Water, Sanitation and Hygiene in Humanitarian Crises: setting the research agenda up to 2030

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ABOUT ELRHA

We are Elrha. A global organisation that finds solutions to complex humanitarian problems through research and innovation.

We are an established actor in the humanitarian community, working in partnership with humanitarian organisations, researchers, innovators, and the private sector to tackle some of the most difficult challenges facing people all over the world.

We equip humanitarian responders with knowledge of what works, so that people affected by crises get the right help when they need it most. We have supported more than 200 world-class research studies and innovation projects, championing new ideas and different approaches to evidence what works in humanitarian response. Elrha has two successful humanitarian programmes: Research for Health in Humanitarian Crises (R2HC) and the Humanitarian Innovation Fund (HIF).

The R2HC aims to improve health outcomes for people affected by humanitarian crises by strengthening the evidence base for public health interventions. Our globally-recognised research programme focuses on maximising the potential for public health research to bring about positive change and transform the effectiveness of humanitarian response.

The HIF aims to improve outcomes for people affected by humanitarian crises by identifying, nurturing and sharing more effective and scalable solutions. The HIF is our globally-recognised programme leading on the development and testing of innovation in the humanitarian system. Established in 2011, it was the first of its kind: an independent, grant-making programme open to the entire humanitarian community.

The views expressed in this paper are those of interviewees and the authors and are not necessarily those of Elrha.

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ABBREVIATIONS AND ACRONYMS

AEA	Average expert agreement
AFR	African Region
AMR	Antimicrobial resistance
CATI	Case-area targeted intervention
CBO	Cash-based organisation
CHNRI	Child Health and Nutrition Research Initiative
DBP	Disinfection by-product
EEHF	Emergency Environmental Health Forum
EMR	Eastern Mediterranean Region
EUR	European Region
FGD	Focus group discussion
FRC	Free residual chlorine
FSM	Faecal sludge management
GWC	Global WASH Cluster
HHWT	Household water treatment
HIF	Humanitarian Innovation Fund
HWISE	Household Water Insecurity Experiences
IDP	Internally displaced person
IPC	Infection, prevention and control
KII	Key informant interview
LAC	Latin American Countries
LSHTM	London School of Hygiene & Tropical Medicine
MHM	Menstrual hygiene management
NFI	Non-food item
NGO	Non-governmental organisation
OCV	Oral cholera vaccine
POU	Point of use
PWD	Person with disabilities
ROA	Region of the Americas
RPS	Research priority score
SEAR	South-East Asian Region
STH	Soil-transmitted helminth
TWG	Technical working group
WASH	Water, sanitation and hygiene
WHO	World Health Organization

FOREWORD

In 2023, the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) anticipates that a record 339 million people will need humanitarian assistance and protection – a significant increase from 274 million people at the beginning of 2022.

Given that humanitarian emergencies are occurring at increasing rates and affecting a growing number of people, evidence-based strategies and new solutions – including in water, sanitation and hygiene (WASH) – are vital to ensure that people's essential needs are met, and that they can live in dignity and are protected from WASH-related diseases.

Seeking to strengthen the collective commitments and strategic engagement of stakeholders active in the WASH sector, the Global WASH Cluster (GWC) in 2020 launched the Humanitarian WASH Road Map 2020–2025. It includes a specific initiative that focuses on research and innovation, recognising that in the context of increasing numbers of more complex humanitarian crises, evidence-based strategies are needed to ensure the delivery of high-quality and accountable WASH interventions to people affected by crises.

Building on an existing collaboration with the GWC, Elrha's Research for Health in Humanitarian Crisis (R2HC) programme commissioned a WASH research priority-setting exercise to support implementation of the road map. Using the rigorous Child Health and Nutrition Research Initiative (CHNRI) method, Lauren D'Mello-Guyett from the London School of Hygiene & Tropical Medicine (LSHTM), Daniele Lantagne from Tufts University, and Monica Ramos from the GWC led the WASH research prioritisation. This was a consultative process undertaken in collaboration with GWC member organisations, the wider WASH community of practice and other stakeholders.

Elrha is committed to supporting efforts to ensure that practitioners and health responders have timely access to evidence-based knowledge and solutions. We encourage researchers and practitioners to address the key research questions identified through the priority-setting exercise, and hope that policymakers and donors will also support this research agenda. Continued investment in research in humanitarian settings is vital if we are to ensure effective, ethical and appropriate humanitarian response to deliver WASH services to people affected by crises.

Anne Harmer
Head of R2HC Programme, Elrha

Executive summary

EXECUTIVE SUMMARY

Background

Humanitarian crises are occurring at increasing rates and affecting a growing number of people. In 2021, when this research was commissioned, an estimated 306.5 million people needed humanitarian assistance. Drivers of crises often intersect, compounding the risk of and exposure to crises. Socioeconomic fragility, conflict, climate change and infectious disease outbreaks, including COVID-19, have all played a role in increasing the number of vulnerable people globally.

With a growing number of people at risk, evidence-based strategies to aid decision-making and selection of effective, appropriate and efficient interventions for people affected by or at risk of humanitarian crises are increasingly important. Water, sanitation and hygiene (WASH) interventions should provide sustainable access to safe water and sanitation, and promote good hygiene practices with dignity, comfort and security. While WASH interventions are commonly implemented as part of humanitarian response activities, five systematic reviews conducted between 2015 and 2021 concluded that there is limited good-quality evidence on the effectiveness of WASH programmes and interventions in humanitarian crises.

The Global WASH Cluster (GWC) in 2020 launched the Humanitarian WASH Road Map 2020–2025, articulating the need to enhance the capacity of the WASH sector to deliver a predictable, quality humanitarian response through strengthened collective commitments and strategic partnerships. Partners and partner consortia developed and designed initiatives that would build the capacity and resources needed to deliver quality WASH responses. A specific initiative was developed by the London School of Hygiene & Tropical Medicine (LSHTM) and Tufts University on research and innovation that included the need for a more evidence-informed humanitarian WASH response.

Building on an existing collaboration between the GWC and Elrha, Elrha's Research for Health in Humanitarian Crises (R2HC) programme commissioned a WASH research priority-setting exercise. Using a rigorous research methodology, Lauren D'Mello-Guyett from LSHTM, Daniele Lantagne from Tufts University and Monica Ramos from the GWC led the WASH research prioritisation, in collaboration with a team of WASH academics and practitioners.

Goals and objectives

The WASH in crises research agenda has three objectives:

1. To identify areas of consensus on research gaps that should be prioritised to meet WASH policy and practice needs.
2. To direct donor funding towards these priorities.
3. To foster a collaborative environment for WASH in crises research that facilitates dialogue between implementers, researchers and policymakers.

Overview of methodology

A consultative approach, based on the Child Health and Nutrition Research Initiative (CHNRI) method was used to identify WASH research priorities in a transparent, consultative, comprehensive and replicable way. The CHNRI method has been used to prioritise multiple health topics and was adapted for the WASH in crises research agenda as a ten-step process (Table 1).

Table 1. Overview of the WASH in crises research agenda methodology

1. Selection of process managers	The project team comprised individuals from LSHTM, Tufts University, Action contre la Faim and GWC.
2. Selection of set of most useful and important criteria	The team defined five criteria by which research questions were critiqued when prioritising the research. The agreed criteria by which to judge research questions included: impact; answerability; relevancy; potential for translation; and implementability.
3. Specification of context in space, impact of interest and context in time	The project team decided on the following scope of the research: • Target populations – all countries and communities affected by or at risk of humanitarian crises (conflict, displacement, complex emergencies, disasters triggered by natural hazards, climate-induced shocks and WASH-related disease outbreaks) • Geographical scope – global, regional, country and local levels • Time scale: – present day to 2030 • Outcomes of interest – any outcome of interest
4. Rapid literature review of WASH in humanitarian crises	A rapid scoping review of the literature on WASH in humanitarian crises was conducted to inform the listing of research questions. A total of 498 journal articles were reviewed and used to generate WASH in crises research questions.

5. Key informant interviews	27 key informant interviews (KIIs) and four focus group discussions (FGDs) were arranged with WASH researchers, technical working groups (TWGs), and member and observing agencies of the GWC. Participants were asked to detail existing research questions within their agency or TWG, including published, ongoing or planned research, and what they perceived were WASH research gaps.
6. Systematic listing of research questions	Research questions were collected and compiled from the rapid scoping review; and KIIs, FGDs and other discussions among the project team. Initially, 932 research questions were listed; after de-duplication and removing questions that were not relevant, 250 remained.
7. Selection of technical experts to reflect on research questions	14 technical advisors reviewed the list of 250 research questions, reducing the list to 130.
8. Scoring of research questions	An online survey was developed and circulated via existing networks, mailing lists, contacts and social media, and posted on the GWC website. For each research question, respondents were asked to judge whether each question met each criterion by indicating "Yes" (allocated 1 point), "Maybe" (0.5 points), "No" (0 points) or "Not my Area of Expertise" (no input), respectively.
9. Calculation of scores and ranking of research questions	Over 1,500 people were invited to score the research questions; 286 took part. For each research question, the weighted research priority score (RPS) and weighted average expert agreement score (AEA) were calculated. Scores were converted into research prioritisation scores ranging from 0% to 100%.
10. Feedback and revisions	Final revisions were made with the technical advisors, which resulted in two pairs of questions being merged within the top 20 research priorities. The WASH in crises research agenda thus resulted in 128 research questions.

Research priorities for WASH in crises

Based on the prioritisation scores, the top 20 highest-scoring research questions were identified based on the collective perspectives of 286 individuals in 65 countries. Respondents were predominantly from the African Region (AFR) (33%), European Region (EUR) (24%) and Eastern Mediterranean Region (EMR) (15%); the majority were male (67%) and most respondents took the survey in English (81%). Respondents had on average 13 years' experience working in WASH and/or humanitarian programmes (range: 1–45 years). Respondents had expertise in all types of WASH interventions or aspects of humanitarian programmes (see Figure 5 in Annex 2.2 for a breakdown of respondents' expertise).

Table 2 presents the top 20 research priorities for WASH in crises. In order of frequency mentioned, the top 20 highest-scoring research questions focused on the following WASH intervention areas:

- distribution of hygiene materials or non-food items (NFIs)
- improvements to the design and implementation of WASH in crises programmes (especially inclusion of women, girls, people with disabilities (PWDs) and older adults)
- improvement of access to and use of sanitation facilities, and reduction of exposure to faeces
- behaviour change for hand, personal and domestic hygiene
- improvement of access to water sources and/or quantity of water
- addressing the burden of and risk factors for WASH-related health and non-health outcomes
- WASH-related climate change interventions
- WASH policy, coordination and/or governance.

The identified priority research questions highlight the need to optimise delivery of existing interventions to maximise their impact on people affected by or at risk of crises, as well as the need to develop or improve existing interventions and strategies.

Table 2. Top 20 research priorities for the WASH in crises research agenda

#	WASH category	Research question	Weighted average expert agreement (AEA) score (%)
1	Distribution of hygiene materials or non-food items (NFIs)	What are the best strategies for the maintenance and operational sustainability of handwashing infrastructures (eg, handwashing stations, facilities or stands) in crises?	100.0
2	Improvements to the design and implementation of WASH in crises programmes	What adaptations to WASH programmes or WASH services (including hardware and software) are appropriate, inclusive and effective for people with disabilities (PWDs) in crises?	98.0
3	Distribution of hygiene materials or non-food items (NFIs)	What WASH non-food items (NFIs) are appropriate, effective and cost-effective for distribution to households during disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19)?	96.0
4	Improvements to the design and implementation of WASH in crises programmes	How can we improve consultation with women and girls to design and provide safe, accessible WASH facilities and infrastructure (eg, sufficient water access, locks on sanitation facilities, bathing areas, appropriate menstrual hygiene management (MHM) products and disposal appropriate to needs and cultural beliefs) in crises?	95.2
5	Improving access to and use of sanitation facilities, and reducing exposure to faeces	What additional features can improve the experience and use of sanitation in humanitarian contexts (eg, lighting, locks, privacy screens, space for menstrual hygiene management (MHM), roofs, torches), particularly by women and girls?	93.6
6	Improving access to and use of sanitation facilities, and reducing exposure to faeces	How effective are existing technologies and approaches in improving sanitation uptake among people affected by crises, particularly among people with disabilities (PWDs) and young children in humanitarian crises?	93.1

7	Behaviour change interventions to improve hand, domestic and food hygiene practices	How can we identify, define and categorise the determinants and motives of hand hygiene behaviour in crises and among different population groups (eg, children, adults, people with disabilities (PWDs), etc), and at different stages of an emergency (acute, post-acute and protracted phases)?	92.5
8	Behaviour change interventions to improve hand, domestic and food hygiene practices	How can we improve and sustain hygiene practices in different humanitarian contexts (eg, disasters triggered by natural hazards, protracted crises, disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19, etc))?	92.4
9	Improving access to and use of sanitation facilities, and reducing exposure to faeces	How can we improve satisfaction with and use of sanitation facilities among people affected by crises, particularly among women and girls regarding menstrual hygiene management (MHM) infrastructure and services?	91.3
10	Distribution of hygiene materials or non-food items (NFIs)	What are the effectiveness and cost-effectiveness of in-kind distribution of WASH items (eg, soap, hygiene kits, menstrual hygiene management (MHM) materials, chlorine water treatment, water containers, etc) on health and non-health outcomes among people affected by crises?	90.6
11	Improvements to the design and implementation of WASH in crises programmes	What are the most effective methods to identify/ monitor WASH needs in host communities and urban centres impacted by population influxes?	89.9
12	Improving access to water sources and/or quantity of water	How effective is improved access to safe water (eg, coverage of water points and distribution networks) in controlling and preventing disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid and COVID-19)?	89.6
13	Improvements to the design and implementation of WASH in crises programmes	How does poor access to WASH contribute to increased risk of gender-based violence in humanitarian settings?	89.6

14	Behaviour change interventions to improve hand, domestic and food hygiene practices	How can hygiene promoters reduce disinformation or myths associated with outbreak-prone diseases (eg, cholera, Ebola, hepatitis E, typhoid and COVID-19)?	88.4
15	Burden of and risk factors for WASH-related health and non-health outcomes	What are the health outcomes (eg, increased incidence of disease, increased morbidity, increased mortality and/or increased incidence of poor mental health outcomes, etc) related to WASH experienced by people affected by crises?	88.1
16	Climate change interventions	What designs or adaptations are required for climate change-resilient water supply and sanitation infrastructure that are appropriate and effective in humanitarian contexts?	86.3
17	Distribution of hygiene materials or non-food items (NFIs)	How can organisations work with people to determine what are the most appropriate products to include in hygiene kits in different response phases (eg, acute, post-acute and protracted) or for different population groups (eg, families with young children, child-headed households, people with disabilities (PWDs), adults with incontinence, etc)?	85.9
18	WASH policy, coordination and/or governance	What are effective mechanisms to build the capacity of WASH professionals who work in emergencies?	85.8
19	Improving access to and use of sanitation facilities, and reducing exposure to faeces	What are the effectiveness and cost-effectiveness of sanitation promotion campaigns on health and non-health outcomes among people affected by crises?	85.7
20	Improving access to water sources and/or quantity of water	How can organisations support people affected by crises in accessing safe, sufficient and reliable drinking water supplies at reasonable cost?	85.6

Recommendations

The WASH in crises research agenda has identified the key evidence gaps of greatest importance to the WASH humanitarian community of practice and established a prioritised list of critical research questions.

All stakeholders are invited to use this research agenda to encourage, inspire and enable relevant and high-quality research that will be used to inform humanitarian response. A collaborative and coordinated environment is required to advance research on WASH in crises; and to strengthen capacity to identify, finance and implement relevant research to answer key humanitarian WASH questions.

The following actions are required to promote the success of the WASH in crises research agenda:

- **Academics** should adopt this research agenda and address priority evidence gaps, collaborating with humanitarian practitioners to ensure the appropriateness and relevance of research, using existing data or designing new studies, as appropriate.
- **Collaborative research teams** – comprising academics and practitioners, including from countries affected by crises – should be established to ensure evidence generated is relevant and appropriate to inform decision-making, policies, strategies, guidelines and practice.
- **Humanitarian organisations** should provide leadership to promote the importance of staff engagement with evidence and its pathways through to practice. WASH practitioners at national, regional and global levels must be supported to use new evidence generated to inform their programmes and humanitarian response.
- **WASH stakeholders**, collectively, should promote the use of knowledge brokers to bridge the gap between research and practice, and support research synthesis and translation to ensure evidence is accessible and available to end users.
- **Donors** should adopt this agenda to guide research investments and ensure funds are used efficiently to address the priority challenges and research questions identified. Interested donors could consider pooling resources to fund research that addresses the top 20 challenges.
- **The WASH community**, collectively, should use the WASH in crises research agenda to align efforts to build the evidence base, and guide investments in appropriate and effective WASH programmes until 2030.

Introduction

INTRODUCTION

Humanitarian crises are occurring at increasing rates and affecting a growing number of people. In 2021, an estimated 306.5 million people were in need of humanitarian assistance[1-5].

Drivers of crises often intersect, compounding the risk of and exposure to crises. Socioeconomic fragility, high-intensity conflict, climate change and COVID-19 have all played a role in increasing the number of vulnerable people globally[6-8]. In 2021, two fifths of people in need (120 million people) were living in countries facing a combination of high-intensity conflict, high levels of socioeconomic fragility and high levels of vulnerability to the impacts of climate change[1]. In the same year, 160.4 million people were experiencing food insecurity (food crisis, emergency or famine)[9].

The number of forcibly displaced people continues to rise; in 2021 the number of displaced persons worldwide rose to 86.3 million, 5% higher than in 2020, and the highest number ever recorded[1, 10]. At the same time, the frequency and magnitude of disease epidemics is increasing[5, 11]. This increase is attributed to microbial adaption of pathogens, climate change, changing human demographics (including increased mobility), economic development, breakdowns in public health, poverty, social inequality, and famine. Long-term, multi-dimensional crisis are increasingly becoming the new norm.

The number of countries with high levels of humanitarian need increased to 49 in 2021 from 40 countries in 2020[1]. In 2021, the number of countries experiencing protracted crisis (countries with five or more consecutive years of UN-coordinated appeals) increased to 36 in 2021, up from 34 countries in 2020. A further 20 countries were experiencing recurrent crisis, with international funding appeals to meet basic humanitarian needs in more than one consecutive prior year. Despite humanitarian needs increasing rapidly, growth in total humanitarian assistance funding has stalled. Governments and agencies are faced with increasingly difficult choices related to their aid budgets, with clear risks to development and humanitarian assistance.

