfer effective approaches to different contexts. There may also be possibilities for innovation and action learning around new approaches or adapting existing approaches to preventing disease transmission, but an initial priority would be to determine the types of WASH activities that are effective at decreasing the prevalence of climate-related waterborne, foodborne and vector-borne diseases.

Research efforts are also needed on the specific relationship between climate change and the current or future prevalence of a specific disease.

9.

Evaluate local hygiene practices, challenges and motivations in changing climate conditions and understand the factors leading to behaviour change.

The literature review provided examples of the ways in which extreme weather events can change behaviour amongst populations affected by crisis, specifically with relation to their personal, food and domestic hygiene practices.

These enforced behavioral changes can lead to an increase in a number of diseases. FGDs also considered the issue of cultural practices impacting hygiene practices and health-seeking behaviours.

The KIs described how, in environments affected by climate change, people can change their food-hygiene behaviours, food storage and preparation processes. There is also some evidence that when water quantity and quality is low, people are unable to practise personal hygiene – face, body, hand, hair washing – which increases the risk of transmission of communicable diseases and also urinary tract infections (UTIs), fungal infection and skin diseases.

Displacement can also influence hygiene practices by disrupting the availability of hygiene materials and products (such as soap, menstrual products, detergent) and/or of a lack of infrastructure such as hand washing, bathing facilities and toilets.

Key informants also suggested that there is a lack of evidence on the different practices, existing coping mechanisms or indigenous knowledge related to hygiene behaviours and more specifically on how people prioritise and adapt their hygiene behaviours related to food and personal and domestic hygiene under situations of climate-related stress.

Recommendation

Conducting research to gather evidence on how affected communities are adapting their hygiene practices under climate-related stress is needed, with a focus on innovative practices identified by communities to address constraints. Research efforts should also seek to understand how communities prioritise personal, food and domestic hygiene practices in different disaster settings, and the reasoning behind these decisions in different cultural and economic contexts. Existing tools and approaches related to behaviour change might also be adapted to capture this specific information and inform better humanitarian WASH response. To have more general applicability to humanitarian settings, this research should be done in a variety of locations and ideally take a longitudinal approach to understand the changes over time.

This evidence could be used to better support existing community-led innovations, and to develop and scale innovative models and approaches to address climate-related behavioural changes that impact health, and particularly in traumatised populations.

10.

Create simplified, low-cost watershed mapping tools and approaches tailored for humanitarian contexts.

The literature review highlighted the need for integrated water resource management (IWRM) approaches to reduce the increased water insecurity resulting from climate change in humanitarian contexts.

Water resource management requires a better understanding and management of watersheds. A watershed is often used to designate a hydrological catchment area which drains rainfall, snowmelt and runoff into a common body of water. For any targeted location it is possible to define an upstream watershed which will be the reference unit to identify water sources, water users and the impact of human activities and climate change-associated hazards.

Both key informants and participants in FGDs confirmed the importance of watershed management and IWRM in humanitarian contexts to manage competing water usages and minimise overextraction. Specific areas for focus included:

- Watershed mapping, which was proposed in several FGDs to support the implementation of IWRM. This would allow a better understanding of water infiltration and groundwater recharge, or minimise pollution risks from agriculture and mining.
- A better understanding of seasonal water flows and storage, and of the impact of climate change on water source storage and recharge capacity. Lack of information on these issues can make it difficult to support water source recharge, to address pollution risks, or to prevent creating downstream flooding.
- Some FGD participants stressed the difficulties in operationalising IWRM regulations and action plans. Key informants identified an important

gap in humanitarian WASH response, which was the coordination with IWRM stakeholders outside the humanitarian sector to develop and operationalise IWRM plans.

Several KIs and FGDs emphasised the lack of information on the impact climate change-related hazards on water source storage and recharge capacity. They also highlighted the lack of evidence and the challenges for humanitarian actors around seasonal water flows and what modified them, and the impacts of climate change on water source recharge, pollution risks or downstream floods.

Recommendation

There are existing technologies and approaches being used in development settings to map watersheds and their key components (including surface and underground water bodies, water flows, land coverage, and aquifer recharging zones). These existing approaches are more commonly used in development contexts, and should be tested in a humanitarian context to understand the tools that can be used to support action planning and decision-making for humanitarian IWRM. Importantly, this should include innovative approaches to monitor situations over time, to identify climate-related impacts.



11.

Develop low-cost desalination technologies that work at both household and community levels.

While this challenge only appeared in two documents within the literature review, it was an important element of the FGDs. The challenge was mentioned particularly in FGDs that were based in MENA and South Asia, as well as by certain countries in Africa.

Low-cost desalination for low-income countries refers to affordable, scalable and energy-efficient desalination methods designed to remove salt and other impurities from seawater or brackish water, making it safe for drinking and other uses. The key elements of low-cost desalination include the technology being affordable and cost-effective, energy-efficient or using alternative energy sources such as solar power, scalable and easily adaptable to different contexts, user-friendly and requiring little technical expertise, as well as having a minimal impact on the environment given that improper disposal of highly concentrated salt waste can harm marine ecosystems and soil.

Key informants discussed current desalination technologies, including solar stills, membrane desalination and electrodialysis and capacitive deionisation. They confirmed that all of these are problematic for humanitarian contexts. For example, solar stills only give a small amount of water per day making the process cost inefficient, whereas membrane desalination technologies mostly require high pressures to force water through the membrane and are expensive. Electrodialysis and capacitive deionisation are only effective for brackish (or low salinity) water.

The KIs did not reveal a low-cost and sustainable system that could be used at a community level within a humanitarian context. As so many coastal and drought-prone areas are experiencing large increases in salinity, a truly

low-cost sustainable desalination system would be transformative in helping to secure water access sustainably and affordably. Currently there is no low-cost community level desalination system, which is where research and innovation could play a role.

The issue of desalination did not score particularly highly in the global survey, likely due to this challenge being specific to a small number of countries. However, the research team and Steering Group decided that it should be included as a priority area because of its importance in the areas where it is a challenge, and because it appears to be an area particularly amenable to innovation.

Recommendation

The development of innovative technologies for low-cost, sustainable desalination is an emerging area of interest in humanitarian contexts. This could be best addressed by bringing together potential innovators and companies already involved with desalination to jointly develop technologies that meet the specific needs and contexts of humanitarian WASH.



The urgent need for clean water solutions in communities.
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Conclusion



Children collect water at the former refugee camp at the Greece-Macedonia border. © Adobe Stock



A mosquito demonstrates the link between water access and disease vectors. © Adobe Stock



Water conservation technology development in Africa. © Adobe Stock



Innovative sanitation solutions in resource-limited environments. © Adobe Stock



Sustainable resettlement village featuring integrated water and energy systems. © Adobe Stock



Conclusion

The escalating impact of climate change on humanitarian WASH services demands urgent action.