Evidence-based strategies to aid decision-making and selection of effective, appropriate and efficient interventions for people affected by or at risk of humanitarian crises are increasingly important[12, 13]. Water, sanitation and hygiene (WASH) interventions should provide access to safe water and sanitation, and promote good hygiene practices with dignity, comfort and security[12]. While WASH interventions are commonly implemented as part of humanitarian response activities, five systematic reviews conducted between 2015 and 2021 concluded that there is limited good-quality evidence on the effectiveness and implementation of WASH programmes and interventions in humanitarian crises[14-18].

The operational and academic community can play an important role in addressing the evidence gap in humanitarian WASH, particularly as there are important questions that can only be addressed by conducting research in humanitarian settings[19-26]. Setting an agenda for WASH research in humanitarian crises to better inform WASH programming is integral to progress in global health. The WASH in crises research agenda will also ensure that we respond to recognised needs and gaps in the sector; ensure fair and direct benefits reach people affected by crises; and mobilise resources among governments, organisations, academic institutions and funders[19].

Setting an agenda for WASH research in humanitarian crises to better inform WASH programming is integral to progress in global health.

GOAL AND OBJECTIVES OF THE WASH IN CRISES RESEARCH AGENDA

The WASH in crises research agenda serves as a guide for researchers, humanitarian practitioners and funding agencies, providing a prioritised list of research questions that, when answered, will contribute to improved WASH policy and practice in humanitarian crises.

The WASH in crises research agenda has three objectives:

To identify areas of consensus on research gaps that should be prioritised to meet WASH policy and practice needs.

To direct donor funding towards these priorities.

To foster a collaborative environment for WASH in crises research that facilitates dialogue between implementers, researchers and policymakers.

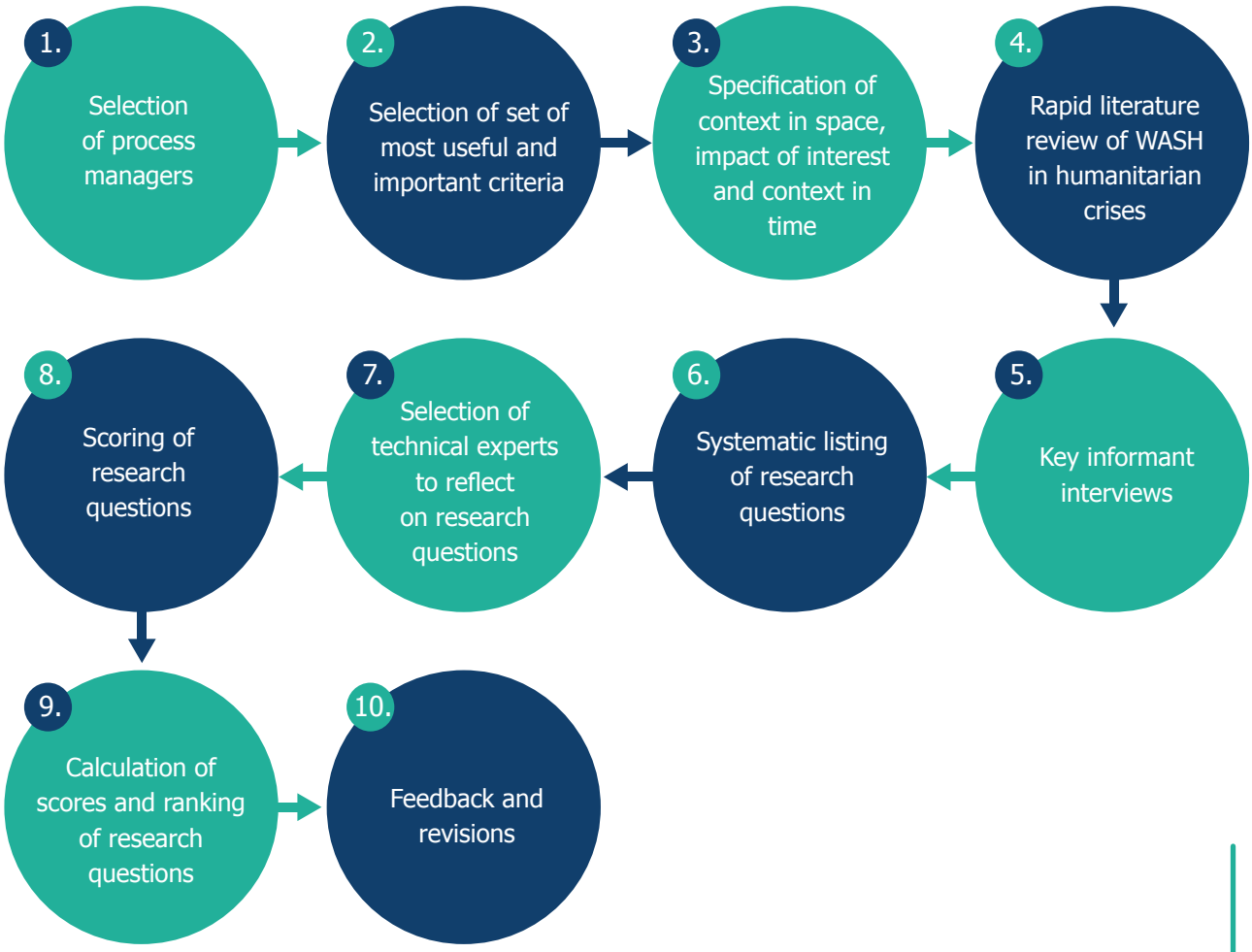
Methodology

METHODOLOGY

A consultative approach, based on the Child Health and Nutrition Research Initiative (CHNRI) method, was used to identify WASH research priorities in a transparent, consultative, comprehensive and replicable way[27-32].

CHNRI has been refined over many years and been used in several other sectors to assist stakeholders in prioritising health research investments. The CHNRI methodology was adapted for the WASH in crises research agenda. It comprised the ten steps in Figure 1.

Figure 1: The 10 steps of the CHNRI methodology adapted for the WASH in crises research agenda for prioritisation of research questions



1. Selection of process managers

A team of seven people were selected as process managers. The process managers all have extensive experience in research and policy in the area of humanitarian WASH and included: Lauren D'Mello-Guyett, Oliver Cumming and Robert Dreibelbis (London School of Hygiene & Tropical Medicine); Daniele Lantagne and Camille Heylen (Tufts University); Jean Lapègue (Action contre la Faim); and Monica Ramos (Global WASH Cluster). The process managers were invited to participate in four virtual meetings to discuss the scope of the work and provide feedback on the process. It is important to note that while these individuals helped design the process and select methods for synthesising information, identification of priorities was based solely on the data collected, as described below.

2. Selection of set of most useful and important criteria

The process managers met virtually to discuss and select five different criteria for prioritising research from a list of 15 potential criteria specified by the CHNRI methodology (Table 3). Selection was made by an online MS Forms survey (Microsoft, Redmond, VA, US), with individuals asked to distribute 100 points (5 x 20 points) across the 15 criteria based on perceived level of importance. The proposed weights were determined by dividing the mean values allocated to each criterion by 20. Once agreed on, the final list of criteria was built into how research questions were critiqued. The criteria selected are presented later in this report.

Table 3: Potential prioritisation criteria

Criterion	Definition
1. Answerability	Some research options will be more likely to be answerable than others
2. Attractiveness	Some research options will be more likely to lead to publication in high-impact journals
3. Novelty	Some research options will be more likely to generate truly novel knowledge that did not exist previously
4. Potential for translation	Some research options will be more likely to generate knowledge that will be translated into health interventions
5. Effectiveness/ impact	Some research options will be more likely to generate or improve truly effective health interventions
6. Affordability	Translation or implementation of knowledge generated through some research options will not be affordable within the context

7. Implementability/ deliverability	Some research options will lead to or impact health interventions that will not be deliverable within the context
8. Sustainability	Some research options will lead to or impact health interventions that will not be sustainable within the context
9. Public opinion	Some research options will seem more justifiable and acceptable to the public than the others
10. Ethical aspects	Some research options will seem more justified and acceptable to the public than the others
11. Maximum potential impact	Some research options will have the theoretical potential to reduce much larger portions of the existing disease burden than others
12. Equity	Some research options will lead to health interventions that will only be accessible to the privileged in the society or context, thus increasing inequity
13. Community involvement	Some research options will have more additional positive side-effects through community involvement
14. Cost and feasibility	All other criteria being equal, some research options will still require more funding than others and thus be less feasible investments
15. Likelihood of generating patents/ lucrative products	Some research options will be more likely to generate patents or other potentially lucrative products, thus promising greater financial return on investments, regardless of their impact on crises affected populations

Source: Adapted from Rudan (2008)[27]

3. Specification of context in space, impact of interest and context in time

Contextual factors determine the scope of the research agenda including the who, where, when and what of the intended research. The process managers were asked to meet and specify the context (who: target populations), context in space (where: geographic scope of the research) and time (when: time in which results may be produced) and impacts of interest (what: health and social outcomes) that would define the scope of the research agenda[27, 33, 34]. The group discussed options in a virtual meeting (Table 4).

Table 4: Proposed target populations, geographic scope, time scale and outcomes of interest

Context/target populations	All countries and communities affected by humanitarian crises (conflict, displacement, complex emergencies, disasters and disease outbreaks)
Context in space/ geographic scope	Global, regional, country and local levels
Context in time/time scale	Option 1: present day to 2025 Option 2: present day to 2030 Option 3: present day to post-2030
Impacts of interest	• Health outcomes (eg, morbidity and mortality) • Behavioural outcomes (eg, hygiene practices) • Human rights-based outcomes (right to adequate WASH, wellbeing, dignity, privacy) • Laboratory efficacy outcomes (eg, pathogen removal) • Economic outcomes • Development outcomes

4. Rapid literature review of WASH in humanitarian crises

Running concurrently to steps 1 and 3 (Figure 1), we conducted a rapid scoping review of the literature on WASH in humanitarian crises to inform the listing of research questions. The review was in line with Preferred Reporting for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines[35, 36], including pre-specified inclusion criteria. It aimed to present a thematically comprehensive synthesis of relevant published papers. Given the large number of reviews on WASH in crises completed between 2015 and 2016[14-17], as well as the updated WASH gap analysis funded by the Humanitarian Innovation Fund (HIF) and published in 2021[37], we included previously selected articles and limited our search strategy to 2016–2022.

Articles were eligible for inclusion if they adhered to the criteria below:

- **Date**: published during or after 2016
- **Language**: any language
- **Types of population/participants**: people of all ages from any country
- **Type of setting**: country or area affected by a humanitarian crisis
- **Types of studies**: all study designs
- **Types of interventions**: any WASH interventions

Working with Jane Falconer, an academic librarian at the LSHTM and Elsa Rohm, a student at Tufts University, search terms were developed according to study setting and types of interventions (Annex 1.1). Searches were conducted in a range of databases (Annex 1.2).

The searches were finalised in October 2022. The search strategy identified a total of 69,730 journal articles from database searches (as listed in Annex 1.3), 76 from manual searches, four systematic reviews that captured research on humanitarian WASH pre-2016[14-17], and four CHNRI or research prioritisation exercises that had relevant questions to WASH[33, 34, 38, 39]. Articles were screened by title and abstract, with 498 journal articles included as a source for generating research questions.

5. Key informant interviews

Simultaneous to step 4 (Figure 1), key informant interviews (KIIs) and focus group discussions (FGDs) were arranged with WASH researchers, technical working groups (TWGs) and the member agencies of the Global WASH Cluster (GWC). The process managers proposed a list of potential candidates for interviews; individuals were selected from a list using block randomisation to reflect professional and gender configurations. Block randomisation increases the probability that a data collection will contain an equal number of individuals by sequencing participant assignments by blocks or organisation type.

Interviews were semi-structured and followed a topic guide (Annex 1.4). Participants were asked to detail any existing research questions within their agency or TWG, including any published, ongoing or planned research, and what they perceived were WASH research gaps. Participants were asked to submit supporting documentation such as existing research documents, articles or reports or links to registered research projects eg, ClinicalTrials.gov[ii], PROSPERO[iii], etc.

From a list of 90 proposed interviewees, 44 were invited to participate in interviews. Of these, four individuals proposed that we should instead speak to the TWGs as a focus group. Interviews and FGDs were all held virtually via Zoom, and also recorded and automatically transcribed by Zoom. Data collection lasted one hour, with participants located either at home or in offices. Two people checked and read transcriptions separately, cleaning them manually where necessary. Informed consent was obtained prior to all interviews. Recordings and transcripts were stored on password protected-servers at LSHTM.

Some 27 KIIs and four FGDs were completed between September and December 2021. Recruitment of participants for interviews continued until the research team had determined that they had reached data saturation; specifically, the point at which participants were proposing similar research questions and topics. The number of FGDs with TWGs was decided by the availability and interest of the TWG in the research agenda exercise; all four GWC TWGs – for faecal sludge management (FSM); hygiene; menstrual hygiene management (MHM); and cash and markets – took part.

There were 23 women and 20 men included in the KIIs and FGDs. Participants were from all regions and various organisations. However, over half of informants were currently based in the European Region (EUR). This was in part due to the location of the central office of the organisation, individuals' nationality and the nature of the organisations (eg, donor agencies are predominantly found in EUR or the Region of the Americas (AMR)) (Table 5).

[ii] ClinicalTrials.gov: www.clinicaltrials.gov

[iii] PROSPERO International prospective register of systematic reviews: www.crd.york.ac.uk/prospero

[iv] Center for Open Science: www.cos.io

Table 5: Characteristics of KII and FGD respondents

Organisation type	Gender	African Region	Region of the Americas	Eastern Mediterranean Region	European Region	South-East Asian Region	Western Pacific Region	Total
Academic	Female	1	3	1	3	–	1	9
	Male	2	–	–	–	2	–	4
Donor	Female	–	3	–	–	–	–	3
	Male	–	–	–	2	–	–	2
Government	Female	–	–	–	–	–		0
	Male	–	–	–	–	–	1	1
International non-governmental organisation	Female	–	–	–	2	–	–	2
	Male	–	–	–	4	–	–	4
Multilateral agency (ie, United Nations agency)	Female	–	–	–	2	–	–	2
	Male	–	–	–	–	–	–	0
TWG	Female	–	1	–	6	–	–	7
	Male	–	1	–	8	–	–	9
Total		**3**	**8**	**1**	**27**	**2**	**2**	**43**

6. Systematic listing of research questions

The CHNRI method involves identifying and listing many possible research questions within a well-defined context. Research questions were collected and compiled from the conclusions and areas for further research sections of included articles from the rapid scoping review; and supplemented with new questions identified in the KIIs, FGDs and discussions between the process managers.

Initially, 932 research questions were identified from the various data collection methodologies employed (Table 6). After three of the process managers had de-duplicated and removed questions that were not relevant to WASH or humanitarian crises, 250 research questions remained (Figure 2).

Table 6: Number of WASH in crises research questions by data collection methodology

Stages of systematic question listing	Number of research questions	Source of research questions by data collection methodology			
		Rapid scoping review	Other CHNRI or prioritisation exercises	KIIs	FGDs
Full listing	932	480	128	294	30
After de-duplication and exclusion based on inclusion criteria	250	62	48	127	13
After technical review	130	27	12	71	11

Each of the 250 questions remaining was assigned to two categories:

- The '4Ds framework' (description, delivery, development and discovery) specified as a step in the CHNRI methodology[27, 33] (Table 7). Under the framework, 'description' includes research to assess the burden of health and non-health outcomes and determinants; 'delivery' encompasses research to evaluate already available interventions; 'development' describes research to improve existing interventions; and 'discovery' includes research that may lead to innovations or completely new interventions. Using these four themes ensures consideration of a wide breadth of possible research options.
- The relevant WASH intervention category (Table 8), where the 17 categorisations and definitions of interventions were based on definitions used in a series of previously published systematic reviews, and common terminologies from the WASH in crises sector[40-46].

Table 7: The 4Ds framework and example question types for WASH in crises research agenda

Description	Measuring the burden of WASH-related health and social outcomes
	Understanding the risk factors of WASH-related health and social outcomes
	Measuring prevalence of exposure to risk factors of WASH-related health and social outcomes
Delivery	Evaluating the efficacy of WASH interventions in a laboratory setting
	Evaluating the efficacy and effectiveness of WASH interventions in place
	Evaluating the financial/cost analysis of WASH interventions in place
	Evaluating the provision of WASH infrastructure or WASH system strengthening
	Evaluating human resources or coordination constraints or requirements
	Evaluating responsiveness and operational feasibility of WASH interventions in place
Development	Improving existing interventions (affordability)
	Improving existing interventions (deliverability)
	Improving existing interventions (effectiveness)
	Improving the responsiveness and operational feasibility of WASH interventions in place
Discovery	Basic, clinical and public health research to advance existing knowledge to develop new capacities
	Basic, clinical and public health research to explore entirely novel ideas to develop new capacities
	Basic, clinical, and public health research to explore entirely novel ideas to develop new interventions

Table 8. Types and definitions of WASH interventions

Category of WASH intervention	Definition
Behaviour change interventions to improve hand, domestic and food hygiene practices	• Any intervention to improve hygiene, including: ◇ Promotion of hygiene behaviours, norms or practices surrounding personal, food and hand hygiene. ◇ Assessment and monitoring of hygiene behaviours, norms or practices, including adaptation of activities. ◇ Any named method of delivery of hygiene promotion (eg, interpersonal channels, house-to-house visits, community meetings, mass and social media, targeted areas or information, education and communication materials, or other hygiene promotion activities). ◇ Any named theory, framework or technique for hygiene promotion (eg, behaviour change communication, community engagement, social marketing and demand creation, integrated hardware).
Burden of and risk factors for WASH-related health and non-health outcomes	• Burden of poor health or non-health outcomes related to WASH in humanitarian contexts, or a description of any WASH-related risk factors for health and non-health outcomes in humanitarian contexts. • Any WASH-related risks or exposures that may affect people affected by crises.
Cash, vouchers and market-based WASH programmes	• Cash and voucher assistance: all programmes where cash transfers or vouchers for goods or services are directly provided to recipients – in the context of humanitarian assistance. The term refers to the provision of cash transfers or vouchers given to individuals, households or community recipients, not to governments or other state actors. They exclude remittances and microfinance in humanitarian interventions, though microfinance and money transfer institutions may be used for the actual delivery of cash. • WASH market-based programming: interventions that work through or support local WASH markets. The term covers all types of engagement with market systems, ranging from actions that deliver immediate relief to those that proactively strengthen and catalyse local market systems or market hubs.

Climate change interventions	• These may include, but are not limited to, a variety of solutions to mitigate climate-related risks to WASH systems; for example, reviewing and altering the location or design of a water point or latrine (to make them flood- or cyclone-proof) or technology (deeper boreholes), or promoting renewable energy instead of diesel. Such changes can ensure that a water point or latrine continue to be functional and accessible for decades, even after extreme weather events.
Distribution of hygiene materials or non-food items	• Any intervention that provides hygiene materials, handwashing facilities or use of other WASH-related materials (eg, soap, hygiene kits, water treatment products, laundry soap, cleaning products, handwashing stands, sinks and other facilities).
Improvements to the design and implementation of WASH in crises programmes	• Any intervention or general aspect of WASH programmes including multi-modal interventions or interventions that do not fit under any specific intervention category.
Improving dead body management and safe funeral practices	• Any intervention to improve safe funeral practices, funeral gatherings and management of corpses in the community.
Improving access to and use of sanitation facilities, and reducing exposure to faeces	• Any intervention to introduce, improve or expand the coverage of facilities for the safe management, disposal and treatment of excreta; in other words, to reduce direct and indirect contact with human faeces (eg, latrine construction, pour flush, composting or water-sealed flush toilet, piped sewer system, septic tank, simple pit latrines, VIP latrine, defecation trenches, or use of a potty or scoop to dispose of children's faeces).
Improving access to water sources and/or quantity of water	• Any intervention to provide a new and/or improved water supply or distribution system, or both; in other words, to reduce direct and indirect exposure to contaminated water (eg, installation of piped water supply, hand pumps, boreholes; installation or extension of distribution networks; water trucking or tankers; and protection of water sources).
Improving management of wastewater and faecal sludge	• Any intervention to improve management of wastewater and faecal sludge.

Improving quality of water: point-of-use treatment and safe storage	• Any intervention to expand use of or improve the microbiological quality of drinking water at the point of use, including: ◇ Assessment and monitoring of water quality (ie, microbiological, chemical and physical quality). ◇ Protecting the microbiological quality of water prior to consumption (eg, chemical treatment, filtration, heat treatment, flocculation, ultraviolet radiation, residual disinfection, protected distribution, improved storage).
Improving quality of water: water treatment at source	• Any intervention to improve the microbiological quality of drinking water at the source, including: ◇ Assessment and monitoring of water quality (ie, microbiological, chemical and physical quality). ◇ Removing or inactivating microbiological pathogens (eg, water source level water treatment systems, filtration, sedimentation, chemical treatment, heat treatment, ultraviolet radiation or flocculation).
Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials	• Any intervention that provides or distributes disinfection materials (eg, chlorine spraying, disinfection of clothes, disinfectants, disinfection of bedding or vehicles) or promotes household cleaning (eg, safe laundry practices, cleaning of floors and furniture).
Promotion or distribution of safe menstrual hygiene management practices or materials	• Any intervention that provides hygiene promotion or hygiene materials for menstrual hygiene management (eg, kits, pads, underwear, etc).
Provision or promotion of interventions for solid waste disposal	• Any intervention to improve solid waste disposal, particularly in public places.
Vector control interventions	• Any intervention to improve vector control (eg, flies, mosquitoes, rats, snakes etc).
WASH policy, coordination and/or governance	• Coordination, policy and governance is a critical component of any WASH response – the state of the environment has a direct impact on the welfare of communities affected by crises. Environmental considerations thus need to be considered in almost all aspects of the coordination of humanitarian response. Due to their inherent links with other sectors, WASH issues cannot be dealt with on their own, nor by a single sector; therefore, collaboration between agencies and especially those dealing with specific sectors must be engaged.

7. Selection of technical experts to reflect on research options

Once the list of 250 research questions had been refined (step 6, Figure 1), a list of technical advisors was drawn up to reflect a broad spread of geographical focus (eg, if the individual had a global, regional, national and sub-national focus that their current professional role related to), types of organisation and area of expertise. The process manager group selected 18 technical advisors from this list to reflect a wide range of individuals from operational humanitarian agencies and academic institutions, with expertise in a variety of disciplines and familiarity with WASH and WASH research (see Acknowledgments).

Bilateral discussions were held with technical advisors to refine language, remove duplicates, merge questions and provide further checks on the relevancy of the research questions included in the WASH in crises research agenda. After being reviewed by 14 of the technical advisors, the list of 250 research questions was further reduced to 130 questions (Figure 2). Of these 130 research questions, 27 originated from the rapid scoping review, 12 from other CHNRI or prioritisation exercises, 71 from KIIs and 11 from FGDs (Table 6). The number of questions per WASH category varied across the 17 WASH intervention categories (Table 9).

Figure 2: Systematic listing of research questions, and refinement of research questions by project team and technical advisors

- Research questions sourced from key informant interviews, focus group discussons and a rapid review of the literature
- Removed duplicates
- Excluded questions not related to WASH
- Exclused questions not related to humanitarian crises contexts
- Reviewed, refined and reworded by technical advisors

Table 9: Summary of the 130 research questions per 17 WASH intervention categories

Category of WASH intervention	Total number of questions included in prioritisation exercise (n)
Distribution of hygiene materials or non-food items	15
Improvements to the design and implementation of WASH in crises programmes	15
Behaviour change interventions to improve hand, domestic and food hygiene practices	14
Improving access to water sources and/or quantity of water	13
Promotion or distribution of safe menstrual hygiene management practices or materials	11
Burden of and risk factors for WASH-related health and non-health outcomes	9
Cash, vouchers and market-based WASH programmes	9
Improving management of wastewater and faecal sludge	9
Improving access to and use of sanitation facilities, and reducing exposure to faeces	7
Improving quality of water: water treatment at source	7
WASH policy, coordination and/or governance	5
Climate change interventions	3
Improving dead body management and safe funeral practices	3
Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials	3
Vector control interventions	3
Improving quality of water: point-of-use treatment and safe storage	2
Provision or promotion of interventions for solid waste disposal	2
Total	**130**

8. Scoring of research questions

Based on the feedback from the technical advisors and final revisions, an online survey was developed using a secure survey platform Qualtrics (SAP, Seattle, WA, US). The programme allowed us to list the 130 questions, with the instruction that each category of WASH intervention questions was shown in a randomised order to ensure a similar response rate for each category. Survey respondents were emailed a link to complete the survey at their own convenience. The survey was available in English, French, Spanish and Arabic. Demographic information on respondents was collected, including: gender; organisation type; cluster affiliation (WASH or other); region and country location according to World Health Organization (WHO) regions; geographic level of focus; region and country of focus for their work; years of experience in WASH; and areas of expertise.

Following a short pilot and adjustments, the survey was made available between June and September 2022. A survey link was circulated via existing networks and mailing lists (GWC; Emergency Environmental Health Forum (EEHF); and, WASH Road Map); through academic contacts at LSHTM, Tufts University, Emory University, University of North Carolina (UNC) and Johns Hopkins University (JHU); through donor contacts at the UK Foreign, Commonwealth & Development Office (FCDO) and US Agency for International Development (USAID), Elrha and the Swiss Agency for Development and Cooperation (SDC); posted to Twitter via the GWC and EEHF; and, posted on the GWC website. Respondents themselves were asked to forward the survey within their organisations, and to colleagues both within and outside the WASH sector.

The project protocol and link to the survey were presented at two international conferences, the World Water Forum in Senegal (March 2022) and EEHF in Hungary (May 2022). Internal meetings to present the project and survey were held with the four GWC TWGs (FSM, hygiene, MHM, cash and markets) and with the WASH Clusters in Lebanon, Ethiopia and Latin American Countries (LAC) region. Internal meetings with the United Nations High Commissioner for Refugees (UNHCR), WHO and the Hand Hygiene for All Initiative were also held and attendees were asked to take part in the survey.

A dedicated email address was created for the project (emergencywash.research@lshtm.ac.uk). It allowed survey respondents and other stakeholders to email the project team with questions or suggestions during the process. The email address is hosted at LSHTM and will continue to provide updates as the WASH in Crises Research and Innovation TWG develops.

9. Calculating of scores and ranking of research questions

The survey invited over 1,500 individuals to score the 130 research questions. Respondents were asked to judge whether each question met each criterion by indicating "Yes" (1 point), "Maybe" (0.5 points), "No" (0 points), or "Not my area of expertise" (no input), respectively.

Figure 3 provides two examples of how participants would have viewed the research questions in the WASH in crises research agenda survey, and how they were asked to respond to the prioritisation criteria for each question.

Figure 3: Example research questions from the WASH in crises research agenda survey

How is inadequate access to WASH related to psychosocial stress in crises contexts?	Yes	No	Maybe	Not my area of expertise
IMPACT Do you think the proposed research will contribute to improve the health, social, economic, or development outcomes of populations affected by or at-risk of humanitarian crises (conflict, displacement, complex emergencies, disasters triggered by natural hazards, climate-induced shocks, and WASH-related disease outbreaks)?	☐	☐	☐	☐
ANSWERABILITY Do you think the proposed research is answerable in humanitarian contexts and time frame (between now and 2030)?	☐	☐	☐	☐
RELEVANCY Do you think the proposed research will answer relevant evidence gaps in the crises-affected populations or contexts?	☐	☐	☐	☐
POTENTIAL FOR TRANSLATION Do you think the proposed research will be more likely to generate knowledge that will be translated into feasible health and WASH interventions?	☐	☐	☐	☐
IMPLEMENTABILITY Do you think the proposed research will lead to solutions that are implementable (e.g., feasible in crises contexts, acceptable to the crises affected populations communities)?	☐	☐	☐	☐

What designs or adaptations are required for climate change resilient water supply and sanitation infrastructure that are appropriate and effective in humanitarian contexts?	Yes	No	Maybe	Not my area of expertise
Impact Do you think the proposed research will contribute to improve the health, social, economic, or development outcomes of populations affected by or at-risk of humanitarian crises (conflict, displacement, complex emergencies, disasters triggered by natural hazards, climate-induced shocks, and WASH-related disease outbreaks)?	☐	☐	☐	☐
Answerability Do you think the proposed research is answerable in humanitarian contexts and time frame (between now and 2030)?	☐	☐	☐	☐
Relevancy Do you think the proposed research will answer relevant evidence gaps in the crises-affected populations or contexts?	☐	☐	☐	☐
Potential for translation Do you think the proposed research will be more likely to generate knowledge that will be translated into feasible health and WASH interventions?	☐	☐	☐	☐
Implementability Do you think the proposed research will lead to solutions that are implementable (e.g., feasible in crises contexts, acceptable to the crises affected populations communities)?	☐	☐	☐	☐

Two scores were calculated for each research question.

Weighted research priority score

The following formula was used, where c is the criterion used to evaluate the research question; a, is the number of criteria selected to prioritise the research question; W is the weight for each criterion; and N is the number of answers by answer type.

$$S_{Weighted\ RPS} = \frac{1}{a} \times \sum_{c=1}^{a} W_c \times \frac{(N_{Yes} \times 1) + (N_{Maybe} \times 0.5)}{N_{Yes} + N_{No} + N_{Maybe}}$$

The level of agreement between respondents was then assessed through average expert agreement (AEA), based on the proportion of scorers who gave the most common score (mode) for a question, divided by the total number of scorers who scored that question. This method of validation is unaffected by the varying number of scorers per criterion and differences in scorer composition for the different criteria. In this validation exercise, all four possible responses (Yes, No, Undecided or Insufficiently informed) are treated as valid. Therefore, if a substantial proportion of the experts respond as Insufficiently informed, the agreement score will reflect this and reduce the level of agreement rather than increase it. AEA is the average proportion of scorers who agreed on the five questions asked.

Weighted average expert agreement scores

AEA is the average proportion of scorers who agreed on the five questions asked. The following formula was used, where c is the five criteria used to evaluate the research question.

$$S_{AEA} = \frac{1}{a} \times \sum_{c=1}^{a} \frac{N_{Most\ frequent\ reponse}}{N_{Yes} + N_{No} + N_{Maybe} + N_{Not\ my\ area\ of\ expertise}}$$

Weights, which were derived by the initial allocation of 100 points by process managers (step 2), were then applied to both the research priority score (RPS) and AEA. These included: impact 0.96, answerability 0.92, relevancy 0.92, potential for translation 0.88 and implementability 0.83, respectively.

The weighted scores for AEA and RPS were calculated for each criterion for each research question. As weights were similar across prioritisation criteria, the unweighted RPS or AEA are not presented in this report.

Lastly, the final score (by method of scoring) was converted into an AEA ranging from 0% to 100%. Based on the final score, a rank was assigned to each research questions, where the highest research priority score was ranked 1 and the lowest research priority score 130.

10. Feedback and revisions

After calculating the scores and preliminary results of the WASH in crises research agenda, the project team engaged the 18 technical advisors for further input. A group of six technical advisors volunteered to assist with the final review. Individuals were requested to provide agreement on or adjustments to the AEA scores for the 130 research questions. This included merging any questions and assessing the questions for missing research options.

The technical review was completed in February 2023. It resulted in two questions that covered similar topics being merged with two other questions within the top 20 research priorities. Comments on the other questions were considered but did not change the ranking. The WASH in crises research agenda thus resulted in 128 research questions after final revisions.

In addition to the research questions listed in this project, survey respondents thought that several thematic areas were missing or required more specific questions. The themes were varied, and individuals did not always refer to specific WASH interventions, but rather to aspects of WASH programming. The thematic areas survey respondents proposed for inclusion in the next WASH in crises research agenda are listed in Annex 2.1.

Ethical approval

LSHTM and Tufts University sought ethical approval for the study as participants were recorded during the KIIs and FGDs. All interviewees received a participant information sheet and signed informed consent forms (Annex 1.5) prior to KIIs. Ethical approval was received from both LSHTM (No. 26312) and Tufts University (No. STUDY00001841).

Survey responses were anonymous as no personal identifiers or information were required from respondents. However, survey respondents were asked at the end of the survey if they would like to join the WASH in Crises Research and Innovation Group and receive further updates on the project by sharing a professional email address. A total of 140 respondents added their email addresses and have been named in the acknowledgments section of this final report (Annex 2.3).

Results

RESULTS

1. Defining the prioritisation criteria and context

Consultations with the process managers defined both the scope of the WASH in crises research agenda and the five different criteria for prioritising the research (Table 10). There was consensus among the group to amend the target population to include all population groups affected by crises, but also to extend this to people at risk of crises; and, to keep the research agenda broad in geographic scope.

The group decided that the optimal time scale for the research outputs would be limited to research that could be produced by 2030; and would include research that was specific to several or a wide variety of outcomes. Table 10 lists the context, scope and timeline of the research agenda. Similarly, it also describes the five criteria that were selected as valuable to priority research for WASH in crises. The process manager group weighted these similarly in importance, demonstrating that they are all important criteria by which to judge questions.

Table 10: WASH in crises research agenda contextual scope and prioritisation criteria for the research

Scope of research
• **Target populations**: all countries and communities affected by or at risk of humanitarian crises (conflict, displacement, complex emergencies, disasters triggered by natural hazards, climate-induced shocks, and WASH-related disease outbreaks) • **Geographical scope**: global, regional, country and local levels • **Time scale**: present to 2030 • **Outcomes of interest**: ◇ Health outcomes (eg, morbidity and mortality) ◇ Behavioural outcomes (eg, hygiene practices) ◇ Human rights-based outcomes (eg, right to adequate WASH, wellbeing, dignity, privacy) ◇ Laboratory efficacy outcomes (eg, pathogen removal) ◇ Economic outcomes (eg, cost-effectiveness, efficiency, value for money) ◇ Humanitarian-development nexus outcomes (eg, sustainability, recovery, war-to-peace transition) ◇ Climate change outcomes (eg, climate change resilience, drought resilience, climate shock resistance) ◇ Process outcomes (eg, coordination, coverage, implementation, sustainability) ◇ Inclusion outcomes (eg, inclusion of people with disabilities, women and girls, older people)

Criteria to score the research questions

- **Impact (0.96)**: Do you think the proposed research will contribute to improve the health, social, economic, or development outcomes of people affected by or at risk of humanitarian crises (conflict, displacement, complex emergencies, disasters triggered by natural hazards, climate-induced shocks, and WASH-related disease outbreaks)?
- **Answerability (0.92)**: Do you think the proposed research is answerable in humanitarian contexts and time scale (between now and 2030)?
- **Relevancy (0.92)**: Do you think the proposed research will answer relevant evidence gaps in people or contexts affected by crises?
- **Potential for translation (0.88)**: Do you think the proposed research will be more likely to generate knowledge that will be translated into feasible health and WASH interventions?
- **Implementability (0.83)**: Do you think the proposed research will lead to solutions that are implementable (eg, feasible in crises, acceptable to people and communities affected by crises)?

2 Prioritising the research questions

2.1 Characteristics of the WASH in crises research agenda survey respondents

To prioritise the research questions for WASH in crises research agenda, 286 people in 65 countries completed the prioritisation exercise[i]. Respondents were predominantly from the African Region (AFR) (33%), European Region (EUR) (24%) and Eastern Mediterranean Region (EMR) (15%); the majority were male (67%) and mostly took the survey in English (81%) (Table 11). On average, they had 13 years' experience working in WASH and/or WASH humanitarian programmes (range: 1–45 years).

Respondents had expertise in all types of WASH interventions or aspects of humanitarian programmes. They could categorise their areas of expertise according to the previously described WASH intervention categories (Table 8), with most having expertise in: improving the quality of water: point-of-use (POU) treatment and safe storage; improvements to the design and implementation of WASH in crises programmes; and behaviour change interventions to improve hand, domestic and food hygiene practices (see Annex 2.2).

Respondents were predominantly from international non-governmental organisations (NGOs) (37%), United Nations agencies (18%) and academic institutions (11%) (Table 12). Their work focused on the AFR, EMR or globally. Most worked for organisations that were part of the GWC (83%) and many were also members of other clusters (see Figure 4 for full characteristics of organisations).

[i] The response rate for the WASH in crises research agenda was higher than other previously published CHNRI exercises on malnutrition (n=146); cholera (n=138)[34]; sexual, reproductive, maternal, newborn, child and adolescent health (n=69); and early childhood development (n=69)[38].