As extreme weather events become more frequent and water resources become increasingly scarce, humanitarian actors must rethink how WASH interventions are designed and implemented. Climate adaptation strategies must prioritise resilient infrastructure, sustainable water management and proactive public health interventions to protect vulnerable communities.

Through targeted research, innovation and cross-sector collaboration, humanitarian actors and communities can develop more effective, climate-adaptive WASH solutions that mitigate the risks of a changing climate and ensure continued access to life-saving services.

This report highlights research and innovation priorities for integrated and coordinated water resource management, investment in climate-resilient infrastructure, increased awareness of climate adaptation by and within communities and the development of low-cost technologies. These priorities can contribute to improved WASH practice in humanitarian crises in the face of climate change.

This sets the agenda for research and innovation, ensuring that we respond to recognised needs and gaps in the sector, and mobilise limited resources to the most pressing issues facing humanitarian WASH in a fast-changing climate.

We invite all stakeholders to use this report to encourage, inspire and drive relevant research and innovation efforts to inform and shape future humanitarian WASH response.



Young Girl Washing Hands in Bowl in Refugee Camp
© Osama Naser/Pexels



Annexes

Annex 1 – Steering Group members

	Name	Organisation	Position
1	Jason Chau	Gates Foundation	Senior Program Officer Emergency Response
2	Julie Bara	Global WASH Cluster	Deputy Global WASH Cluster Coordinator
3	Esther Shaylor	UNICEF	WASH Innovation Manager
4	Siobhán McGrath	International Organization for Migration	WASH Officer (Climate & Environment Lead)
5	Alexandra Machado Soergel	IFRC	WASH in Public Health Senior Officer
6	Lauren D'Mello-Guyett	The London School of Hygiene & Tropical Medicine	Assistant Professor at the Faculty of Infectious and Tropical Diseases
7	Baptiste Lecuyot	Solidarities International	WASH Coordinator
8	Toriquel Islam	NGO Forum Bangladesh	Operations Manager
9	Paula Morcillo de Amuedo	ARUP	Senior Consultant
10	Anna Greaves	ARUP	Senior Consultant
11	Elizabeth Seeman	Impact/REACH	Kenya/Somalia Country Coordinator and climate change focal point



Annex 2 – Key informants

	Name	Organisation
1	Michel Beck	Netherlands RC
2	Jose Gestí	Sanitation and Water for All
3	Sera Young	Northwestern University
4	Siobhán McGrath	International Organization for Migration
5	Lauren D’Mello-Guyett	The London School of Hygiene & Tropical Medicine
6	Tom Heath	Stockholm International Water Institute
7	Pasquale Capizzi	ARUP
8	Barbara Evans	EPSRC Centre for Doctoral Training Water-WISER
9	Toriqul Islam	NGO Forum for Public Health Bangladesh
10	Guy Howard	University of Bristol
11	Nicole Weber	Save the Children
12	Katrice King	Foreign, Commonwealth, Development Office (FCDO)
13	Matt Bentley	USAID
14	Antoine Walter	Georg Fischer Piping Systems
15	Katrina Charles	University of Oxford – REACH Project
16	Natalie Rzehak	German Toilet Organization
17	Ahmad Masoud	Acted
18	Remi Kaupp	Container Based Sanitation Alliance
19	George Wainaina	Eawag
20	Kelly Willis	Malaria No More
21	Jill John Kall	International Medical Corps
22	Tilly Alcayna	Red Cross Red Crescent Climate Centre
23	Natalya Kostandova	International Medical Corps
24	Emma Lovell	Overseas Development Institute
25	Rajeshree Sisodia	Overseas Development Institute
26	Lynn Chestit	Wokike

Annex 3

Focus group discussion – facilitation guide

Through a literature review, 21 essential challenges to the WASH sector as a result of climate change have been identified. After a first ranking exercise, seven of these areas have been selected for the current stage of the research.

Participants of the group discussion are requested to examine these thematically and identify opportunities for research and innovation.

Content

- PowerPoint to introduce the research project and discussion objective
- Methodology for facilitating the group discussion session
- One-pager for printing, each describing one theme to be discussed (each document reminding the guiding questions to define research and innovation opportunities, giving a short title to be reported on top of flip chart and report as well as any guidance for discussion):
 1. Increased infectious disease prevalence and risk of outbreak (as a result of changes in temperature and precipitation; extreme weather events; and displacement to areas of high population density and poor sanitation conditions).
 2. Limited access to WASH services for vulnerable population groups affects their capacity to maintain hygiene.
 3. Increased water demand and poor management of competing demands increase risks of water scarcity.
 4. Extreme weather events increase domestic water supply pollution.

5. People fail to engage in adaptation activities which could help in preventing increasing disease transmission risks (as a result of existing norms and beliefs, competing concerns and other psychological or situational barriers).
6. Decreased surface water and groundwater availability.
7. People and WASH actors fail to engage in adaptation activities because of high level of uncertainty around future impacts of climate change.

- Consent form for people sharing their name and contact details.
- Reporting format for facilitator.

Methodology – session guide

Output: For each of the selected themes a list of 5 to 10 ranked problem statements that could be solved by innovation or research.

Choose a location with enough walls and/or tables for posting up to 21 flip charts.



Climate Change Adaptation Workshop Brief – 2 hours total session

Time	Activity	Resources Required	Outputs
15 min	<p>Introduction – PPT</p> <p>Depending on the size of the group: plan five to seven groups, three to five people per group. If there are not enough people for seven groups, then with a simple hands-up vote establish which of the seven themes people are most interested in and do fewer topics aiming to have a minimum of four people per group.</p>	<p>Use PPT 1 CCA ELRHA project intro</p> <p>Provide at least three flip chart sheets for each group to record the discussion results: one for challenges/problem statement that can be solved by research, one for those that can be solved by innovation and one for any other challenges.</p>	
<p>Themes are labelled on the sheets as 1. Infectious Diseases 2. Limited Access 3. Water Demand 4. Water Pollution 5. Barriers & Enablers 6. Water Availability 7. Climate Uncertainty</p>			
50 min	<p>Exploration of the theme: Each group reads the one-pager and answers the questions: Question 1: Can you describe what this theme looks like in your country or area of operation?</p> <p>Question 2: What are the challenges you are facing in order to mitigate the risks analysed in question 1, and what research, innovation guidance or other means would you need in order to solve these challenges?</p> <p>Assign a note-taker – key points on a flip chart or A4 paper as preferred.</p>	<p>Flip charts, pens and markers, printed one-page description of each thematic for each table with guiding question on the meaning of “research”, “innovation” and “other means”.</p> <p>Paper on tables all with the clear theme of that group.</p>	
40 min	<p>Feedback from each group (5 min each), presenting the table (as described in the theme one-pager). Other participants can propose additions, or inform if any ongoing project or communities coping mechanism respond to any idea proposed by the groups.</p>		<p>Photo of each flip chart with key points of the answers for each question.</p>
20 min	<p>If time allows, try a ranking exercise: Each participant goes through every theme and votes for the three most important actions/items per theme.</p> <p>1 vote = 1 tick with a marker pen.</p> <p>Facilitator wrap-up & was this useful – The End.</p>	<p>Marker pens.</p>	<p>Take a photo of each flip chart after the ranking exercise.</p>

Theme 1

Increased infectious diseases prevalence and risk of outbreak (because of changes in temperature and precipitation; extreme weather events; and displacement to areas of high population density and poor sanitation conditions)

Short title (to record on paper notes and flip chart): **Infectious diseases**

Climate change and its impacts provide favourable conditions for pathogens and vectors carrying pathogens to develop and disseminate into new communities and countries. Movement of population and the mixing of communities with different experience of contact with pathogens reduces the protective herd immunity effect, increasing the likelihood of disease outbreaks as well as increasing the burden on health systems and households due to infection diseases. Which new disease transmission risks will people face that they are not prepared for? How will WASH actors be informed of new risks? Which activities are WASH actors used to doing in a certain way but will increase the proliferation of vectors? How does the WASH sector support health systems and communities to mitigate, prepare and respond to new risks?

Discuss the theme going through the following guiding questions:

Question 1: Can you describe what this theme looks like in your country or area of operation? To ease the discussion, separate between vector-borne diseases (such as those carried by mosquitoes or snails) and waterborne diseases (such as cholera) that you are aware of. How does climate change impact directly (extreme heat, intense rain event, long, dry period) and indirectly (through human and environment response) their proliferation?

When WASH projects and activities intersect with these diseases' transmission pathways, do they favour or reduce the proliferation of vectors and pathogens?

Question 2: What are the challenges you are facing in order to mitigate the risks analysed in question 1, and what research, innovation, guidance or other means would you need in order to solve these challenges? Record your input following the table template below (column 1, list the challenges – column 2, list the topic/ issues you need to research – column 3, list the innovation needs – column 4, list the type of guidance to support the implementation of any known solution – column 5, any other solution not fitting the other categories).

Use the following guiding remark to classify each potential solution under the categories 'research', 'innovation' or 'other':

- If you are not able to find a solution for a challenge, is it because you don't know enough about the issues causing this challenge? If yes... then 'research' thematic should be answered.
- If you know enough of the issues causing the challenges, is there a lack of technology or approach to support you implementing/ finding a solution? If yes... then 'innovation' needs to be filled in.
- If no to both questions, category 'other' should be answered.

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other



Theme 2

Limited access to WASH services for vulnerable population groups affects their capacity to maintain hygiene

Short title (to record on paper notes and flip chart): **Limited access**

Flood, conflict (including water conflict) and loss of livelihood due to drought are all factors for peoples' displacement toward urban zones whose WASH services are rarely designed to absorb sudden increase of users. People living in informal urban settlements and in rural areas are more likely to access limited water and sanitation services at risk during extreme weather events (e.g. flooded wells and latrines, interrupted water supply or polluted water). On the other hand, a city which doesn't provide equal access to water and sanitation services is likely to face higher non-revenue water, more pollution risks and higher disease outbreak risk. With more spending required to manage the consequence of these risks, less income is used to adapt to climate change impacts. People with disabilities and poor socioeconomic status are less likely to influence decision-making on WASH services design and adaptation (e.g. renting a house without latrine or a latrine not resilient to extreme weather events such as flood).

Question 1: Can you describe what this theme looks like in your country or area of operation? Start with a few probing questions to orient the discussion: Which socioeconomic groups have limited access to WASH services and what is limiting this access (punctually or regularly)? How climate change's direct and indirect impacts (extreme heat, intense rain event, long, dry period, people displacement) affect their access to WASH services? Are there any consequences to the overall WASH

services when a section of the population has insufficient access to them (whether constantly or punctually during extreme weather events)?

Question 2: What are the challenges you are facing in order to mitigate the risks analysed in question 1, and what research, innovation, guidance or other means would you need in order to solve these challenges? Record your input following the table template below (column 1, list the challenges – column 2, list the topic/ issues you need to research – column 3, list the innovation needs – column 4, list the type of guidance to support the implementation of any known solution – column 5, any other solution not fitting the other categories).

Use the following guiding remark to classify each potential solution under the categories 'research', 'innovation' or 'other':

- If you are not able to find a solution for a challenge, is it because you don't know enough about the issues causing these challenges? If yes... then 'research' thematic should be answered.
- If you know enough of the issues causing the challenges, is there a lack of technology or approach to support you implementing/ finding a solution? If yes... then 'innovation' needs to be filled in.
- If no to both questions, category 'other' should be answered.

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Increased water demand and poor management of competing demands increase risks of water scarcity

Short title (to record on paper notes and flip chart): **Water demand**

Climate change doesn't automatically cause water scarcity but because the annual average temperature increases, there is a higher percentage of water lost through evaporation in irrigation or water supply systems. All biological systems such as plants, people and animals also need more water to rehydrate as the sweating process is essential to keep internal body temperature stable, and when it is insufficient additional water may be required for external cooling systems. With human activities competing between themselves and with environmental needs, the risks to mismanage existing water resources increase, leading to seasonal and systemic water scarcity. Not paying attention to environmental water needs decreases biodiversity and makes the environment more fragile, impacting its capacity to capture and store water.

Question 1: Can you describe what this theme looks like in your country or area of operation? Keep in mind that evaporation, environmental needs and water losses in water supply systems are also taking their share of the water resources. Some probing questions: What are the various water users (including the environment) and how are their water needs affected by climate change impacts (extreme heat, flood, long, dry spell, people and animal displacement)? Is there collaboration between users and joint planning to optimise the existing resources when allocating water permits?

Are all water users and their respective water needs considered equitably? Are water users adapting their water needs to the weather forecast?

Question 2: What are the challenges you are facing in order to mitigate the risks analysed in question 1, and what research, innovation, guidance or other means would you need in order to solve these challenges? Record your input following the table template below (column 1, list the challenges – column 2, list the topic/ issues you need to research – column 3, list the innovation needs – column 4, list the type of guidance to support the implementation of any known solution – column 5, any other solution not fitting the other categories).

Use the following guiding remark to classify each potential solution under the categories 'research', 'innovation' or 'other':

- If you are not able to find a solution for a challenge, is it because you don't know enough about the issues causing this challenge? If yes... then 'research' thematic should be answered.
- If you know enough of the issues causing the challenges, is there a lack of technology or approach to support you implementing/ finding a solution? If yes... then 'innovation' needs to be filled in.
- If no to both questions, category 'other' should be answered.