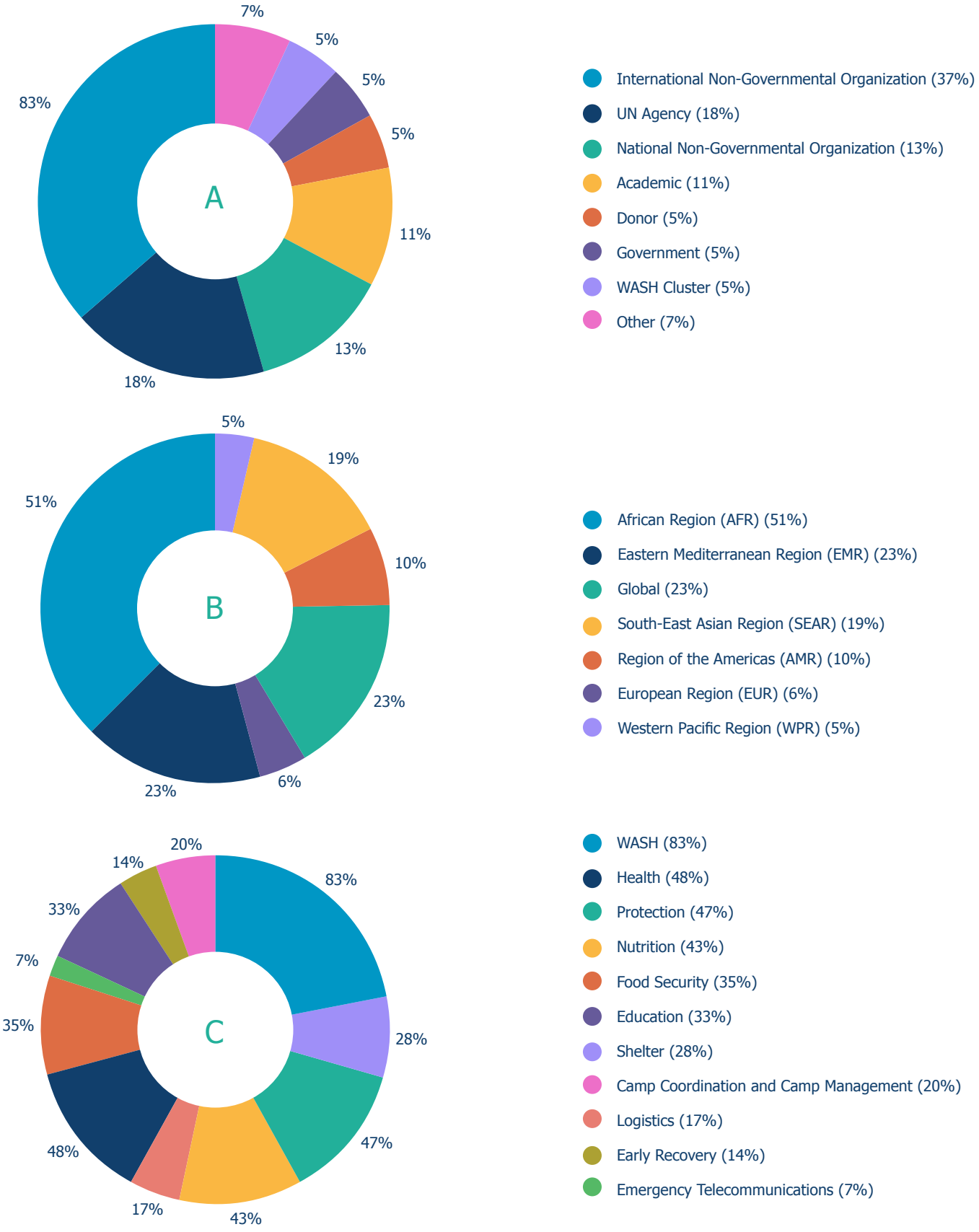
Table 11: Demographic characteristics of respondents (n=286)

	N	%
Region of origin		
African Region	94	33
European Region	68	24
Eastern Mediterranean Region	43	15
Region of the Americas	34	12
South-East Asian Region	28	10
Western Pacific Region	7	2
Not reported	12	4
Gender		
Male	192	67
Female	90	31
Non-binary	1	<1
Not reported	3	2
Language survey taken in		
English	231	81
French	25	9
Arabic	19	7
Spanish	11	3
Average experience (years)	13 (1–45)	

Table 12: Organisational characteristics of respondents (n=286)

	N	%
Region of focus		
African Region (AFR)	145	51
Eastern Mediterranean Region (EMR)	67	23
Global	67	23
South-East Asian Region (SEAR)	55	19
Region of the Americas (AMR)	30	10
European Region (EUR)	17	6
Western Pacific Region (WPR)	15	5
Member of the Global WASH Cluster		
Yes	236	83
No	29	10
Not reported	21	7
Member of other cluster		
WASH	236	83
Health	137	48
Protection	135	47
Nutrition	122	43
Food security	100	35
Education	93	33
Shelter	81	28
Camp coordination	57	20
Logistics	48	17
Early recovery	39	14
Telecommunication	19	7

Figure 4: Characteristics of the survey respondents



Key: (A) organisation type (n=286); (B) region of focus (n=396), multiple choice responses; (C) member of a humanitarian cluster; multiple choice responses (n=1,067)

2.2 Top 20 research priorities for the WASH in crises research agenda

Based on the prioritisation scores, the top 20 highest-scoring research questions were identified based on the collective perspectives of 286 individuals. The number of respondents per criterion and question ranged from 200 to 216; this was higher than the number of respondents for the remaining research questions. The AEA in the top 20 research questions was high (85.6–100%), indicating a high level of agreement among respondents. The weighted AEA was selected over the weighted RPS as a more reliable score that would not be affected by the number of respondents with knowledge of the subject matter. The weighted RPS is presented alongside the AEA in the Annex 3 to show both results.

The WASH intervention categories most commonly mentioned were, in order of frequency:

- distribution of hygiene materials or non-food items (NFIs)
- improvements to the design and implementation of WASH in crises programmes, (especially inclusion of women, girls, people with disabilities (PWDs) and older adults)
- improving access to and use of sanitation facilities, and reducing exposure to faeces
- behaviour change for hand, personal and domestic hygiene
- improving access to water sources and/or quantity of water
- burden of and risk factors for WASH-related health and non-health outcomes
- climate change interventions
- WASH policy, coordination and/or governance.

According to the 4Ds framework, the top 20 questions selected represent and highlight the need to optimise delivery of existing interventions to maximise their impact on people affected by or at risk of crises (delivery: n=8, 40%) and the need to develop or improve existing interventions and strategies (development: n=6, 30%). Some of the questions related to describing the current associated health and wellbeing burden, or practices and services of WASH interventions (description: n=5, 25%) and there was a single research question on new interventions (discovery: n=1, 5%) (Table 13). While discovery research plays an important part in humanitarian programmes, the emphasis of the WASH in crises research agenda is on implementation of research to evaluate existing interventions or develop them further, and describing the status of WASH in crises globally.

Table 13: Research questions organised by the 4Ds framework: description, delivery, development and discovery

	Questions (n=128)	Questions in the top 20 (n=20)	Proportion in the top 20 research questions (%)
Description	36	5	25
Delivery	60	8	40
Development	30	6	30
Discovery	2	1	5

Table 14 shows the key 20 priorities for the WASH in crises research agenda. The full list of 128 research questions, and their WASH intervention and 4Ds categories can be found in Annex 3.1.

Table 14: Key 20 research priorities for the WASH in crises research agenda by 4Ds framework

#	WASH category	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
1	Distribution of hygiene materials or non-food items (NFIs)	Delivery	What are the best strategies for the maintenance and operational sustainability of handwashing infrastructures (eg, handwashing stations, facilities or stands) in crises?	208	100.0
2	Improvements to the design and implementation of WASH in crises programmes	Development	What adaptations to WASH programmes or WASH services (including hardware and software) are appropriate, inclusive and effective for people with disabilities (PWDs) in crises?	209	98.0
3	Distribution of hygiene materials or non-food items (NFIs)	Development	What WASH non-food items (NFIs) are appropriate, effective and cost-effective for distribution to households during disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19)?	202	96.0
4	Improvements to the design and implementation of WASH in crises programmes	Development	How can we improve consultation with women and girls to design and provide safe, accessible WASH facilities and infrastructure (eg, sufficient water access, locks in sanitation facilities, bathing areas, appropriate menstrual hygiene management (MHM) products and disposal appropriate to needs and cultural beliefs) in crises?	213	95.2
5	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Development	What additional features can improve the experience and use of sanitation in humanitarian contexts (eg, lighting, locks, privacy screens, space for menstrual hygiene management (MHM), roofs, torches), particularly by women and girls?	207	93.6

6	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Delivery	How effective are existing technologies and approaches in improving sanitation uptake among people affected by crises, particularly among people with disabilities (PWDs) and young children in humanitarian crises?	207	93.1
7	Behaviour change interventions to improve hand, domestic and food hygiene practices	Description	How can we identify, define and categorise the determinants and motives of hand hygiene behaviour in crises and among different population groups (eg, children, adults, people with disabilities (PWDs), etc), and at different stages of an emergency (acute, post-acute and protracted phases)?	214	92.5
8	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	How can we improve and sustain hygiene practices in different humanitarian contexts (eg, disasters triggered by natural hazards, protracted crises, outbreaks (eg, of cholera, Ebola, hepatitis E, typhoid, COVID-19, etc))?	209	92.4
9	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Development	How can we improve satisfaction with and use of sanitation facilities among people affected by crises, particularly among women and girls regarding menstrual hygiene management (MHM) infrastructure and services?	200	91.3
10	Distribution of hygiene materials or non-food items (NFIs)	Delivery	What are the effectiveness and cost-effectiveness of in-kind distribution of WASH items (eg, soap, hygiene kits, menstrual hygiene management (MHM) materials, chlorine water treatment, water containers, etc) on health and non-health outcomes among people affected by crises?	202	90.6
11	Improvements to the design and implementation of WASH in crises programmes	Description	What are the most effective methods to identify/monitor WASH needs in host communities and urban centres impacted by population influxes?	214	89.9

12	Improving access to water sources and/or quantity of water	Development	How effective is improved access to safe water (eg, coverage of water points and distribution networks) in controlling and preventing outbreaks (eg, of cholera, Ebola, hepatitis E, typhoid and COVID-19)?	204	89.6
13	Improvements to the design and implementation of WASH in crises programmes	Description	How does poor access to WASH contribute to increased risk of gender-based violence in humanitarian settings?	209	89.6
14	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	How can hygiene promoters reduce disinformation or myths associated with outbreak-prone diseases (eg, cholera, Ebola, hepatitis E, typhoid and COVID-19)?	210	88.4
15	Burden of and risk factors for WASH-related health and non-health outcomes	Description	What are the health outcomes (eg, increased incidence of disease, increased morbidity, increased mortality and/or increased incidence of poor mental health outcomes, etc) related to WASH experienced by people affected by crises?	210	88.1
16	Climate change interventions	Discovery	What designs or adaptations are required for climate change-resilient water supply and sanitation infrastructure that are appropriate and effective in humanitarian contexts?	211	86.3
17	Distribution of hygiene materials or non-food items (NFIs)	Delivery	How can organisations work with people to determine what are the most appropriate products to include in hygiene kits in different response phases (eg, acute, post-acute and protracted) or for different population groups (eg, families with young children, child-headed households, people with disabilities (PWDs), adults with incontinence, etc)?	200	85.9
18	WASH policy, coordination and/or governance	Description	What are effective mechanisms to build the capacity of WASH professionals who work in emergencies?	216	85.8

19	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Delivery	What are the effectiveness and cost-effectiveness of sanitation promotion campaigns on health and non-health outcomes among people affected by crises?	207	85.7
20	Improving access to water sources and/or quantity of water	Delivery	How can organisations support people affected by crises in accessing safe, sufficient and reliable drinking water supplies at reasonable cost?	205	85.6

2.3 Top five research priorities by WASH intervention category

For the WASH sector to tackle these research questions, the top five highest-scoring questions per the 17 WASH intervention categories (see Table 8 for the definitions of WASH intervention categories) were selected to form intervention-specific research priorities. Table 9 summarises the number of questions available for the prioritisation exercise. Full text questions, scores and ranking can be seen across the following tables (Tables 15–31). Not all intervention categories had more than five questions; thus, all questions within this category are included in the top five.

a) Behaviour change interventions to improve hand, domestic and food hygiene practices

Regular and effective hygiene practices are an effective means of preventing infectious disease. Meta-analyses suggest that handwashing with soap can reduce the risk of diarrhoeal disease by 23–48%[47-49] and reduce the risk of acute respiratory infectious by 21–23%[50, 51]. However, we still do not know how best to go about promoting hygiene, or handwashing with soap, and sustainable hygiene practices in communities and especially among people affected by crises. To elicit behaviour change, it is necessary to identify factors or determinants that influence behavioural outcomes. The identified behaviour change research priorities focus on identifying these factors generally and with reference to specific population groups affected by crises (Table 15).

Table 15: Behaviour change interventions to improve hand, domestic and food hygiene practices

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
7	Description	How can we identify, define and categorise the determinants and motives of hand hygiene behaviour in crises and among different population groups (eg, children, adults, people with disabilities (PWDs), etc), and at different stages of an emergency (acute, post-acute and protracted phases)?	214	92.5
8	Delivery	How can we improve and sustain hygiene practices in different humanitarian contexts (eg, disasters triggered by natural hazards, protracted crises, disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19, etc))?	209	92.4
14	Delivery	How can hygiene promoters reduce disinformation or myths associated with outbreak-prone diseases (eg, cholera, Ebola, hepatitis E, typhoid and COVID-19)?	210	88.4
22	Delivery	To what extent are hygiene interventions (generally or by specific type of intervention) effective at improving personal and domestic hygiene behaviours among different population groups (eg, children, adults, people with disabilities (PWDs), etc), different types of displaced people (eg, internally displaced people (IDPs), refugees, people on the move) and different settings (eg, camps, host communities)?	215	85.0
26	Description	How does risk perception influence hand hygiene behaviour during disease outbreaks and how does this change over time? And can this information be used to inform programming?	214	82.6

b) Burden of and risk factors for WASH-related health and non-health outcomes

Estimating the burden of and risk factors for WASH-related health outcomes and non-health outcomes is important to identify priorities for improving population health and wellbeing, and tracking changes in the relative importance of different diseases and risk factors. The burden of health outcomes (eg, incidence of disease, morbidities and mortality) or non-health outcomes (eg, dignity, privacy, income, violence and inequality) from inadequate WASH interventions is not routinely or comparatively estimated in humanitarian crises settings[52-54]. The identified research priorities will help the sector estimate the impact of WASH-related burdens and risks, and will be in an important step in prioritising WASH interventions across people affected by or at risk of crises (Table 16).

Table 16: Burden of and risk factors for WASH-related health and non-health outcomes

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
15	Description	What are the health outcomes (eg, increased incidence of disease, increased morbidity, increased mortality and/or increased incidence of poor mental health outcomes, etc) related to WASH experienced by people affected by crises?	210	88.1
23	Description	What are the most significant non-health outcomes (eg, reduced dignity, reduced income, increased inequality, etc) related to poor access to WASH services experienced by people affected by crises?	209	84.7
24	Description	What are the specific factors during floods, droughts or other disasters triggered by natural hazards that lead to increased risk of cholera outbreaks?	205	83.3
25	Description	What are the prevalence of and risk factors for sexual abuse and assault risks related to water and sanitation access in emergencies?	209	83.1
35	Description	What are the WASH risk factors and risk factor cascades for communicable disease outbreaks in specific humanitarian settings?	205	78.7

c) Cash, vouchers and market-based WASH programmes

The distribution of cash, on its own or in conjunction with other interventions, is a widely used crisis intervention tool. Emergency cash transfer programmes or voucher-based transfers are intended to provide immediate relief to households and communities affected by crises by helping them to acquire the goods and services necessary to sustain themselves[42, 55]. Research that provides critical evaluation of whether cash and market stimulation are appropriate and effective for WASH programmes is needed, especially comparisons to distribution of NFIs or installation of WASH infrastructure or services[56, 57], and what would enable cash transfer programmes or market-based WASH solutions to work in crises (Table 17).

Table 17: Cash, vouchers and market-based WASH programmes

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
45	Delivery	Under what conditions are cash/vouchers more effective than WASH non-food item (NFI) distributions (eg, hygiene kits, menstrual hygiene management (MHM) materials, soap, cleaning products, etc) at reducing poor health outcomes among people affected by crises? And what are the advantages and disadvantages of cash/ vouchers versus distribution?	205	75.8
84	Description	What are the barriers, enablers and contextual influences that affect the use of cash and markets in humanitarian WASH programmes?	208	59.4
89	Description	What WASH interventions are most suitable for market-based solutions in various humanitarian settings?	209	56.0
90	Delivery	Under what conditions are cash/vouchers an effective means to improve access to water among people affected by crises?	207	55.5
93	Delivery	To what extent are market-based modalities more cost-efficient and effective than direct service delivery for the WASH sector in emergency settings, and what specific WASH interventions are most suitable for market-based approaches?	202	53.2

d) Climate change interventions

Climate change is leading to unprecedented changes in the frequency, intensity, location, timing and duration of extreme climate events, such as floods, droughts, cyclones and heatwaves[58]. Without mitigation, the effect of climate events and shocks will have far-reaching impacts on human and planetary health. Indeed, climate affects the incidence of infectious disease outbreaks affecting humans[59] and threatens people globally. Similarly, the risk and incidence of disasters triggered by natural hazards worsens existing WASH conditions through physical destruction of infrastructure or increasing people's water insecurity. A limited number of research questions proposed climate change interventions, which may be an indication that this is a new research area to explore. In the top 20 research priorities, one 'discovery' question focused on new designs for resilient, climate shock resistant- WASH infrastructure and how to integrate climate action into WASH programmes (Table 18).

Table 18: Climate change interventions

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
16	Discovery	What designs or adaptations are required for climate change-resilient water supply and sanitation infrastructure that are appropriate and effective in humanitarian contexts?	211	86.3
37	Discovery	What WASH interventions are available, adaptable and effective at improving household resilience to climate change-induced shocks (eg, floods, droughts) in crises?	211	78.5
58	Delivery	How can climate change actions be effectively integrated into WASH in crises programmes?	211	72.1

e) Distribution of hygiene materials or NFIs

Like many public health interventions, distribution of hygiene materials or other WASH-related NFIs – including handwashing facility provision, hygiene kits or POU water treatment – features several interacting components to deliver something appropriate and effective to target populations[12, 60-66]. Their appropriateness, effectiveness and sustainability may vary across people, contexts, and delivery modalities. In crises, it can be difficult to organise distribution in a manner that is fair, appropriate and effective, and will deliver interventions that will last or sustain behaviour change[60, 67, 68]. Operational sustainability of handwashing facilities was highlighted, along with assessing what would be appropriate to include in WASH NFI or hygiene kit distribution, and if they would be effective in outbreak and non-outbreak settings (Table 19).

Table 19: Distribution of hygiene materials or NFIs

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
1	Delivery	What are the best strategies for the maintenance and operational sustainability of handwashing infrastructures (eg, handwashing stations, facilities or stands) in crises?	208	100.0
3	Development	What WASH non-food items (NFIs) are appropriate, effective and cost-effective for distribution to households during disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19)?	202	96.0
10	Delivery	What are the effectiveness and cost-effectiveness of in-kind distribution of WASH items (eg, soap, hygiene kits, menstrual hygiene management (MHM) materials, chlorine water treatment, water containers, etc) on health and non-health outcomes among people affected by crises?	202	90.6
17	Delivery	How can organisations work with people to determine what are the most appropriate products to include in hygiene kits in different response phases (eg, acute, post-acute and protracted) or for different population groups (eg, families with young children, child-headed households, people with disabilities (PWDs), adults with incontinence, etc)?	200	85.9
31	Delivery	What are new innovative, appropriate and sustainable technologies, products or infrastructure that could facilitate hand hygiene in crises?	209	80.3

f) Improvements to the design and implementation of WASH in crises programmes

The importance of safe WASH interventions has long been recognised with regard to public health, dignity and wellbeing[47, 69-71]. There is a need to go beyond basic provision to ensure the needs of all groups are met[72, 73]. The research questions prioritised under this category related to inclusion, consultation and safety of vulnerable groups such as PWDs, and women and girls (Table 20). Other key areas identified included assessment of needs both for WASH in urban crises, and to understand water use patterns and water insecurity.