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other



Theme 4

Extreme weather events increase domestic water supply pollution

Short title (to record on paper notes and flip chart): **Water pollution**

Intense and short rain events create more important runoff carrying topsoil and any chemical and organic deposit it contains into water supply system, such as unprotected borehole or leaking distribution pipes. During flood events (especially flash floods), solid wastes are washed out into water bodies where they can decay into harmful elements. Overflowing toilet and other sanitation systems will release organic pollutant and pathogens. With higher water temperature, various chemical and biological reactions are activated or accelerated, such as chlorine decaying faster, but also more chemical elements from soil and rock are being released into groundwater or algal bloom in surface water reservoir releasing toxins. Sea-level rise and storm surge in coastal areas can increase groundwater salinisation, and higher evaporation rate and irrigation malpractice can increase salinisation in drought-prone areas.

Question 1: Can you describe what this theme looks like in your country or area of operation? What are the types of pollution affecting water supply (bacteriological, chemical from human activities such as agriculture or industry, from soil, etc.), where are they coming from and how are these sources of pollution affected by climate change's direct and indirect impact (extreme heat, flood, drought or long, dry

spells, animal and people displacement)?

Question 2: What are the challenges you are facing in order to mitigate the risks analysed in question 1, and what research, innovation, guidance or other means would you need in order to solve these challenges? Record your input following the table template below (column 1, list the challenges – column 2, list the topic/ issues you need to research – column 3, list the innovation needs – column 4, list the type of guidance to support the implementation of any known solution – column 5, any other solution not fitting the other categories).

Use the following guiding remark to classify each potential solution under the categories 'research', 'innovation' or 'other':

- If you are not able to find a solution for a challenge, is it because you don't know enough about the issues causing this challenge? If yes... then 'research' thematic should be answered.
- If you know enough of the issues causing the challenges, is there a lack of technology or approach to support you implementing/ finding a solution? If yes... then 'innovation' needs to be filled in.
- If no to both questions, category 'other' should be answered.

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Theme 5

People fail to engage in adaptation activities which could help in preventing increasing disease transmission risks (as a result of existing norms and beliefs, competing concerns and other psychological or situational barriers)

Short title (to record on paper notes and flip chart): **Enablers and barriers**

All WASH practitioners know the F-diagram and that the barriers to disease transmission are handwashing, using a toilet and drinking only safe water. Easy, right? So, what should a family do when washing hands means walking several kilometres with more jerrycans under extreme heat? And what about a family who have seen their toilet collapse every rainy season because of high water table or water runoff, and cannot afford a better adapted toilet design? Flood, drought and pollution of drinking water sources are on the rise because of climate change. How does it affect practices preventing disease transmission in a context where infectious disease prevalence will increase? What are the positive and negative practices, and what are the enablers and barriers that influence people and communities' attitudes and practices?

Question 1: Can you describe what this theme looks like in your country or area of operation?

You may want to consider the following two situations to focus your discussion:

- A severe water shortage is ongoing, water is delivered in the village once a day for 2 hours. An extreme heat event is forecast for tomorrow.
- A river crossing the village has partially damaged the water supply system and flooded the toilets of 30% of the households.

How will people's practices and behaviours adapt to this sudden change, individually and as a group? Will people be aware of disease transmission risks and try to mitigate them, or react more

to other communities or social influences? Are there positive practices that may be reduced and negative practices that may be reinforced in such situations? If such situations repeat frequently, would people give up or try to bring long-term change in their practices and behaviours?

Question 2: What are the challenges you are facing in order to mitigate the risks analysed in question 1, and what research, innovation, guidance or other means would you need in order to solve these challenges? Record your input following the table template below (column 1, list the challenges – column 2, list the topic/ issues you need to research – column 3, list the innovation needs – column 4, list the type of guidance to support the implementation of any known solution – column 5, any other solution not fitting the other categories).

Use the following guiding remark to classify each potential solution under the categories 'research', 'innovation' or 'other':

- If you are not able to find a solution for a challenge, is it because you don't know enough about the issues causing this challenge? If yes... then 'research' thematic should be answered.
- If you know enough of the issues causing the challenges, is there a lack of technology or approach to support you implementing/finding a solution? If yes... then 'innovation' needs to be filled in.
- If no to both questions, category 'other' should be answered.



Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other
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Theme 5

Decreased surface water and groundwater availability

Short title (to record on paper notes and flip chart): **Water availability**

For every additional degree Celsius, air can absorb 7% more water with two main consequences:

1 – any surface water bodies, as well as shallow aquifers, lose water faster through greater evaporation process, 2 – saturated atmosphere releases its humidity content during more intense and shorter rain events which are linked to higher percentage of runoff and less water infiltration into the ground. Climate change is not the only culprit responsible for reduced groundwater recharge. The way people manage land, and its biodiversity, has a greater impact in the capacity of soil to retain and absorb rain. Indeed, non-compacted land, well covered with deep-rooted plants, with a lively fauna (e.g. worm and other insects) has the capacity to retain water and facilitate infiltration into deeper aquifer. On the other hand, not paying attention or not knowing water storage capacity and how much water is available increases the risk of groundwater and surface water overextraction. In the long term, an overused aquifer which cannot recharge is more prone to compaction, and over time will see its storage capacity decrease.

Question 1: Can you describe what this theme looks like in your country or area of operation?

What are the different water storage systems, natural and man-made, surface or underground, you are relying on? Are they regularly refilled or not? How would they be affected by climate change's direct and indirect impact (extreme heat,

flood, drought, people and animal displacement)? Do you expect these water storages, as they are now, to be always sufficient for all needs for the next 10 to 20 years?

Question 2: What are the challenges you are facing in order to mitigate the risks analysed in question 1, and what research, innovation, guidance or other means would you need in order to solve these challenges? Record your input following the table template below (column 1, list the challenges – column 2, list the topic/ issues you need to research – column 3, list the innovation needs – column 4, list the type of guidance to support the implementation of any known solution – column, 5 any other solution not fitting the other categories).

Use the following guiding remark to classify each potential solution under the categories 'research', 'innovation' or 'other':

- If you are not able to find a solution for a challenge, is it because you don't know enough about the issues causing this challenge? If yes... then 'research' thematic should be answered.
- If you know enough of the issues causing the challenges, is there a lack of technology or approach to support you implementing/ finding a solution? If yes... then 'innovation' needs to be filled in .
- If no to both questions, category 'other' should be answered.

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other
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Theme 7

People and WASH actors fail to engage in adaptation activities because of a high level of uncertainty around future impacts of climate change

Short title (to record on paper notes and flip chart):
Climate uncertainty

Mean temperature is increasing globally, increasing the number of extreme heat events and accelerating the water cycle, which translates into shorter and more intense rain events followed by longer dry spells. Do WASH actors in your area integrate these consequences into planning and designing? The cycle of droughts and floods are increasing, but at what level? Flash floods and flash droughts are touching more regions; the sea level is rising, increasing the impact of storm surge in coastal areas. Are these a concern for you and the communities you are serving?

Global predictions are unable to predict locally if annual total precipitation will be reduced, increase or stay stable. The variations induced by climate change are chaotic and past trends don't give enough clues on what the future holds for people and communities. Not knowing what shape disasters will look like in future means people and WASH actors tend to take a 'wait-and-see' attitude, whereas climate adaptation requires decisions to be taken as soon as possible, considering finding funding and building solutions takes time that people and communities may not be able to afford. Any new disaster destroys more communal and household infrastructures. Rebuilding as before just ensures more wastage of energy while delaying necessary adaptation.

Question 1: Can you describe what this theme looks like in your country or area of operation?
 Some probing questions: What are the well-known climate change impacts in your country? Do you know what some of the solutions are? Is there a plan to implement them or do you continue with business as usual? What are the socio-technical

locks (policies, traditional budgeting practices, legal environment, etc.) that block the necessary decision-making to implement solutions to adapt to climate change impacts? Some of the solutions require collaboration between sectors (e.g. agriculture, water and sanitation), how do these sectors and their actors' interdependencies act as blockage or leverage to promote and implement innovation?

Question 2: What are the challenges you are facing in order to mitigate the risks analysed in question 1, and what research, innovation, guidance or other means would you need in order to solve these challenges? Record your input following the table template below (column 1, list the challenges – column 2, list the topic/ issues you need to research – column 3, list the innovation needs – column 4, list the type of guidance to support the implementation of any known solution – column 5, any other solution not fitting the other categories).

Use the following guiding remark to classify each potential solution under the categories 'research', 'innovation' or 'other':

- If you are not able to find a solution for a challenge, is it because you don't know enough about the issues causing this challenge? If yes... then 'research' thematic should be answered.
- If you know enough of the issues causing the challenges, is there a lack of technology or approach to support you implementing/finding a solution? If yes... then 'innovation' needs to be filled in.
- If no to both questions, category 'other' should be answered.

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other



Reporting format

Country: Facilitated by (position and organisation, name optional and only if consent form is provided)

In the following paragraph if it is not obvious from the challenge's description, please write an extra sentence on the nature of the problem

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Theme 1 Infectious diseases

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Add lines as necessary. Add any remarks on the process or challenges identified.

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Theme 2 Limited access to WASH facilities

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Add lines as necessary. Add any remarks on the process or challenges identified.

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Theme 3 Water demand

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Add lines as necessary. Add any remarks on the process or challenges identified.

Theme 4 Water pollution

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Add lines as necessary. Add any remarks on the process or challenges identified.

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Theme 5 Enablers and barriers

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Add lines as necessary. Add any remarks on the process or challenges identified.

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Theme 6 Water availability

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Add lines as necessary. Add any remarks on the process or challenges identified.



Theme 7 Climate uncertainty

Challenges (Describe the specific challenges that can be solved by innovation, research or other means)	Research (What would be the research question?)	Innovation (What technology or approach?)	Guidance (To achieve what?)	Other

Add lines as necessary. Add any remarks on the process or challenges identified.

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Existing project or community's coping strategies addressing which theme and challenge

Name of project	Implementing agency	Location	Related theme(s)	Challenge(s) addressed by the project	Contacts email

Add lines as necessary.

Type of coping strategy	Location	Socioeconomic type of population group involved in coping strategy	Related theme(s)	Challenge(s) addressed by the coping strategy

Add lines as necessary.

Description of participant – OK to do this as a separate doc

Name (optional depending on consent)	Organisation	Position/role (engineering or hygiene promotion)	Gender	Contact email (optional depending on consent)	Signed consent form provided Y/N

Add lines as necessary.

Annexes: Photos of flip chart produced by participants, before and after ranking exercise. Consent form for people involved in existing project addressing some of the challenges and willing to share more detail (where).

Annex 4

Global survey questionnaire

Global Survey for Innovation and Research opportunities in Humanitarian Climate Change Adaptation

This questionnaire is part of a project aimed at identifying key research and innovation opportunities related to humanitarian WASH and climate change.

Page 1 – Objectives of the research

1. Identifying challenges and public health impacts. Establish what challenges an increase in extreme weather events may bring to WASH humanitarian responses in the next 10 to 20 years and the possible associated public health risks.
2. Identifying research and innovation opportunities. Evaluate these challenges to identify those that may represent good RESEARCH AND INNOVATION opportunities.

All responses will be anonymous, though we would like to know where you are in the world for our stats.

1. What type of organisation do you work for – drop-down list of NGO, INGO, UN, Red Cross, Government, other?
2. Is your role at – drop-down – country level, HQ, regional level?

Page 2 – Main topics

This survey asks about seven broad topics. Each of these topics has been identified as an area of humanitarian WASH that is particularly affected by climate change.

You can answer questions on as many of these topics as you wish. Please focus on those topics which you have some knowledge about, and which are particularly relevant to your work.

Please select the first topic that you want to consider – (they click on one of the seven and it takes them to the questions)

1. Increased infectious disease burden.
2. Limited access to WASH services for vulnerable groups.
3. Increased water demand induced by climate change combined.
4. Extreme weather events increase domestic water supply pollution.
5. Understanding facilitators and barriers to disease transmission pathways is complicated by psychological factors vis-à-vis climate change and adaptation.
6. Climate change affects both surface and groundwater availability.
7. Climate uncertainty impacts the capacity of household, communities and WASH practitioners to take decisions to invest in solutions participating in climate adaptation.

Through a literature review, series of focus groups and key informant interviews, the following issues related to [Increased prevalence of infectious diseases] have been identified as requiring further research, innovation or development of guidance.

By research, in this context we mean that there is a need for further investigation of the issue before a solution is found.

By innovation, we mean that there is a process of creating and implementing new ideas, products or methods that provide novel solutions or improvements.

By development of guidance, we mean that research evidence exists, and innovation activities have been conducted, but that the results have not been pulled together into guidance that can be used by humanitarian WASH actors, and there is a need to create and disseminate this guidance.



1.0 Increased prevalence of infectious diseases

1.1 If you think any of the issues below should be a priority for research, please indicate by selecting the box (maximum 2). If you do not think any of these issues require new research, please go to the next question

- How diseases are spreading/forecast to spread in countries where humanitarians operate.
- How to strengthen surveillance systems to identify disease outbreaks (including inclusion of new and emerging diseases).
- How to better link disease surveillance and early warning systems to health and WASH responses.
- Genetic and biological control methods as alternatives to traditional insecticides for vector control.
- How to engage communities in vector control efforts, especially in mobile or underserved populations.
- The behaviour and persistence of cholera vibrio in specific locations and triggers for outbreaks.
- The effectiveness of existing WASH activities in preventing infectious disease transmission in different contexts.

1. Please enter any comments or further explanation of your answer here:

1.1 From the list below, please indicate two issues that you think should be a priority for **innovation** activities. If you do not think any of these issues require new research, please go to the next question:

- Utilising AI and big data to forecast disease outbreaks based on climate and environmental data.
- Using technological/mobile solutions to speed up the collection, analysis and flow of information from primary healthcare sites to central decision-making bodies.