Table 20: Improvements to the design and implementation of WASH in crises programmes

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
2	Development	What adaptations to WASH programmes or WASH services (including hardware and software) are appropriate, inclusive and effective for people with disabilities (PWDs) in crises?	209	98.0
4	Development	How can we improve consultation with women and girls to design and provide safe, accessible WASH facilities and infrastructure (eg, sufficient water access, locks on sanitation facilities, bathing areas, appropriate menstrual hygiene management (MHM) products and disposal appropriate to needs and cultural beliefs) in crises?	213	95.2
11	Description	What are the most effective methods to identify/monitor WASH needs in host communities and urban centres impacted by population influxes?	214	89.9
13	Description	How does poor access to WASH contribute to increased risk of gender-based violence in humanitarian settings?	209	89.6
34	Description	What are the water use patterns (eg, drinking, cooking, personal and domestic hygiene) among people affected by crises (in various scenarios)?	214	79.1

g) Improving dead body management and safe funeral practices

For people handling dead bodies (eg, rescue workers, mortuary workers, etc), there is a risk if the deceased are infected with highly infectious diseases transmittable after death (such as Ebola, Lassa fever or cholera). The infectious agents responsible for these diseases last for varying periods after death. Questions around the design of body bags, ways to engage people and minimum requirements for dead body management featured in the research agenda. Prioritisation scores were low for this category of WASH interventions and may not be a focus area for research currently (Table 21).

Table 21: Improving dead body management and safe funeral practices

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
123	Development	How do body bag technologies compare in performance, safety and appropriateness to the local context?	209	26.9
127	Development	What are the optimal strategies, including behaviour change strategies and engaging religious leaders, for delivering interventions related to safe burial practices and funeral hygiene during disease outbreaks?	209	1.1
128	Delivery	What are the minimum requirements for safe and culturally appropriate dead body management for outbreak-prone diseases (eg, Ebola, cholera, plague, other haemorrhagic fevers)?	209	0.0

h) Improving access to and use of sanitation facilities, and reducing exposure to faeces

With an estimated 2.4 billion people who lack access to improved sanitation and 946 million still practising open defecation[74], securing high coverage and use of sanitation is essential in order to move towards better health[44, 47, 75-81] and wellbeing among people[82-84]. However, even when high sanitation coverage is achieved, users may not feel able or inclined to use the facilities available. That decision is likely influenced by several technological and behavioural factors. The research priorities identified what additional features are required to improve the safety, privacy, dignity and inclusivity of existing sanitation facilities. Research is required to understand how to best improve coverage and use for all population groups, and how to better implement interventions to reach the coverage and use thresholds required to improve health and wellbeing (Table 22).

Table 22: Improving access to and use of sanitation facilities, and reducing exposure to faeces

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
5	Development	What additional features can improve the experience and use of sanitation in humanitarian contexts (eg, lighting, locks, privacy screens, space for menstrual hygiene management (MHM), roofs, torches), particularly by women and girls?	207	93.6
6	Development	How effective are existing technologies and approaches in improving sanitation uptake among people affected by crises, particularly among people with disabilities (PWDs) and young children in humanitarian crises?	207	93.1
9	Delivery	How can we improve satisfaction with and use of sanitation facilities among people affected by crises, particularly among women and girls with regards to menstrual hygiene management (MHM)?	200	91.3
19	Development	What are the effectiveness and cost-effectiveness of sanitation promotion campaigns on health and non-health outcomes among people affected by crises?	207	85.7
52	Delivery	What are the effectiveness and cost-effectiveness of sanitation construction and repairs to sanitation facilities on health and non-health outcomes among people affected by crises?	207	73.9

i) Improving access to water sources and/or quantity of water

Although 91% of the world's population uses improved drinking water sources, 663 million people use unimproved sources such as unprotected springs, wells and surface water[74]. Furthermore, it has been estimated that 10% of improved drinking water sources are heavily contaminated with faecal materials[85]. Research has shown than improvements to water availability can result in up to a 25% reduction in diarrhoea rates[47]. As daily capita use of water decreases, the risk of faecal-oral disease and other WASH-related diseases increases, and WHO considers people with access to an average of 20 litres per capita per day to be at a "high level of health concern"[86]. Questions to be answered included understanding what level of coverage is required in humanitarian crises to prevent outbreaks of disease; to maintain access to water at reasonable costs; to mitigate water scarcity and conflicts between host and IDP/refugee communities; to rehabilitate water points; and around the impact of intermittent water supply systems on health and water quality (Table 23).

Table 23: Improving access to water sources and/or quantity of water

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
12	Development	How effective is improved access to safe water (eg, coverage of water points and distribution networks) in controlling and preventing disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid and COVID-19)?	204	89.6
20	Development	How can organisations support people affected by crises in accessing safe, sufficient and reliable drinking water supplies at reasonable cost?	205	85.6
27	Description	To what extent do water resource-related conflicts exist between refugees/internally displaced people (IDPs) and host communities? And how can water services be designed to serve both refugees/IDPs and host communities in a sustainable manner?	197	82.3
29	Delivery	What are the costs and cost-effectiveness of repairs to damaged water points or water trucking programmes compared to installation/ construction of new water supply systems in crises?	204	81.7
38	Delivery	What is the impact of intermittent water supply on diarrhoeal disease in crises and how can we ensure the microbiological quality of intermittent piped supply?	200	78.3

j) Improving management of wastewater and faecal sludge

Commonly in humanitarian contexts, it can be local contractors rather than humanitarian response agencies who undertake FSM or management of wastewater. The efficiency and efficacy of FSM or wastewater depend on the availability of services, technologies available, and operations and maintenance of any service[87]. Despite existing guidelines and efforts to improve standards on excreta and wastewater management, there are still questions to be answered. These include operations and maintenance in protracted settings; viability of technologies in closed settings or according to phases of the emergency; treatment of wastewater; and minimum standards for safe FSM (Table 24).

Table 24: Improving management of wastewater and faecal sludge

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
48	Delivery	How do we engage people affected by crises with wastewater and faecal sludge management (FSM), including the operation and maintenance of services?	212	74.9
59	Development	What are the most effective practices and technologies (including identifying alternative technologies) to collect, treat and dispose of cholera and Ebola effluent?	212	71.7
63	Delivery	How is wastewater collected, treated, reused and disposed of in closed emergency contexts (ie, camps for refugees/internally displaced people (IDPs))?	212	71.2
65	Development	What are feasible options for faecal sludge management (FSM) in the different phases of emergencies (ie, acute phase solutions or sustainable options) for scaling up?	206	70.7
79	Description	What are the minimum quality standards (physical, chemical and biological) required for safe faecal sludge plants in crises, and how can we monitor safe faecal sludge plants?	206	61.1

k) Improving water quality: POU treatment and safe storage

POU water treatment and safe storage methods have been found to improve water quality and are effective in reducing diarrhoeal illnesses[45, 47, 88]. Those technologies provide a solution when employed correctly and consistently[89], but demand and adoption remain variable (estimates of adoption vary between 0% and 90%[17]) across humanitarian contexts[90, 91]. The research priorities focus on previously identified barriers to bringing the technologies to the user and sustaining adoption, including user preference, guidance and market strategies (Table 25).

Table 25: Improving the quality of water: POU treatment and safe storage

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
21	Delivery	What is the preference for and uptake of, and how can we encourage use of, water treatment technologies among populations affected by crises?	201	85.4
119	Delivery	Do simple, targeted messages in an SMS (text message) campaign have an impact on chlorine purchase and use in crises?	201	35.3

l) Improving water quality: water treatment at source

Source-based treatments, occurring at the point of collection, have reported a reduction of diarrhoeal disease[47, 88, 92]. Interventions to improve water quality at source in humanitarian contexts usually include bulk or decentralised treatment, water trucking, chlorine dispensers or bucket chlorination[17], and are implemented where access is secured. Although research is growing in this area[93-96], water treatment at source, such as in-line chlorination or centralised treatment units rather than POU, are not often evaluated, particularly in crises, and require further evaluation. Questions to be answered relate to the efficacy of those interventions on specific pathogens and chemicals, and on chlorine dosage recommendations in emergencies (Table 26).

Table 26: Improving the quality of water: water treatment at source

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
41	Delivery	What is the efficacy, effectiveness and cost-effectiveness of non-centralised water treatment (eg, bucket chlorination, in-line, well water chlorination, etc) on health and non-health outcomes among people affected by crises?	216	77.3
46	Delivery	What are appropriate, effective and cost-effective options for centralised water treatment in emergencies, and what barriers are there to centralised treatment across crises?	215	75.4
73	Delivery	What water treatment methods are effective at treating uncommon pathogens such as hepatitis E and other viruses, and are applicable in crises?	216	66.8
96	Development	What are the treatment methods to remove high chemical content from water in areas affected by crises?	211	51.4
107	Development	Can practitioners generate site-specific and evidence-based chlorination targets for water systems in camps for refugees/ internally displaced people (IDPs), and evaluate whether these site-specific free residual chlorine (FRC) targets could increase the proportion of households that have safe water at the point of use (POU), compared to the status quo Sphere Standards FRC target?[12]	214	43.2

m) Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials

The disinfection of surfaces, devices and for cleaning and disinfecting the household environment can occur during specific disease outbreaks in humanitarian crises (eg, cholera, Ebola, COVID-19 outbreaks[40]). This largely occurs through use of chemical disinfectants such as chlorine, alcohols, formaldehydes, hydrogen peroxide and quaternary ammonium compounds[97]. Choice of chemical disinfectant, concentration, exposure time, and whether disinfection is carried out by trained personnel or households themselves is based on the risk of infection associated with the surface or device and other factors (eg, costs, practice, acceptability). There has been little evaluation of promotion or distribution of disinfection materials in humanitarian crises[98-100]. There were few research questions in this category and they were ranked low in terms of priority. The questions identified aim to understand what the minimum standards are for infection, prevention and control (IPC) in healthcare facilities for cholera and Ebola; and the efficacy, acceptability and effectiveness of chlorine spraying and surface disinfection for virus-based outbreaks (Table 27).

Table 27: Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
74	Development	What are the most essential – or the minimum set of – infection, prevention and control (IPC) interventions in cholera and Ebola treatment facilities and oral rehydration points to reduce risk of transmission within these facilities?	207	66.6
95	Delivery	Are household spraying programmes and household disinfection programmes effective, cost-effective and acceptable, and do they reduce cholera or other outbreak-prone diseases (eg, Ebola, hepatitis E, typhoid, COVID-19)?	207	51.8
124	Delivery	How efficacious is chlorine on different types of surfaces found in low-resource households and healthcare settings against SARS-CoV-2, Ebola and other viruses?	206	25.6

n) Promotion or distribution of safe MHM practices or materials

Safe and appropriate MHM layers issues of health and wellbeing outcomes with gender-based violence, inequality and human rights[101]. WASH interventions are essential to improve MHM practices as part of a cross-sectoral approach[102-104]. However, there is currently insufficient data to establish which interventions are most effective to provide safe and appropriate MHM in crises[105, 106]; and a lack of evidence-based guidelines on the effectiveness of MHM materials and supplies, and improved participatory assessments of MHM needs. The identified questions highlighted the need to improve access and availability of products for MHM or to support to populations for safe and appropriate MHM. Other questions related to the need to identify social and cultural considerations required for MHM programmes and programme delivery; and how to better integrate MHM into humanitarian WASH programmes (Table 28).

Table 28: Promotion or distribution of safe MHM practices or materials

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
30	Development	How do we improve the choice of, access to and availability of menstrual materials or menstrual hygiene management (MHM) products among women and girls affected by crises?	213	81.5
32	Delivery	What are culturally appropriate and effective menstrual hygiene management (MHM) interventions (eg, MHM materials and supplies, MHM education and promotion, disposal options and waste management, bathing and laundering areas, etc) for women and girls affected by humanitarian crises?	211	79.7
51	Description	What are the social, behavioural and cultural facilitators and barriers that impact menstrual hygiene management (MHM) among women and girls in crises?	210	73.9
56	Development	What are effective approaches that can be used to integrate hygiene management (MHM) into existing emergency responses and different phases of an emergency?	209	72.3
68	Development	What other supplies around managing menstruation are needed to support women and girls' menstrual hygiene management (MHM) practices in emergencies (eg, torch, bucket, soap, washing line, etc)?	209	68.4

o) Provision or promotion of interventions for solid waste management

Poor solid waste management may have negative consequences on public health, the environment and wellbeing[107]. But while solid waste disposal is a very visible issue, it is often a neglected area of WASH programmes. Only a few studies described the effectiveness of existing interventions for specific contexts and waste types[108-110]. Research that provides critical evaluation of solid waste disposal interventions and recycling options is needed, at community and household levels, as well as assessment of perceptions and behaviours regarding solid waste management including recycling[107] (Table 29).

Table 29: Provision or promotion of interventions for solid waste disposal

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
28	Delivery	What and how appropriate, effective and cost-effective are solid waste solutions in emergencies (including burning/incineration, recycling, reduction, biodegradable and other waste management options)?	207	82.0
86	Development	How can solid waste be managed in the absence of recycling in crises? How is solid waste managed by households in crises, and how willing are households to separate waste or recycle?	207	57.8

p) Vector control interventions

The use of single or integrated vector control interventions can play a role in controlling and reducing the burden of disease[111], but evidence-based interventions are limited in many cases due to poor conduct of vector control studies in humanitarian crises[112, 113]. The identified research priorities have suggested that research should focus on the appropriateness, effectiveness and cost-effectiveness of vector control tools for use against *Anopheles* spp., *Aedes* and *Culex* spp., scabies, lice and other vectors in crowded spaces, or in contexts with refugees and internally displaced people (IDPs). These research questions were a low priority, which may be due to vector control not being identified as a typical WASH intervention among humanitarian WASH actors; thus, it may be unclear who should undertake research on or implementation of these interventions (Table 30).

Table 30: Vector control interventions

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
106	Delivery	What are appropriate, effective and cost-effective vector control tools for use against *Anopheles* spp. mosquitoes (malaria) by people affected by crises?	208	43.8
116	Delivery	What are appropriate, effective and cost-effective vector control tools for use against *Aedes* and *Culex* spp. mosquitoes (dengue fever, chikungunya, yellow fever, lymphatic filariasis) by people affected by crises?	207	37.2
117	Delivery	What are appropriate, effective and cost-effective vector control tools used for scabies, lice and other vectors in crowded camps for refugees/internally displaced people (IDPs)?	207	36.7

q) WASH policy, coordination and/or governance

Coordination, policy and governance is a critical component of any humanitarian response[114]. Due to their inherent links with other sectors, WASH issues cannot be dealt with on their own; therefore, collaboration between agencies and other stakeholders (eg, government and private sector institutions) must be engaged[115]. However, consistent, intractable challenges remain and need to be addressed in the future. The identified research priorities included questions that would aid capacity development of WASH professionals; improve ways of working with water service providers; and aid in the transition of coordination from the emergency phase to recovery and long-term programmes, and working with different stakeholders (Table 31).

Table 31: WASH policy, coordination and/or governance

#	4Ds framework	Research question	Number of respondents (n)	Weighted AEA (%)
18	Description	What are effective mechanisms to build the capacity of WASH professionals who work in emergencies?	216	85.8
53	Development	What are effective ways of working with (formal and informal) water service institutions in emergencies?	216	73.4
54	Development	What are the barriers and facilitators to enabling funding that transitions from emergency WASH response to recovery and long-term programmes?	216	73.3
61	Description	What are the current coordination mechanisms, enabling factors for and barriers to transitionary handover of WASH services from response agencies to national governments and/or other development actors?	216	71.6
100	Development	How can intra-agency coordination aid or standardise the selection, promotion and monitoring of WASH non-food items (NFIs) (eg, hygiene kits, soap, water treatment technologies, etc) used in crises?	216	48.1

2.4 Regional and organisational lists of priorities for WASH in crises research agenda

The results of this research initiative have also been demonstrated on an online interactive data visualisation tool hosted on Elrha's website.

Lastly, given the extensive consultations conducted by the WASH in crises research agenda, we stratified research priorities by individuals focused on each of the WHO regions globally. This may help researchers and national and regional implementers identify which research questions were considered the highest priority from a national or regional perspective. There was some variation in priorities between regions, with the biggest differences being between the AMR and the AFR and EMR. This may be due to the high- or middle-income nature of countries in the AMR experiencing different types of crises compared to the AFR and EMR, and thus affecting the research priorities identified in different regions. Further analysis may be useful beyond this stratification by region to understand the extent of regional differences, what contributes to these differences and how these may change over time. The list of regional research priorities can be found in an online interactive data visualisation tool.

Similarly, we have stratified research priorities by organisation type. This shows which priorities are important to which agency, and which organisation could be willing to collaborate on prioritised topics. The research priorities identified by individuals from academic institutions varies the most from other organisational research priorities. The project team hypothesised that this may be due to academic awareness of the evidence base. Academics may be more aware than individuals in other organisations of what research already exists, and thus they have prioritised different questions as they find evidence in these areas lacking. Further analysis may be required beyond this stratification by organisation type to evaluate the differences between organisations, and to understand what contributes to their different perspectives on what should or should not be prioritised. The list of research priorities by organisation can be found in an online interactive data visualisation tool.

Discussion

DISCUSSION

Summary of findings

The WASH in crises research agenda has identified the key research gaps that are most important to the WASH sector and produce a consensus-based list of key research questions for the 2022–2030 period. From this exercise, 286 individuals prioritised and ranked the 128 final questions proposed. This exercise allowed us to identify:

- 20 key research questions for WASH in crises research agenda that spans eight areas of WASH programme implementation including:
  - distribution of hygiene materials or NFIs
  - improving access to and use of sanitation facilities, and reducing exposure to faeces
  - improvements to the design and implementation of WASH in crises programmes, (especially inclusion of women, girls, PWDs and older people)
  - behaviour change for hand, personal and domestic hygiene
  - improving access to water sources and/or quantity of water
  - burden of and risk factors for WASH-related health and non-health outcomes
  - climate change interventions
  - WASH policy, coordination and/or governance.
- Up to five key research questions for each WASH intervention category.
- Research priorities stratified by geographic location and organisation can be explored using an online interactive data visualisation tool - this may help direct researchers and national agencies to identify research priorities that are relevant to their setting and/or organisation.