- Developing integrated disease surveillance systems that combine health, environmental and climate data to provide a comprehensive picture of disease risks.
- Improving intra- and inter-organisational communication and decision-making to improve responses to early warning and surveillance of infectious diseases.
- Using biological control methods as alternatives to traditional insecticides for vector control.
- Engaging communities in vector-control efforts, especially in mobile or underserved populations.
- Using new approaches for analysing AWD transmission pathways in different contexts.

Please enter any comments or further explanation of your answer here:

From the list below, please indicate one or two issues that you think should be a priority for development of guidance. If you do not think any of these issues require new research, please go to the next question.

- Prioritising, designing and setting up AWD/cholera preventive measures and infrastructure.
- Integrated vector management strategies that integrate multiple control methods for sustainable vector management in humanitarian settings.
- Engaging communities in vector-control efforts, especially in mobile or underserved populations.
- Improving intra- and inter-organisational communication and decision-making to improve responses to early warning and surveillance of infectious diseases.

Please enter any comments or further explanation of your answer here. If you are aware of any existing guidance on any of these topics, please put titles or links here:

Page 4 – Main topics (again, but now with option to leave)

This survey asks about seven broad topics. Each of these topics has been identified as an area of humanitarian WASH that is particularly affected by climate change.

You can answer questions on as many of these topics as you wish. Please focus on those topics which you have some knowledge about, and which are particularly relevant to your work.

If you wish to consider another topic, please select it below. If you wish to finish the survey, please select “I do not wish to consider any more topics.”

1. Increased infectious disease burden.
2. Limited access to WASH services for vulnerable groups.
3. Increased water demand induced by climate change combined.
4. Extreme weather events increase domestic water supply pollution.
5. Understanding facilitators and barriers to disease transmission pathways is complicated by psychological factors vis-à-vis climate change and adaptation.
6. Climate change affects both surface and groundwater availability.
7. Climate uncertainty impacts the capacity of household, communities and WASH practitioners to take decisions to invest in solutions participating in climate adaptation.

Page 5 – Limited access to WASH services for vulnerable groups

Through a literature review, series of focus groups and key informant interviews, the following issues related to [Limited access to WASH services for vulnerable groups] have been identified as requiring further research, innovation or development of guidance.

By research, in this context we mean that there is a need for further investigation of the issue before a solution is found.

By innovation, we mean that there is a process of creating and implementing new ideas, products or methods that provide novel solutions or improvements.

By development of guidance, we mean that research evidence exists, and innovation activities have been conducted, but that the results have not been pulled together into guidance that can be used by humanitarian WASH actors, and there is a need to create and disseminate this guidance.

2.0 Limited access to WASH services for vulnerable groups

2.1 From the list below, please indicate one or two issues where you think that not enough research has been conducted and which you think should be a priority for new research. If you do not think any of these issues require new research, please go to the next question.

- What management models work best in humanitarian contexts/case studies?
- What professionalised services work in what contexts?
- What is that makes people use mwise and other climate risk assessment tools?
- Capacity building on maintenance of systems – what would make a difference?
- Equity in WASH Services: Research the impact of unequal access to WASH services



on health outcomes and identify effective interventions.

- Need monitoring matrices on accessibility/ who will be most affected and what can be done about it.
- Impact of Heat on WASH Services: Investigate how extreme heat affects WASH services, including construction, water demand, sanitation system performance and disease-transmission dynamics.

2.3 From the list below, please indicate two issues that you think should be a priority for innovation activities. If you do not think any of these issues require new research, please go to the next question:

- Making landfill sites more resilient to flooding.
- Heat-resilient water storage.
- Low-cost air coolers.
- WASH infrastructure designs that are resilient to extreme heat, such as shaded areas and heat-resistant materials.

2.4 From the list below, please indicate one or two issues that you think should be a priority for development of guidance. If you do not think any of these issues require new research, please go to the next question

- Surveillance and Early Warning Systems: Strengthen systems to better track and respond to disease outbreaks, including updating indicators for new or emerging diseases.
- Setting up of solid waste recycling systems.
- Increased water demand/poor management of competing demands.

3.0 Increased water demand/poor management of competing demands

3.1 From the list below, please indicate one or two issues where you think that not enough research has been conducted and which you think should be a priority for new research. If you do not think any of these issues require new research, please go to the next question.

- Demand Forecasting: Research future water demand under various climate scenarios and develop predictive models to inform planning.
- Impact of Agriculture on Water Demand: Study how agricultural practices contribute to water demand and explore alternative, water-saving methods.
- What are the best incentives for encouraging water conservation?
- A comprehensive understanding of community water use and coping strategies in times of drought and floods is needed.

3.2 From the list below, please indicate two issues that you think should be a priority for innovation activities. If you do not think any of these issues require new research, please go to the next question:

- Water Recycling and Reuse: Promote technologies and practices for water recycling and reuse, particularly in water-scarce regions.
- Low-Cost Monitoring Equipment: Develop and deploy low-cost monitoring tools for groundwater and water use, including borehole sensors and flow meters.

3.3 From the list below, please indicate one or two issues that you think should be a priority for development of guidance. If you do not think any of these issues require new research, please go to the next question:

Guidance:

- Integrated Water Resource Management (IWRM): Develop and disseminate guidelines

for implementing IWRM in humanitarian settings to ensure sustainable water use.

- Water Conservation: Provide guidance on water conservation practices and how to incentivise behavioural change in water-scarce areas.
- Need more accurate predictions and guidance on domestic water use, possibly adjusting Sphere standards.

- Investigate correlation between increasing salinity and climate change/prediction and impact including what is the cause of salinisation and what can be done to prevent it?
- Salinity mapping by country/scale of the problem.

4.2 From the list below, please indicate two issues that you think should be a priority for innovation activities. If you do not think any of these issues require new research, please go to the next question:

- How to make low-cost flood-resistant sanitation facilities.
- More water, less sanitation techniques.
- Need low-cost treatment system to eliminate fluoride and arsenic.
- Low-cost way of taking oil out of water. Follow-up on water quality in rivers/streams at risk of pollution due to mining activities, especially for toxic metals.
- Need better low-cost surveillance systems.
- Low-cost desalination – both household and community.
- Home water treatment: design appropriate water filters for home water treatment, especially for villages at risk of chemical pollution related to mining activities or the nature of geological formations.

4.3 From the list below, please indicate one or two issues that you think should be a priority for development of guidance. If you do not think any of these issues require new research, please go to the next question

- Guidance on a range of nature-based fecal sludge treatment plants.

4.0. Extreme weather events increase domestic water supply pollution

4.1 From the list below, please indicate one or two issues where you think that not enough research has been conducted and which you think should be a priority for new research. If you do not think any of these issues require new research, please go to the next question.

Research

- How to reduce algal blooms occurring, in low-cost settings, and what is the best water treatment system for eliminating the fine organic particles.
- What is the disinfection byproducts (DBP) occurrence, and how to avoid creating DBPs (some of which are carcinogenic) in water disinfection where there are fine organic particles in the water.
- How does heat affect water testing in general?
- What is the scale of chemical pollution in humanitarian context from farming and industry?
- How will water quality change as the temperature increases?
- How heat affects water treatment processes?
- Health Impact of long-term drinking of saline water.



5.0. Understanding facilitators and barriers to disease transmission pathways related to climate change and adaptation

5.1 From the list below, please indicate one or two issues where you think that not enough research has been conducted and which you think should be a priority for new research. If you do not think any of these issues require new research, please go to the next question:

- Transmission Pathways: Investigate how psychological factors influence disease transmission and assess the effectiveness of various interventions.

5.2 From the list below, please indicate two issues that you think should be a priority for innovation activities. If you do not think any of these issues require new research, please go to the next question:

- Behavioural Change Models: Develop new models to address climate-related behavioural changes that impact health, particularly in traumatised populations.
- Low-Cost Cooling Technologies: Develop low-cost air coolers, solar-powered fans and other technologies to help communities cope with extreme heat.

5.3 From the list below, please indicate one or two issues that you think should be a priority for development of guidance. If you do not think any of these issues require new research, please go to the next question:

- What is extra to normal hygiene promotion due to climate change?
- Effectiveness of WASH actors mitigation and response measures.
- Risk Communication and Community Engagement (RCCE): Provide detailed guidelines on how to effectively communicate risks and promote behaviour change in the context of climate change.
- What is the best action to take for people experiencing extreme heat?

6.0 Climate Change Affects Both Surface and Groundwater Availability

6.1 From the list below, please indicate one or two issues where you think that not enough research has been conducted and which you think should be a priority for new research. If you do not think any of these issues require new research, please go to the next question:

- Understand communities' acceptance of different types of grey water recycling and reuse initiatives.
- Instruction to ensure residual chlorine concentration is maintained at an effective concentration during extreme heat event.
- Chloramine management when using chlorine for disinfection with high organic matter content.
- Groundwater dynamics: research the effects of climate change on groundwater resources, focusing on recharge rates and the sustainability of extraction practices.

6.2 From the list below, please indicate two issues that you think should be a priority for innovation activities. If you do not think any of these issues require new research, please go to the next question:

- Low-cost grey water recycling system for institutions and households.
- Low-cost household rainwater harvesting system storage and treatment.
- Low-cost GW monitoring system.
- Low-cost watershed mapping tools and approaches to identify and monitor water surface and groundwater storages, water source's recharge zone, landslide risks, vegetation coverage – including seasonal and yearly variations.
- How to provide more natural, low-cost shading for storage and reservoirs.

- How to decrease evaporation from agriculture.
- More use of smart water technologies on all water sources – to better monitor and identify leakage from systems. Needs to be low cost and accessible.
- Aquifer recharge technologies: implement and refine technologies for enhancing groundwater recharge, including managed aquifer recharge (MAR).
- Rainwater harvesting systems: improved rainwater harvesting systems at the household and community levels to increase water availability.

6.3 From the list below, please indicate one or two issues that you think should be a priority for development of guidance. If you do not think any of these issues require new research, please go to the next question.

- Water Resource Management Plans: Develop comprehensive guidance on managing water resources in the face of climate change, incorporating both surface and groundwater considerations.
- More specific country-detailed climate predictions and consequences and prioritisation of actions.
- What are the triggers to change and increase effort to mitigate climate change impact, and how to decide what needs to be done?
- Where and what types of early warning systems are seen as working well and could be replicated/modified/improved for use by other countries?
- More accurate flooding maps and hydraulic modelling to better predict scale of flood.
- Need to understand, as climate change progresses, where will people migrate to/ scenarios and routes.
- More specific country-detailed climate predictions and consequences and prioritisation of actions.
- Need case studies on good climate change adaptation – what works well.
- How to collect and use indigenous knowledge on adaptation and nature-based solutions.
- Review efficiency of existing mitigation and adaptation measures and strategies.

7.0 Climate uncertainty impacts the capacity of households, communities and WASH practitioners to make investment decisions in climate adaptation solutions

7.1 From the list below, please indicate one or two issues where you think that not enough research has been conducted and which you think should be a priority for new research. If you do not think any of these issues require new research, please go to the next question.

- Coping mechanisms: research existing coping mechanisms used by communities to adapt to climate change and identify ways to support or improve these practices.
- Decision support tools: develop tools that assist communities and WASH practitioners in making informed decisions despite the uncertainty surrounding climate impacts.
- Cost-effective adaptation solutions: promote 'no regrets' adaptation strategies that are beneficial under a range of future climate scenarios.

7.3 From the list below, please indicate one



or two issues that you think should be a priority for development of guidance. If you do not think any of these issues require new research, please go to the next question:

- Making data on hydraulic monitoring more accessible to communities.
- Climate adaptation planning: provide detailed guidelines for planning and implementing climate adaptation measures within WASH programmes.

7. Social and behaviour change, risk communication and/or community engagement including supporting communities in community-driven environmental initiative and/or integrating local or indigenous knowledge of climate into humanitarian WASH.
8. Gender and social inclusion aspects of WASH and climate change.
9. WASH aspects of water resources management, water security, wetlands, flooding etc.
10. Other (please specify).

8.0 Capacity to Respond to Climate Change

In which areas of climate change and humanitarian WASH do you or your organisation feel you need the most improvement or support? (Please select the three most important to you)

1. Capacity in climate risk identification (including health impacts), vulnerability, resilience assessments and action planning, including access of and use of climate information/climate data.
2. Monitoring and evaluation of climate resilience and adaptation WASH interventions.
3. Design and implementation of climate-adaptive water and/or sanitation infrastructure.
4. Protecting and enhancing the environment during WASH interventions (e.g. using NEAT+ at the project planning stage; decommissioning unused latrines).
5. Implementing climate change mitigation approaches (e.g. reducing greenhouse gas emissions, integrating solar and other clean energy technologies in WASH programmes).
6. Advocacy skills and/or coordination skills around roles and responsibilities of agencies related to climate change and emergency WASH.

8.2 How would you like to learn about these topics? (Please select your three preferred options)

- In-person workshops
- Short, specific onsite certified courses by formal academic or research institutions.
- Self-paced formal online courses (e.g. DisasterReady, Agora, Kaya).
- Short videos (e.g. YouTube).
- Peer-to-peer learning groups (e.g. WhatsApp Group, LinkedIn Group, Telegram).
- Live webinars or virtual workshops.
- Mentorship, coaching or on-the-job training.
- Written guidance.
- AI/Chatbot.
- Podcasts/audio recordings.
- Other (please specify).
-

8.3 How would you like to access guidance – select your top three methods of accessing guidance from the list below.

- Written document – technical brief.
- Video.
- Podcast.
- Laptop.
- Printed document.
- Phone-compatible information.
- Online access or offline (downloadable).