Reflections on availability of WASH in crises research

Although the study used a validated approach associated with comprehensibility, good replicability and transparency, several potential considerations may arise from the methodology and limit the full potential of the CHNRI exercise to represent all research gaps in the WASH sector. These include:

- **Biased reporting of ongoing or planned research** – there can be bias in the reporting of ongoing research or planned research by agencies. Some agencies may not feel inclined to share plans for competitive bids or their avenues of funding. There may also be publication bias in the selection of studies previously published by agencies (ie, not publishing negative impact studies), which would affect the results of the literature review and how the project team systematically listed questions using

the existing evidence base.

- **Limited registered research on WASH** – the identification of open access or pre-specified protocols was limited for WASH in crises research agenda. There were few trials or observational studies registered[ii], systematic reviews listed[iii], or other study designs posted on WASH in crises[iv]. More could be done in the WASH sector to improve pre-specification, registration or posting of research updates, and also promote the protocols of new research ahead of time.

Limitations on the WASH in crises research agenda

Several limitations on how the CHNRI exercise was carried out may bias how representative the priorities selected for the WASH in crises research agenda are. These include:

- **Simplifying complex questions** – For practical reasons, questions were condensed or phrased differently to encompass many areas of WASH. Although constructive for the CHNRI exercise, it may be a reductive approach to take among complex interventions in complex settings. Further, questions had to be consolidated to reduce the length of the survey. This may have been reductive and led some participants to think that some areas of WASH had been missed out or not included in the questions in the prioritisation survey.

- **Range of agreement in the top 20 research questions and use of AEA over RPS** – The AEA in the top 20 research questions was high (85.6–100%), indicating a high level of agreement among respondents. However, this also indicates that it may have been difficult for participants to rank all research questions and decide clearly between options. The ranking may also have presented differently if we had used the weighted RPS instead of the weighted AEA. While the RPS would provide the overall score, it is affected by respondents' expertise. As WASH has such a broad variety of disciplines, the AEA allows for questions to be ranked more equally.

- **Limited involvement of all stakeholders, especially national NGOs and national governments involved in KIIs and FGDs** – Identification of evidence gaps and listing of research questions relied heavily on the network of the process managers, as well as additional consultations with TWGs and technical advisors. This approach may not have captured all the global viewpoints and WASH evidence gaps. There was suboptimal engagement with governments and individuals based outside Europe for the KIIs and FGDs. The CHNRI process is limited to those it can reach and who is able to respond. We endeavoured to reach all stakeholders and will attempt to mitigate limited reach this by presenting the results at various forums where national governments and national NGOs may be in attendance, so there will be scope for discussion about other priorities not mentioned here.

[ii] ClinicalTrials.gov: www.clinicaltrials.gov

[iii] PROSPERO International prospective register of systematic reviews: www.crd.york.ac.uk/prospero

[iv] Center for Open Science: www.cos.io

- **Lack of involvement of local communities** – The project did not consult or include the viewpoints of the communities in which the research may have been conducted. Unlike the WASH gap analysis funded by Elrha's Humanitarian Innovation Fund (HIF)[116], where researchers spoke to communities to understand innovation gaps and challenges, it would have been difficult to include community perspectives on research questions. However, the research agenda promoted the approach that when conducting research in humanitarian contexts it is important to prioritise ethical principles of consultation, feedback and dissemination.

- **Bias in self-selection for the survey** – Due to the online nature of the survey and meetings, selection bias among respondents may have been introduced through differences in who was likely to respond, internet connectivity, language of the survey or inclusion in WASH networks. This may also have led to differences in global, national and sub-national response rates.

- **Length of time taken to respond to the survey** – The survey took 2–3 hours to complete, on average. Although the survey was designed to factor in potential attrition, 612 individuals opened the link in our email, but only 286 ranked the research questions in the survey. This may bias the results, as we were not able to capture the priorities of non-responders.

- **Bias in the ranking of the 128 research questions** – This project did not quantify existing available evidence on each WASH intervention category or even each question included in the list of 128 questions included in the survey. Some may be questions where a large or robust body of evidence already exists. Furthermore, it may be that respondents were not entirely 'up to date' with most recent research findings and/or that dissemination of recent research had not yet been carried out. Thus, the ranking may have falsely prioritised certain questions, based not on what is impactful, answerable, implementable, translatable and relevant, but rather on what individuals thought there were gaps based on their current knowledge and awareness.

Expected lifespan of the WASH in crises research agenda

The identified research priorities were ranked based on current opinions agendas and environment. The lifespan of the WASH in crises research agenda is only projected to be up to 2030. Aligning with the Sustainable Development Goals, the 2030 timescale prioritises research that can be done now to put all available resources into these priorities over the next seven years. Continuous monitoring will still be required during this period, and can signal when the process needs to be refreshed or repeated in future.

The research priorities will inevitably change over time. New or unpredictable humanitarian crises may elicit new challenges and new questions. Research questions will be answered and influence change in both policy and practice, and new thematic areas could emerge and evolve. The environment itself may change and new important areas for efforts may receive attention that was previously withheld.

Other research agenda exercises have been conducted or are ongoing in this field. Examples include the 2022 Bureau for Humanitarian Assistance Emergency WASH Research and Capacity Building Priorities[v]; 2020 Cholera Road Map Research Agenda[vi]; the newly established WHO WASH and Public Health Emergencies Group, which intends to reflect on key research priorities in the post-COVID-19 era; and others that have or may develop research agendas up to 2030[33, 38, 39, 117-119]. These will align or could be in tension with the findings we have presented here. Collaboration and joint discussions between these other research agendas and across sectors will be needed to further expand the evidence base for WASH in crises.

[v] See: www.youtube.com/watch?v=XGYejyw2vLw

[vi] www.gtfcc.org/cholera-roadmap-research-agenda/

Annexes

ANNEX 1

Annex 1.1. Search terms

Search concepts

The search strategy included strings of terms, synonyms and controlled vocabulary terms (where available) to reflect the following concepts:

- Concept 1: water, sanitation and hygiene (WASH)
- Concept 2: humanitarian crises

Terms for the two concepts were combined using the Boolean operator AND to find items discussing both concepts.

Terms for concept 1 were initially derived from the searched used by Watson et al[120]. After discussion with the project team, a draft strategy was compiled in the OvidSP Medline database by an experienced information specialist, Jane Falconer. The search strategy was refined with the project team until the results retrieved reflected the scope of the project. The agreed OvidSP Medline search was adapted for each database to incorporate database-specific syntax and controlled vocabularies.

Limits

Searches were run with no limits to retrieve the widest range of material possible. However, after the searches were run and duplicates were removed, it was decided to limit the search by date; items published before 2016 were removed. Thus, only items published since the 2016 review[17] was completed were included.

No language restrictions were specified. No geographical limits were specified, to make sure items from across the world were included in the review.

Annex 1.2. Search strategy

Information sources were chosen to search as wide a selection of sources as possible. Care was taken to choose sources that included locally published titles and a variety of publication types.

Databases

The following bibliographic databases were searched on either 27 July or 3 August 2022:

- OvidSP Medline ALL – 1946 to 26 July 2022
- OvidSP Embase Classic + Embase – 1947 to 26 July 2022
- OvidSP Global Health, 1910 to 2022, week 29
- EBSCO CINAHL Complete – complete database to 3 August 2022
- EBSCO Africa-Wide Information – complete database to 3 August 2022
- Clarivate Analytics Web of Science Core Collection – this contains several databases that were searched simultaneously on 3 August 2022. These were:
  - Science Citation Index Expanded (SCI-EXPANDED) – 1970 to present
  - Social Sciences Citation Index (SSCI) – 1970 to present
  - Arts & Humanities Citation Index (AHCI) – 1975 to present
  - Conference Proceedings Citation Index-Science (CPCI-S) – 1990 to present
  - Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH) – 1990 to present
  - Emerging Sources Citation Index (ESCI) – 2017 to present
- Clarivate Analytics Web of Science SciELO – complete database to 3 August 2022
- Wiley Cochrane Library, issue 7 of 12, July 2022 – this contains several databases which were searched simultaneously on 27 July 2022. Results were retrieved from the following:
  - Cochrane Database of Systematic Reviews (CDSR)
  - Cochrane Central Register of Controlled Trials (CENTRAL)
  - Global Index Medicus – complete database to 27 July 2022

Trials registers

The following trials registers were searched on 3 August 2022:

- WHO International Clinical Trials Registry Platform (ICTRP) – complete database.
- ClinicalTrials.gov – complete database.

Information management

All citations identified by our searches were imported into EndNote 20 software. Duplicates were identified and removed using the method described on the London School of Hygiene & Tropical Medicine Library & Archives Service blog[121].

Items published before 2016 were removed in EndNote.

Annex 1.3. Search results

A total of 246,024 results were retrieved by the search; 72,003 (29%) were identified as duplicates. This left 174,021 items to screen, so it was decided to remove items published before 2016. The number of results pre- and post-deduplication, and after items published before 2016 were removed, are listed in Table 1.3.

Table 1.3: Databases and search results

Database name	Total number of results	Number of results once duplicates removed	Number of results once pre-2016 publication date items removed
OvidSP Medline ALL	37,171	34,927	13,566
Embase Classic + Embase	61,474	36,775	14,667
Global Health	31,994	21,784	6,320
CINAHL Complete	15,105	9,901	4,021
Africa-Wide Information	5,032	2,380	609
Web of Science Core Collection	86,883	62,970	28,457
SciELO	2,076	1,156	513
Cochrane Library	1,232	620	289
Global Index Medicus	5,067	3,496	1,279
ICTRP	14	11	9
ClinicalTrials.gov	47	12	9
Total	**246,024**	**174,021**	**69,730**

Annex 1.4. Key informant interview topic guide

Key Informant Interview Guide: Water, Sanitation, and Hygiene (WASH) Research in Humanitarian Crisis: The Child Health and Nutrition Research Initiative (CHNRI) Prioritisation Exercise

General information

1. Can you describe your experience and current role in WASH response in humanitarian emergencies?
2. Can you describe the role of the organization you're working with in regard to its work internationally?

Research within their organization

3. Can you describe what research means to your organization?
4. Has your organization been involved in research on WASH response in humanitarian crises?
    a. If yes, can you tell us which projects your organization has been involved with? And share any related documents, registration (eg, PROSPERO, Clinical Trials.gov, etc) or articles associated to the work?
5. Is your organization currently conducting research in WASH response in humanitarian crises?
    a. If yes, can you describe what research you are conducting?
6. Is your organization planning any research on WASH response in humanitarian crises?
    a. If yes, can you describe what research you are planning?

Gaps in WASH humanitarian crisis research

7. Have you ever found a lack of available research in a WASH area needed for your work?
    a. If so, in what areas?
8. Are there certain WASH practices or interventions you feel are not supported by research that should be?
    a. Are there certain contexts or emergencies you feel are not supported by research that should be?
9. Have you noticed research gaps in the any of the following interventions? Can you describe them if so?
    i. Water supply interventions?
    ii. Water treatment interventions?

iii. Sanitation interventions?
iv. Hygiene promotion? Or handwashing promotion?
v. Distribution of hygiene materials or other NFIs?
vi. Menstrual hygiene management?
vii. Wastewater management?
viii. Faecal sludge management?
ix. Solid waste management?
x. Combined WASH programmes?
xi. Any other specific interventions?
xii. Any other interventions to specific crises eg, dead body management, vector control?

10. Do you think that within different WASH humanitarian responses (eg, disease outbreaks, conflicts, disasters triggered by natural hazards) there are certain types of emergencies that are not as supported by research?
11. Are there any other gaps in research for WASH interventions you would recommend filling?

Annex 1.5. Participant information sheet and informed consent form

Title of research: Water, Sanitation, and Hygiene (WASH) Research in Humanitarian Crisis: the Child Health and Nutrition Research Initiative (CHNRI) Prioritisation Exercise

Sponsor: This study is supported by Elrha, UK

Investigators: Lauren D'Mello-Guyett (London School of Hygiene & Tropical Medicine, London, England) and Daniele Lantagne (Tufts University, Medford, USA).

Background:

You are being invited to take part in a research study led by the London School of Hygiene & Tropical Medicine and Tufts University in collaboration with the Global WASH Cluster. Before you decide whether to participate, it is important for you to understand why the research is being done and what it will involve. Please ask us if anything is not clear or you would like more information, and please take time to decide whether or not you wish to participate.

Purpose of the research:

The purpose of this study is to collaboratively generate a consensus-based research agenda that can steer WASH in the humanitarian crisis field for the next ten years. As part of this study, key informative interviews will be conducted among key stakeholders, including agencies, academics and donors. These stakeholders will be purposively selected based on their involvement in the emergency WASH sector. We would like to ask you about your priorities for WASH in crises research. Information sought includes qualitative information on WASH response in humanitarian emergencies, particularly working in different contexts, use of research and evidence, decision-making and programmatic aspects, and recommendations from your work.

This expert feedback from the key informant interviews will be incorporated into the final reports and peer-reviewed publication and presented virtually to the Global WASH Cluster and associated agencies.

Procedures:

If you choose to take part, participation in this study will consist of a semi-structured interview via Zoom. We expect that the interview will take about 1 hour, and we suggest you find a comfortable private room. With your permission, we will audiotape the interview solely to accurately transcribe the conversation. The transcriptions will be stored securely in secure servers at the London School of Hygiene & Tropical Medicine, UK.

Confidentiality and risk:

There is no anticipated risk if you choose to participate. Your name, position, or organization will not be specifically attributed to any quote or the standalone notion that would be identifiable. Although your participation will not be anonymous as we will collect your name, gender, titles and work experience, this information will be kept in a separate file from the written transcripts (audio recordings will be deleted). Each interview will have a code used for analysis. Since much of the interview is based on work experience, some identifiable work experience may remain in the transcript file but will not be explicit.

The database for the overall study will be maintained by the PI in a password-protected server hosted by the London School of Hygiene & Tropical Medicine, UK. All files will be destroyed after three years. With your permission, we will include your name in the acknowledgement section of the report. Please know though that you do not have to answer any questions or discuss any topics that make you feel uncomfortable.

Voluntary participation and withdrawal of participation:

Participation in this research is completely voluntary. Should you decide at any time during the interview or discussion that you no longer wish to participate, you may withdraw your consent without prejudice. To withdraw from the study, please inform the interviewer, and they will stop the interview. If you withdraw from the study, you can decide whether you want us to destroy the interview notes, or whether you allow us to use the collected data. There is no penalty should you decide not to participate in some or all of the research.

Costs and benefits:

You are not expected to incur any costs to your participation in this study, outside of the time spent conducting the interview. There are also no direct benefits to you. However, your participation will contribute to greater knowledge and understanding of WASH research in humanitarian crisis. The final report will be produced in the form of a guidance document, your participation might help to bring greater awareness and change to the operation. A copy of the final report can be sent to you if desired.

Future research studies:

Information collected during this research will not be used or distributed for future research studies.

Request for more information:

You may ask more questions about the study at any time. Please contact the research team by emailing the Principal Investigators:

- Dr. Lauren D'Mello-Guyett, London School of Hygiene & Tropical Medicine: lauren.dmello-guyett@lshtm.ac.uk
- Dr. Daniele Lantagne, Tufts University: daniele.lantagne@tufts.edu

The London School of Hygiene & Tropical Medicine holds insurance policies which apply to this study. If you experience harm or injury as a result of taking part in this study, you may be eligible to claim compensation. If you have questions or concerns about your rights as a research participant, formally complain or if you would like to discuss the study with someone outside of the research team, you may contact:

- London School of Hygiene & Tropical Medicine Ethical Review Board.
  - Patricia Henley at rgio@lshtm.ac.uk or +44 (0) 20 7927 2626
- Tufts Social Behavioral & Educational Research Institutional Review Board (Tufts SBER IRB).
  - Tufts SBER IRB, 75 Kneeland Street, 6th Floor | Boston, MA 02111
  - Telephone: 617-627-8804
  - Email: sber@tufts.edu
  - Website: https://viceprovost.tufts.edu/sberirb/

You can find out more about how your information will be used:

- At https://www.lshtm.ac.uk/files/research-participant-privacy-notice.pdf
- By asking one of the research team members
- By sending an email to DPO@lshtm.ac.uk

Signatures

The participant confirms that the purpose of the research, the study procedures, the possible risks and discomforts as well as benefits have been explained. All the participant's questions have been answered. Please complete the following information if you wish to participate:

Participant Name	
Participant Signature	
Date	

	Yes	No
Does the participant consent to participate?	☐	☐
Does the participant agree to audio recording?	☐	☐
Does the participant consent to their name being recorded?	☐	☐
Does the participant request a copy of the final report?	☐	☐
If yes, please provide your email address:		
Does the participant agree that the personal information provided under this study may be transferred to the United States?	☐	☐
Signature of PI to sign off agreement		

GDPR Extension to consent form

If the subject is physically located in the EEA, UK or Switzerland, the Data Protection Notice will be also sent (Appendix 5). Please complete the following information in addition to the consent form.