Annex 5

Global survey results

Longlist – Themes by order of ranking and their respective top research and innovation opportunities

Survey respondents 181: 121 at country level (67%), 20 at regional (11%) and 40 at HQ (22%)

Issues that require both research and innovation
<p>Technologies and practices for water recycling and reuse, particularly in water-scarce regions – (98) selected by 52% country level, 55% regional and 58% HQ</p> <p>+ Low-cost grey water recycling system for institutions and households – (45) selected by 18% country level, 35% regional and 38% HQ</p>
<p>What has worked in interventions to increase access to WASH services for vulnerable groups affected by climate change? – (66) selected by 38% country level, 30% regional and 33% HQ</p> <p>+ Methods to monitor accessibility to WASH services – (46) selected by 24% country level, 25% regional and 30% HQ</p>
<p>What climate risk assessment tools communities are using and why? Factors that lead people and communities to take action on climate adaptation – ‘triggers for change’ – (62) selected by 37% country level, 45% regional and 20% HQ</p> <p>+ Decision support tools to assist communities and WASH practitioners in making informed decisions despite the uncertainty surrounding climate impacts – (53) selected by 26% country level, 30% regional</p> <p>+ Project design approaches that integrate local and external knowledge around climate adaptation – (59) selected by 45% country level, 47% regional and 33% HQ</p>
<p>How to better link disease surveillance and early warning systems to health and WASH responses – (51) selected by 28% country level, 35% regional and 25% HQ</p> <p>+ Developing integrated disease surveillance systems that combine health, environmental and climate data – (39) selected by 18% country level, 30% regional and 28% HQ</p> <p>+ Using technological/mobile solutions to speed up the collection, analysis and flow of information from primary healthcare sites to decision makers – (41) selected by 21% country level, 15% regional and 30% HQ</p> <p>+ Tool to analyse the impact of increased heat/changes in precipitation on pathogens and on disease transmission dynamics – (31) selected by 15% country level, 30% regional and 18% HQ</p>
<p>Approaches to ensuring ongoing maintenance of systems in low-resource contexts – what works? – (53) selected by 28% country level, 15% regional and 40% HQ</p> <p>+ Impact of different management models on access to WASH services – (47) selected by 26% country level, 30% regional and 23% HQ</p> <p>+ Approaches to ensuring ongoing maintenance of systems in low resource contexts – what works? – (72) selected by 40% country level, 25% regional and 45% HQ</p> <p>+ Tools to support the most appropriate management model according to context and vulnerable groups – (70) selected by 44% country level, 20% regional and 33% HQ</p>
Research
<p>Community water use and coping strategies in times of drought and floods – (80) selected by 44% country level, 60% regional and 35% HQ</p> <p>+ Coping mechanisms used by communities to adapt to impacts of climate change on WASH, and ways to support or improve these practices – (58) selected by 27% country level, 50% regional and 38% HQ</p> <p>+ Tools for understanding community water use and coping strategies in times of drought and floods – (69) selected by 40% country level, 65% regional and 20% HQ</p>
<p>How to integrate indigenous knowledge into programming – (57) selected by 36% country level, 25% regional and 23% HQ</p>
<p>The effectiveness of existing WASH activities in preventing infectious disease transmission in different contexts – (47) selected by 26% country level, 40% regional and 20% HQ</p> <p>+ The effectiveness of interventions to address behaviours around disease transmission in the context of climate change – (36) selected by 19% country level, 20% regional and 23%</p>



<p>How people prioritise and adapt their personal, food and domestic hygiene practices in different disaster settings – (46) selected by 23% country level, 30% regional and 30% HQ</p> <p>+ New models and approaches to address climate-related behavioural changes that impact health, particularly in traumatised populations – (52) selected by 27% country level, 35% regional and 30% HQ</p> <p>+ How knowledge and beliefs around climate change influence behaviours related to disease transmission – (37) selected by 21% country level, 20% regional and 18% HQ</p> <p>+ Pilot behaviour change adaptations/coping strategies and develop monitoring indicators – (50) selected by 29% country level, 25% regional and 25% HQ</p>
<p>What works in using low-cost monitoring equipment for groundwater and water use in humanitarian contexts – (90) selected by 49% country level, 35% regional and 58% HQ</p>
<p>Innovation</p>
<p>Low-cost watershed mapping tools and approaches (including water surface and groundwater storages, water sources recharge zones, landslide risks, vegetation coverage) – (36) selected by 19% country level, 25% regional and 20% HQ</p>
<p>Low-cost desalination – both household and community – (23) selected by 13% country level, 25% regional and 5% HQ</p>
<p>Modelling extreme weather impact on water quality to improve water safety plans – (32) selected by 18% country level, 20% regional and 15% HQ</p>
<p>Scale of chemical pollution in humanitarian contexts from farming & industry – (18) selected by 10% country level, 0% regional and 15% HQ</p>
<p>Cost-effective, ‘no regrets’ adaptation solutions that are beneficial under a range of future climate scenarios – (44) selected by 26% country level, 25% regional and 20% HQ</p>
<p>Demand Forecasting – understanding future water demand under various climate scenarios and develop predictive models to inform planning – (73) selected by 40% country level, 40% regional and 43% HQ</p>
<p>Country-specific, detailed climate predictions and consequences for WASH and prioritisation of actions – (68) selected by 36% country level, 50% regional and 38% HQ</p>
<p>Nature-based solutions approaches for humanitarian WASH to increase water infiltration and storage during rainfall events including extreme ones – (63) selected by 29% country level, 65% regional and 35% HQ</p>
<p>The effects of climate change on groundwater resources, focusing on recharge rates and the sustainability of extraction practices – (61) selected by 27% country level, 45% regional and 45% HQ</p>
<p>Impact of agriculture on water demand: study how agricultural practices contribute to water demand and explore alternative, water-saving methods – (56) selected by 30% country level, 30% regional and 35% HQ</p>
<p>Measurement of increased risk and/or burden of wider variety of diseases in population, which risks factors are changing due to climate change or not and how they evolve according to settings – (40) selected by 20% country level, 10% regional and 35% HQ</p>
<p>Relationships between climate change and increased salinity – (26) selected by 15% country level, 20% regional and 10% HQ</p>
<p>Methods to identify in advance likely barriers to WASH accessibility – (48) selected by 22% country level, 60% regional and 23% HQ</p>
<p>Low-cost household rainwater harvesting system, storage and treatment – (39) selected by 20% country level, 15% regional and 28% HQ</p>
<p>Cash-based approaches to support climate change adaptations (behaviours) – (37) selected by 18% country level, 20% regional and 28% HQ</p>
<p>WASH infrastructure designs (including storage) that are resilient to extreme heat – (28) selected by 15% country level, 25% regional and 13% HQ</p>
<p>Low-cost flood-resistant sanitation facilities – (26) selected by 12% country level, 20% regional and 20% HQ</p>
<p>Appropriate water filters for home water treatment, including treatment of chemical pollution – (22) selected by 12% country level, 20% regional and 10% HQ</p>

Annex 6

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