	Yes	No
I have read and considered the information presented in this form and in the Data Protection Notice. I confirm that I understand the purpose of the research and the study procedures. I understand that I may ask questions at any time and can withdraw my participation without prejudice. I have read this consent form. My signature below indicates my willingness to participate in this study.	☐	☐
Participant Name		
Participant Signature		
Date		
	Yes	No
I have read and understand the attached GDPR Data Protection Notice. I understand that my personal information, will be processed as described in the attached GDPR Data Protection Notice.	☐	☐
I consent to the transfer of any of my personal information collected in connection with this Study out of the European Economic Area, UK and Switzerland to the United States and within the UK	☐	☐
I affirmatively consent that the GDPR personal data may be used for research purposes of this study.	☐	☐
Does the participant request a copy of the final report?	☐	☐
If yes, email address:		
Does the participant agree that the personal information provided under this study may be transferred to the United States?	☐	☐
Signature of PI to sign off agreement		

ANNEX 2

Annex 2.1. New or further thematic areas for WASH in crises research agenda suggested by survey respondents

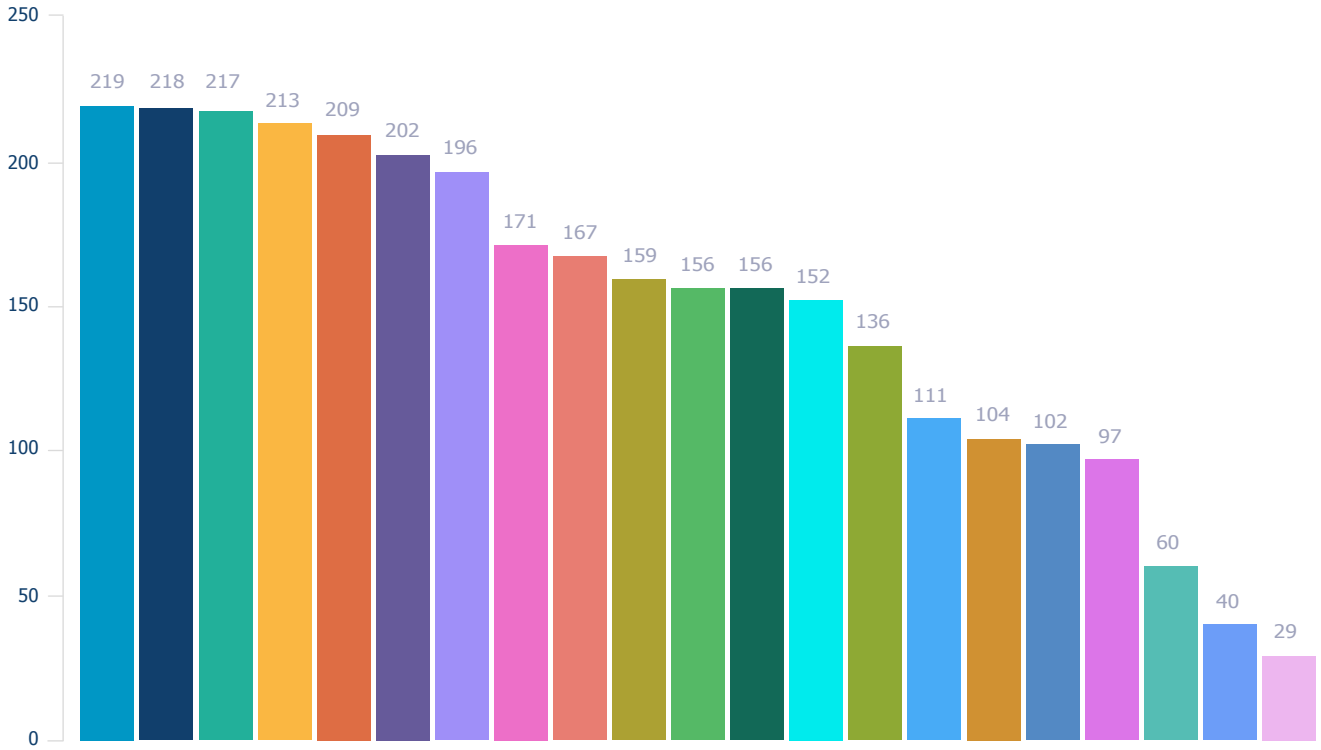
Table 2.1: Topics that were potentially missing or could have been elaborated on in the WASH in crises research agenda

Airborne transmission of infectious diseases in healthcare facilities
Antimicrobial resistance in crises
Baby WASH
Chemical and nuclear risks to water
Climate-adaptive WASH programmes
Community engagement and participation in WASH programmes
Continuous water quality testing in humanitarian crises
Coordination of humanitarian WASH programmes
Desalination options for humanitarian crises
Evaluations of cash transfer programmes
Gender-responsive WASH programmes
Greater specificity for disabilities and impairments and how this relates to access and use of WASH services
Groundwater monitoring in crises
Inclusion of cost-effectiveness of WASH in humanitarian programmes in research questions
Indoor air quality
Localisation of WASH programmes
Low water use sanitation technologies for water-insecure contexts
MHM delivery modalities (eg, choice of products, opportunities for market linkages and other delivery modalities)
MHM for PWDs and older people
Molecular monitoring of wastewater in humanitarian crises
On-site sanitation technologies
Private sector involvement in WASH in crises
Renewable/solar energy
Solid waste management options

Support to or restoration of water governance to national organisations
Sustainability
Sustainability and exit strategies
Vector control interventions
WASH for a specific disease focus (eg, leptospirosis)
WASH in healthcare facilities
WASH in schools
Water for livestock
Water quality for severe acute malnutrition/moderate acute malnutrition and treatment programmes

Annex 2.2. WASH expertise among survey respondents

Figure 5: WASH expertise reported by survey respondents (n=286)



- Improving the quality of water: point of use (POU) and safe storage (219)
- General WASH (218)
- Behaviour change interventions to improve hand, domestic and food hygiene practices (217)
- Improving the access to and use of sanitation facilities and reducing exposure to faeces (213)
- Improving the access to water sources and/or quantity of water (209)
- Distribution of hygiene materials or non-food items (NFIs) (202)
- Improving the quality of water: water treatment at source (196)
- WASH policy, coordination and/or governance (171)
- Inclusion of people with disabilities (167)
- Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials (159)
- Improving the management of wastewater and faecal sludge (156)
- Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials (156)
- Provision of interventions that improve solid waste disposal (152)
- Gender (136)
- Burden of and risk factors for WASH-related health and non-health outcomes (111)
- Use of vector control interventions (104)
- Inclusion of older adults (102)
- Climate change interventions (97)
- Cash and Markets (60)
- Improving dead body management and safe funeral practices (40)
- Other (29)

Annex 2.3. Further acknowledgements

The project team would like to acknowledge and thank the survey respondents, interviewees, focus group partcipants, Global WASH Cluster technical working groups, and all and any observers, who provided time and feedback throughout this process, particularly in identifying, developing and refining the research questions. Throughout the entire process, numerous experts provided their time and input to shape this research agenda. These individuals came from countries in all regions and represent themselves as individuals or the following organisations:

- Action contre la Faim (ACF)
- African Development Bank
- African Population and Health Research Center (APHRC)
- Africa Prosperity Inc.
- Agence Française de Développement (AFD)
- American University of Beirut, Lebanon
- Amhara National Regional State Bureau of Water and Energy, Ethiopia
- Bandung Institute of Technology (ITB), Indonesia
- Bioforce
- Bremen Overseas Research & Development Association (BORDA)
- Brescia University, Italy
- Bureau for Humanitarian Assistance (BHA), USAID, US
- CAPNI-Iraq
- Care International
- Caritas International (CAFOD)
- Centers for Disease Control and Prevention (CDC), US
- Centre for Infectious Disease Research in Zambia (CIDRZ)
- City of Harare Health Department, Zimbabwe
- Columbia University, US
- Community Development Pathway Foundation
- Coopération d'Aide Humanitaire, Central African Republic
- Cranfield University, UK
- Department of Water Resources, Vanuatu
- Elrha
- Emory University, US
- Environment Technology & Community Health (ETCH)
- European Civil Protection and Humanitarian Aid Operations (ECHO)
- Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria
- Federal University of Bahia (UFBA), Brazil
- FHI 360
- Foreign, Commonwealth & Development Office (FCDO), UK
- German Jordanian University (GJU), Jordan

- German WASH Network (WASH Netzwerk)
- Global Task Force on Cholera Control (GTFCC)
- Global WASH Cluster (GWC)
- Harvard University, US
- Hope in Action
- Human Life Foundation for Development and Relief
- Humanitarian Development Program
- International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR'B)
- IHE Delft Institute for Water Education, Netherlands
- Imperial College London, UK
- Institute of Tropical Medicine (ITM), Belgium
- International Committee of the Red Cross (ICRC)
- International Federation of Red Cross and Red Crescent Societies (IFRC)
- International Humanitarian Infrastructure Platform (IHIP)
- International Institute for Water and Environmental Engineering (2iE), Burkina Faso
- International Medical Corps (IMC)
- International Organisation Development (IOD PARC)
- International Organization for Migration (IOM)
- International Rescue Committee (IRC)
- INTERSOS
- Jimma University, Ethiopia
- Johns Hopkins University, US
- London School of Hygiene & Tropical Medicine (LSHTM), UK
- Makerere University, Kenya
- Medair
- Médecins Sans Frontières (MSF)
- Mubende Women with Disabilities Association (MUDIWA)
- National Environmental Engineering Research Institute, India
- National Institute of Health (INS), Mozambique
- Norwegian Church Aid (NCA)
- Norwegian Refugee Council (NRC)
- Office of US Foreign Disaster Assistance (OFDA), US
- Oxfam
- Peace and Social Security
- Plan International
- Population Services International (PSI)
- Première Urgence Internationale
- REACH
- Save the Children
- Sida (Swedish International Development Cooperation Agency)
- Solidarités International (SI)

- Stanford University, US
- Stichting Cordaid
- Stockholm International Water Institute (SIWI)
- Swedish Civil Contingencies Agency
- Swiss Agency for Development and Cooperation (SDC), Switzerland
- Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland
- Tufts University, US
- United Nations Children's Fund (UNICEF)
- United Nations High Commissioner for Refugees (UNHCR)
- United Nations Population Fund (UNFPA)
- Universidad Peruana Cayetano Heredeia (UPCH), Peru
- University of Brighton, UK
- University of British Columbia, Canada
- University of East Anglia, UK
- University of Kent, UK
- University of Leeds, UK
- University of North Carolina, US
- University of Toronto, Canada
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- WaterAid
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- World Health Organization (WHO)
- World Vision
- York University, Canada

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- **Alejandro Andres García**, IOM
- **Anthony Harvey**, Africa Prosperity Inc
- **Assih Tagba**, UNICEF
- **Atte Guillaume Atte**, IOM
- **Aurora Egea**, Médecins Sans Frontières
- **Bibek Balla**, Stichting Cordaid
- **Brian Reed**, Independent
- **Chandapiwa Kativu**, Swedish Civil Contingencies Agency
- **Chloe Morrison**, World Vision Vanuatu
- **David Omolo**, Intersos
- **Didier Monteiro**, UNICEF Guinea-Bissau
- **Diogo Trajano Gomes da Silva**, University of Brighton
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- **Ganga Datta Nepal**, USAID
- **George Wambugu**, CAFOD
- **Guillaume Pierrehumbert**, ICRC
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- **Hemiar Ali M. al-Harbi**, Human Life Foundation for Development and Relief
- **Humphrey Marangu**, Oxfam
- **James Brown**, Independent
- **James Robertson**, UNICEF Pacific Office
- **Jane Wilbur**, LSHTM
- **Joseph Konan**, IRC
- **Justine Haag**, GTFCC/WHO/SDC
- **Laura Conde Gonzalez**, Médecins Sans Frontières
- **Lena Tareq Abdullah Alakhali**, Humanitarian Development
- **Lise Lacan**, UNICEF
- **Mark Sobsey,** University of North Carolina at Chapel Hill
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- **Monther Hamed Abdulkader Mahyoob Alattar**, Oxfam
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- **Emmanuel Sakwe**, Community Development Pathway Foundation
- **Palago Toussaint**, Coopération d'Aide Humanitaire
- **Paul R. Hunter,** University of East Anglia
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- **Roben Picalli**, UNICEF
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- **Sonia Pérez**, IOD PARC
- **Stephen Okello**, FHI 360
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- **Taha Farea Ghaleb**, OPSS
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- **Travis Yates**, USAID/Bureau for Humanitarian Assistance
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- **Winfred Namukwaya**, Mubende Women with Disabilities Association (Mudiwa)

ANNEX 3

Annex 3.1: Prioritisation analysis of the 128 WASH in crises research questions

#	WASH intervention category	4Ds category	Data source	Research question	Average number of respondents (n)	Weighted RPS (%)	Weighted AEA (%)
1	Distribution of hygiene materials or non-food items (NFIs)	Delivery	Interview	What are the best strategies for the maintenance and operational sustainability of handwashing infrastructures (eg, handwashing stations, facilities or stands) in crises?	208.4	94.8	100.0
2	Improvements to the design and implementation of WASH in crises programmes	Development	Interview	What adaptations to WASH programmes or WASH services (including hardware and software) are appropriate, inclusive and effective for people with disabilities (PWDs) in crises?	208.6	92.7	98.0
3	Distribution of hygiene materials or non-food items (NFIs)	Development	Interview	What WASH non-food items (NFIs) are appropriate, effective and cost-effective for distribution to households during disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19)?	202	93.1	96.0
4	Improvements to the design and implementation of WASH in crises programmes	Development	Interview	How can we improve consultation with women and girls to design and provide safe, accessible WASH facilities and infrastructure (eg, sufficient water access, locks on sanitation facilities, bathing areas, appropriate menstrual hygiene management (MHM) products and disposal appropriate to needs and cultural beliefs) in crises?	213	86.9	95.2
5	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Development	Interview	What additional features can improve the experience and use of sanitation in humanitarian contexts (eg, lighting, locks, privacy screens, space for menstrual hygiene management (MHM), roofs, torches), particularly by women and girls?	207	84.3	93.6
6	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Delivery	Literature review	How effective are existing technologies and approaches in improving sanitation uptake among people affected by crises, particularly among people with disabilities (PWDs) and young children in humanitarian crises?	207	85.0	93.1

7	Behaviour change interventions to improve hand, domestic and food hygiene practices	Description	Other prioritisation	How can we identify, define and categorise the determinants and motives of hand hygiene behaviour in crises and among different population groups (eg, children, adults, people with disabilities (PWDs), etc), and at different stages of an emergency (acute, post-acute and protracted phases)?	214	89.2	92.5
8	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Interview	How can we improve and sustain hygiene practices in different humanitarian contexts (eg, disasters triggered by natural hazards, protracted crises, disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19, etc))?	209	85.2	92.4
9	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Development	Interview	How can we improve satisfaction with and use of sanitation facilities among people affected by crises, particularly among women and girls with regards to menstrual hygiene management (MHM)?	200	83.6	91.3
10	Distribution of hygiene materials or non-food items (NFIs)	Delivery	Interview	What are the effectiveness and cost-effectiveness of in-kind distribution of WASH items (eg, soap, hygiene kits, menstrual hygiene management (MHM) materials, chlorine water treatment, water containers, etc) on health and non-health outcomes among people affected by crises?	202	74.3	90.6
11	Improvements to the design and implementation of WASH in crises programmes	Description	Interview	What are the most effective methods to identify/monitor WASH needs in host communities and urban centres impacted by population influxes?	214	84.9	89.9
12	Improving access to water sources and/or quantity of water	Development	Other CHNRI	How effective is improved access to safe water (eg, coverage of water points and distribution networks) in controlling and preventing disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid and COVID-19)?	204.4	81.1	89.6

13	Improvements to the design and implementation of WASH in crises programmes	Description	Literature review	How does poor access to WASH contribute to increased risk of gender-based violence in humanitarian settings?	209	83.0	89.6
14	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Interview	How can hygiene promoters reduce disinformation or myths associated with outbreak-prone diseases (eg, cholera, Ebola, hepatitis E, typhoid and COVID-19)?	210	81.8	88.4
15	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Interview	What are the health outcomes (eg, increased incidence of disease, increased morbidity, increased mortality and/or increased incidence of poor mental health outcomes, etc) related to WASH experienced by people affected by crises?	210	71.6	88.1
16	Climate change interventions	Discovery	Interview	What designs or adaptations are required for climate change-resilient water supply and sanitation infrastructure that are appropriate and effective in humanitarian contexts?	210.8	90.0	86.3
17	Distribution of hygiene materials or non-food items (NFIs)	Delivery	Other prioritisation	How can organisations work with people to determine what are the most appropriate products to include in hygiene kits in different response phases (eg, acute, post-acute and protracted) or for different population groups (eg, families with young children, child-headed households, people with disabilities (PWDs), adults with incontinence, etc)?	200	76.8	85.9
18	WASH policy, coordination and/or governance	Description	Interview	What are effective mechanisms to build the capacity of WASH professionals who work in emergencies?	216	73.8	85.8
19	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Delivery	Interview	What are the effectiveness and cost-effectiveness of sanitation promotion campaigns on health and non-health outcomes among people affected by crises?	206.8	74.5	85.7

20	Improving access to water sources and/or quantity of water	Development	Literature review	How can organisations support people affected by crises in accessing safe, sufficient and reliable drinking water supplies at reasonable cost?	205	70.2	85.6
21	Improving the quality of water: point of use (POU) treatment and safe storage	Delivery	Interview	What is the preference for and uptake of, and how can we encourage use of, water treatment technologies among people affected by crises?	200.8	78.1	85.4
22	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Literature review	To what extent are hygiene interventions (generally or by specific type of intervention) effective at improving personal and domestic hygiene behaviours among different population groups (eg, children, adults, people with disabilities (PWDs), etc), different types of displaced populations (eg, internally displaced people (IDPs), refugees, people on the move) and different settings (eg, camps, host communities)?	215	83.6	85.0
23	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Interview	What are the most significant non-health outcomes (eg, reduced dignity, reduced income, increased inequality, etc) related to poor access to WASH services experienced by people affected by crises?	209	70.7	84.7
24	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Literature review	What are the specific factors during floods, droughts or other disasters triggered by natural hazards that lead to increased risk of cholera outbreaks?	204.6	82.0	83.3
25	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Interview	What are the prevalence of and risk factors for sexual abuse and assault risks related to water and sanitation access in emergencies?	209	73.9	83.1
26	Behaviour change interventions to improve hand, domestic and food hygiene practices	Description	Interview	How does risk perception influence hand hygiene behaviour during disease outbreaks and how does this change over time? And can this information be used to inform programming?	214	80.0	82.6

27	Improving access to water sources and/or quantity of water	Description	Interview	To what extent do water resource-related conflicts exist between refugees/internally displaced people (IDPs) and host communities? And how can water services be designed to serve both refugees/IDPs and host communities in a sustainable manner?	197	78.4	82.3
28	Provision or promotion of interventions for solid waste disposal	Delivery	Interview	What and how appropriate, effective and cost-effective are solid waste solutions in emergencies (including burning/incineration, recycling, reduction, biodegradable and other waste management options)?	207.4	86.4	82.0
29	Improving access to water sources and/or quantity of water	Delivery	Literature review	What are the costs and cost-effectiveness of repairs to damaged water points or water trucking programmes compared to installation/construction of new water supply systems in crises?	203.8	64.3	81.7
30	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Development	TWG	How do we improve the choice of, access to and availability of menstrual materials or menstrual hygiene management (MHM) products among women and girls affected by crises?	213	100.0	81.5
31	Distribution of hygiene materials or non-food items (NFIs)	Development	Interview	What are new innovative, appropriate and sustainable technologies, products or infrastructure that could facilitate hand hygiene in crises?	209	60.9	80.3
32	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Delivery	Interview	What are culturally appropriate and effective menstrual hygiene management (MHM) interventions (eg, MHM materials and supplies, MHM education and promotion, disposal options and waste management, bathing and laundering areas, etc) for women and girls affected by humanitarian crises?	211	92.6	79.7
33	Distribution of hygiene materials or non-food items (NFIs)	Delivery	Interview	What WASH products and services are appropriate to meet the needs of adults with incontinence who are affected by crises?	200	88.6	79.7

34	Improvements to the design and implementation of WASH in crises programmes	Description	Interview	What are the water use patterns (eg, drinking, cooking, personal and domestic hygiene) among people affected by crises (in various scenarios)?	214	60.5	79.1
35	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Literature review	What are the WASH risk factors and risk factor cascades for communicable disease outbreaks in specific humanitarian settings?	205	72.0	78.7
36	Distribution of hygiene materials or non-food items (NFIs)	Delivery	Literature review	What is required to ensure timely, appropriate and high-coverage delivery of WASH non-food items (NFIs) (eg, hygiene kits, soap, water treatment, cleaning products, etc) to people affected by crises?	201.8	62.4	78.5
37	Climate change interventions	Discovery	Interview	What WASH interventions are available, adaptable and effective at improving household resilience to climate change-induced shocks (eg, floods, droughts) in crises?	211	81.6	78.5
38	Improving access to water sources and/or quantity of water	Delivery	Other CHNRI	What is the impact of intermittent water supply on diarrhoeal disease in crises and how can we ensure the microbiological quality of intermittent piped supply?	200	83.8	78.3
39	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Other CHNRI	To what extent are hygiene interventions (generally or by specific type of intervention) effective at reducing the incidence of faecal–oral-transmitted diseases among different population groups (eg, children, adults, people with disabilities (PWDs), etc), different types of displaced populations (eg, internally displaced people (IDPs), refugees, people on the move) and different settings (eg, camps, host communities)?	209.8	65.7	78.2
40	Improving access to water sources and/or quantity of water	Development	Interview	How can we improve water source planning and hydrogeology in humanitarian contexts?	203.4	76.5	77.6

41	Improving the quality of water: point of use (POU) treatment and safe storage	Delivery	Literature review	What are the efficacy, effectiveness and cost-effectiveness of non-centralised water treatment (eg, bucket chlorination, in-line, well water chlorination, etc) on health and non-health outcomes among people affected by crises?	216	83.4	77.3
42	Distribution of hygiene materials or non-food items (NFIs)	Delivery	Interview	What is the effectiveness of different handwashing products to prevent Ebola or cholera transmission within healthcare facilities?	201.8	82.0	77.2
43	Distribution of hygiene materials or non-food items (NFIs)	Description	Other prioritisation	What types of technical assistance (eg, trainings, toolkits, guidance documents, etc) yield the greatest improvements in the design and implementation of hand hygiene interventions in crises?	200	67.1	76.2
44	Distribution of hygiene materials or non-food items (NFIs)	Description	Other prioritisation	What are the current types, availability or accessibility of hand hygiene services in crises (eg, handwashing stands, infrastructure, materials and products used to perform hand hygiene)?	209.8	52.0	75.9
45	Cash, vouchers and market-based WASH programmes	Delivery	Interview	Under what conditions are cash/vouchers more effective than WASH non-food item (NFI) distributions (eg, hygiene kits, menstrual hygiene management (MHM) materials, soap, cleaning products, etc) at reducing poor health outcomes among people affected by crises? And what are the advantages and disadvantages of cash/ vouchers versus distribution?	205	85.6	75.8
46	Improving the quality of water: point of use (POU) treatment and safe storage	Delivery	Interview	What are appropriate, effective and cost-effective options for centralised water treatment in emergencies, and what barriers are there to centralised treatment across crises?	215	70.2	75.4
47	Improving access to water sources and/or quantity of water	Development	Interview	What systems can be used in humanitarian contexts to monitor and regulate the quantity and quality of water supply systems?	196.6	75.9	75.3

48	Improving management of wastewater and faecal sludge	Delivery	Interview	How do we engage people affected by crises with wastewater and faecal sludge management (FSM), including the operation and maintenance of services?	211.8	77.3	74.9
49	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Other prioritisation	To what extent do current hand hygiene interventions in crises address known behavioural determinants (ie, barriers and facilitators), and how do those determinants mediate adoption of improved hand hygiene behaviours?	214	71.5	74.0
50	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Other prioritisation	To what extent are hygiene interventions (generally or by specific type of intervention) effective at improving personal and domestic hygiene behaviours among different population groups (eg, children, adults, people with disabilities (PWDs), etc), different types of displaced populations (eg, internally displaced people (IDPs), refugees, people on the move) and different settings (eg, camps, host communities)?	210	65.4	74.0
51	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Description	Literature review	What are the social, behavioural and cultural facilitators and barriers that impact menstrual hygiene management (MHM) among women and girls in crises?	210	82.0	73.9
52	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Delivery	Literature review	What are the effectiveness and cost-effectiveness of sanitation construction and repairs to sanitation facilities on health and non-health outcomes among people affected by crises?	206.8	58.0	73.9
53	WASH policy, coordination and/or governance	Development	Interview	What are effective ways of working with (formal and informal) water service institutions in emergencies?	215.6	70.6	73.4
54	WASH policy, coordination and/or governance	Development	Interview	What are the barriers and facilitators to enabling funding that transitions from emergency WASH response to recovery and long-term programmes?	216	61.6	73.3

55	Improvements to the design and implementation of WASH in crises programmes	Delivery	Other CHNRI	What level of coverage for relevant WASH interventions is required in cholera hotspots to control and ultimately eliminate the risk of cholera?	214	72.5	72.5
56	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Development	Literature review	What are effective approaches that can be used to integrate menstrual hygiene management (MHM) into existing emergency responses and different phases of an emergency?	209	84.0	72.3
57	Behaviour change interventions to improve hand, domestic and food hygiene practices	Development	Other CHNRI	What are appropriate, effective and cost-effective food safety and food hygiene interventions for crises?	209	77.2	72.3
58	Climate change interventions	Delivery	Interview	How can climate change actions be effectively integrated into WASH in crises programmes?	211	64.7	72.1
59	Improving management of wastewater and faecal sludge	Development	Other CHNRI	What are the most effective practices and technologies (including identifying alternative technologies) to collect, treat and dispose of cholera and Ebola effluent?	212	88.5	71.7
60	Improvements to the design and implementation of WASH in crises programmes	Delivery	Interview	What evaluation measures, indicators and frameworks are applicable to measure uptake and use of WASH interventions in crises? And can the reliability, usability and availability of data be improved?	208.8	54.0	71.7
61	WASH policy, coordination and/or governance	Description	Literature review	What are the current coordination mechanisms, enabling factors for and barriers to transitionary handover of WASH services from response agencies to national governments and/or other development actors?	216	59.1	71.6
62	Distribution of hygiene materials or non-food items (NFIs)	Delivery	Interview	What is the impact of distributing hygiene kits or WASH non-food items (NFIs) to reduce severe acute malnutrition (SAM) and improve recovery?	202	77.5	71.4

63	Improving management of wastewater and faecal sludge	Delivery	Interview	How is wastewater collected, treated, reused and disposed of in closed emergency contexts (ie, camps for refugees/internally displaced people (IDPs))?	212	70.1	71.2
64	Distribution of hygiene materials or non-food items (NFIs)	Development	Interview	How can WASH non-food item (NFI) distributions for disease outbreaks (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19) and other health crises (malnutrition) be better standardised between agencies?	200	58.5	71.0
65	Improving management of wastewater and faecal sludge	Development	Interview	What are feasible options for faecal sludge management (FSM) in the different phases of emergencies (ie, acute phase solutions or sustainable options) for scaling up?	206	79.2	70.7
66	Behaviour change interventions to improve hand, domestic and food hygiene practices	Description	Other prioritisation	What are hand hygiene interventions (eg, educational messages, psychosocial messages, nudges, etc) used for people affected by crises?	215	43.4	70.4
67	Improving access to and use of sanitation facilities, and reducing exposure to faeces	Description	Interview	What interventions or design changes to sanitation facilities, laundry spaces and bathing areas are required for people with incontinence in emergencies?	200	72.2	70.2
68	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Development	Interview	What other supplies around managing menstruation are needed to support women and girls' menstrual hygiene management (MHM) practices in emergencies (eg, torch, bucket, soap, washing line, etc)?	209	78.5	68.4
69	Improvements to the design and implementation of WASH in crises programmes	Description	Interview	What is the global coverage of key WASH indicators in camps for refugees/internally displaced people (IDPs), and what are key factors in not meeting Sphere Standards?	216	53.4	67.8

70	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Delivery	TWG	What is the effectiveness of existing menstrual hygiene management (MHM) tools to inform, encourage and enable safe and dignified MHM among different population groups, including menstruating women and girls, young children, boys and men?	210.6	72.3	67.5
71	Improving access to water sources and/or quantity of water	Description	Literature review	What is the experience of water insecurity of people affected by crises, and what affects the availability, accessibility and quality of water they use (eg, during disease outbreaks, disasters triggered by natural hazards or climate change-induced shocks)? And what options are available for water conservation and reuse?	197	53.9	67.5
72	Improving access to water sources and/or quantity of water	Development	Interview	What solutions, including non-conventional options, are available, effective and sustainable to improve water security in crises?	196	58.6	67.3
73	Improving the quality of water: point of use (POU) treatment and safe storage	Delivery	Interview	What water treatment methods are effective at treating uncommon pathogens such as hepatitis E and other viruses, and are applicable in crises?	216	73.2	66.8
74	Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials	Development	Other CHNRI	What are the most essential – or the minimum set of – infection, prevention and control (IPC) interventions in cholera and Ebola treatment facilities and oral rehydration points to reduce risk of transmission within these facilities?	206.8	88.6	66.6
75	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Delivery	TWG	What would enable improved integration and delivery of menstrual hygiene management (MHM) interventions (including education, promotion, distribution of supplies and building of MHM-appropriate WASH infrastructure) among humanitarian workers?	209	70.9	65.0

76	Distribution of hygiene materials or non-food items (NFIs)	Development	Interview	What are options for no-touch handwashing devices in emergency settings?	208.6	32.1	63.5
77	Improvements to the design and implementation of WASH in crises programmes	Delivery	Other prioritisation	What specific WASH interventions at household, community or facility level can contribute to improved maternal and neonatal health outcomes?	209	70.2	63.2
78	Improvements to the design and implementation of WASH in crises programmes	Delivery	Other prioritisation	What specific WASH interventions can contribute to: reduced rates of moderate acute malnutrition (MAM) and severe acute malnutrition (SAM) among infants and children aged 0–59 months; relapse rates; duration of treatment; and overall mortality due to acute malnutrition among children affected by crises?	210	75.2	61.1
79	Improving management of wastewater and faecal sludge	Description	TWG	What are the minimum quality standards (physical, chemical and biological) required for safe faecal sludge plants in crises, and how can we monitor safe faecal sludge plants?	205.6	74.0	61.1
80	Distribution of hygiene materials or non-food items (NFIs)	Delivery	Interview	How frequently do WASH non-food items (NFIs) need restocking among people affected by crises and what is the cost-effectiveness of different intervals for restocking (eg, 30 days or 60 days)?	200	44.1	60.8
81	Behaviour change interventions to improve hand, domestic and food hygiene practices	Description	Other prioritisation	What are current practices around safe food hygiene in crises?	209	45.4	60.1
82	Improving access to water sources and/or quantity of water	Delivery	Interview	What multi-use water systems are appropriate, effective and cost-effective in humanitarian contexts, and how do they affect the rates or burden of disease (eg, diarrhoeal disease, acute malnutrition) and poor health outcomes in crises?	204	51.7	60.1

83	Improving management of wastewater and faecal sludge	Delivery	TWG	What are the efficiency and effectiveness of different faecal sludge treatment regimens (including lime) or wastewater plant designs on pathogen reduction?	206	68.4	60.0
84	Cash, vouchers and market-based WASH programmes	Description	Interview	What are the barriers, enablers and contextual influences that affect the use of cash and markets in humanitarian WASH programmes?	208	73.6	59.4
85	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Other CHNRI	What combinations/interactions of WASH risk factors (and their prevalence) by age/sex contribute to severe acute malnutrition (SAM) or moderate acute malnutrition (MAM) or relapse to SAM/MAM in a given humanitarian context?	205	77.3	59.2
86	Provision or promotion of interventions for solid waste disposal	Development	Interview	How can solid waste be managed in the absence of recycling in crises? How is solid waste managed by households in crises, and how willing are households to separate waste or recycle?	207	52.2	57.8
87	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Interview	What is the burden of outbreak-prone diseases (eg, cholera, Ebola, hepatitis E, typhoid, COVID-19) in crises?	208.4	30.5	57.2
88	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Interview	How do agencies/organisations/government partners make decisions around hand hygiene programme design and delivery during emergencies?	209	29.5	56.7
89	Cash, vouchers and market-based WASH programmes	Description	Interview	What WASH interventions are most suitable for market-based solutions in various humanitarian settings?	209	82.8	56.0
90	Cash, vouchers and market-based WASH programmes	Delivery	Interview	Under what conditions are cash/vouchers an effective means to improve access to water among people affected by crises?	207	50.1	55.5

91	Improving management of wastewater and faecal sludge	Description	TWG	What types of materials should be included in desludging kits?	212	74.0	55.1
92	Improvements to the design and implementation of WASH in crises programmes	Delivery	Other prioritisation	What specific WASH interventions can be implemented to support safe delivery practices at home or facility level to reduce maternal and neonatal morbidity and mortality?	209	62.3	53.4
93	Cash, vouchers and market-based WASH programmes	Delivery	TWG	To what extent are market-based modalities more cost-efficient and effective than direct service delivery for the WASH sector in emergency settings, and what specific WASH interventions are most suitable for market-based approaches?	202	53.2	53.2
94	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Description	Literature review	What are appropriate and effective treatment strategies, disposal options or collection processes for menstrual hygiene management (MHM) waste that factor in disposal behaviour and absorbent material types in crises?	209	56.1	52.6
95	Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials	Delivery	Interview	Are household spraying programmes and household disinfection programmes effective, cost-effective and acceptable, and do they reduce cholera or other outbreak-prone diseases (eg, Ebola, hepatitis E, typhoid, COVID-19)?	207	58.5	51.8
96	Improving the quality of water: point of use (POU) treatment and safe storage	Development	Interview	What are the treatment methods to remove high chemical content from water in areas affected by crises?	211.2	53.6	51.4
97	Improving access to water sources and/or quantity of water	Delivery	Interview	What is the viability of treating rainwater in protracted crises? And is the treatment of rainwater scalable in protracted crises?	200	34.8	51.0

98	Cash, vouchers and market-based WASH programmes	Delivery	TWG	What are the most effective ways of engaging with WASH markets before, during and after emergencies to ensure adequate linkages between humanitarian interventions and long-term development approaches?	202	52.1	50.2
99	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Interview	How is inadequate access to WASH related to psychosocial stress in crises?	208.8	39.3	49.4
100	WASH policy, coordination and/or governance	Development	Literature review	How can intra-agency coordination aid or standardise the selection, promotion and monitoring of WASH non-food items (NFIs) (eg, hygiene kits, soap, water treatment technologies, etc) used in crises?	216	22.5	48.1
101	Improving management of wastewater and faecal sludge	Delivery	Interview	What are appropriate and effective faecal sludge management (FSM) technologies (eg, geotubes, bio-additives) that can serve both people affected by crises and host communities?	206	64.2	47.9
102	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Development	Interview	What approaches can be used to involve men and boys in menstrual hygiene management (MHM) programme delivery in crises settings?	209	50.7	46.7
103	Cash, vouchers and market-based WASH programmes	Description	Interview	What are successful strategies for transitioning from distribution of household water treatment (HHWT) products to ensure access to local markets in humanitarian settings?	202	51.4	46.5
104	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Development	Interview	What approaches can be used to reach child-headed households, orphaned children or people with disabilities (PWDs) with menstrual hygiene management (MHM) information and supplies in emergencies?	208.2	48.7	44.7

105	Cash, vouchers and market-based WASH programmes	Description	TWG	What are the best practices for developing successful partnerships between humanitarian actors, local governments, cash-based organisations (CBOs) and the private sector for market-based WASH programming in humanitarian settings?	208	50.4	44.6
106	Vector control interventions	Delivery	Interview	What are appropriate, effective and cost-effective vector control tools for use against Anopheles spp. mosquitoes (malaria) by people affected by crises?	208	92.0	43.8
107	Improving the quality of water: point of use (POU) treatment and safe storage	Development	Literature review	Can practitioners generate site-specific and evidence-based chlorination targets for water systems in camps for refugees/internally displaced people (IDPs), and evaluate whether these site-specific free residual chlorine (FRC) targets could increase the proportion of households that have safe water at the point of use (POU), compared to the status quo Sphere Standards FRC target?	214	38.0	43.2
108	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Literature review	To what extent do hygiene interventions have an effect on non-health outcomes among people affected by crises?	210	18.9	43.1
109	Improvements to the design and implementation of WASH in crises programmes	Delivery	Literature review	What WASH interventions are most appropriate during typhoid outbreaks in crises, and how can WASH interventions be successfully integrated into typhoid vaccination campaigns in emergencies?	209	54.9	42.8
110	Cash, vouchers and market-based WASH programmes	Delivery	TWG	What is the added value of combining market-based and WASH-specific modalities (such as hygiene behaviour change communication or WASH market support), compared to interventions that use one approach or the other?	202	44.2	41.9

111	Improving the quality of water: point of use (POU) treatment and safe storage	Description	Literature review	What are the post-distribution chlorine decay and household water safety in humanitarian response, including camps for refugees/internally displaced people (IDPs)?	210.6	39.5	41.6
112	Behaviour change interventions to improve hand, domestic and food hygiene practices	Delivery	Literature review	To what extent are hygiene interventions (generally or by specific type of intervention) effective at reducing soil-transmitted helminths (STHs) among children in crises?	210	45.3	39.5
113	Improving access to water sources and/or quantity of water	Delivery	Interview	What is the association between groundwater access and quality with rates of malnutrition in water-scarce areas?	197	38.3	39.2
114	Improvements to the design and implementation of WASH in crises programmes	Delivery	Literature review	What are the effectiveness and cost-effectiveness of case-area targeted interventions (CATIs) using WASH alone, oral cholera vaccine (OCV) alone, or WASH and OCV combined to reduce cholera transmission?	211	67.4	38.8
115	Improving access to water sources and/or quantity of water	Description	Literature review	What frameworks, such as the Household Water Insecurity Experiences (HWISE) scale, can be used as a household water insecurity measure across crises in low- and middle-income countries?	199	42.7	38.3
116	Vector control interventions	Delivery	Interview	What are appropriate, effective and cost-effective vector control tools for use against Aedes and Culex spp. Mosquitoes (dengue fever, chikungunya, yellow fever, lymphatic filariasis) by people affected by crises?	207.4	91.5	37.2
117	Vector control interventions	Delivery	Interview	What are appropriate, effective and cost-effective vector control tools used for scabies, lice and other vectors in crowded camps for refugees/internally displaced people (IDPs)?	207	79.3	36.7
118	Promotion or distribution of safe menstrual hygiene management (MHM) practices or materials	Description	TWG	How much waste is produced from menstrual hygiene management (MHM)?	209	14.4	36.3

119	Improving the quality of water: point of use (POU) treatment and safe storage	Delivery	Literature review	Do simple, targeted messages in an SMS (text message) campaign have an impact on chlorine purchase and use in crises?	200.8	4.1	35.3
120	Improving the quality of water: point of use (POU) treatment and safe storage	Description	Literature review	What disinfection by-products (DBPs) are generated from emergency water supply interventions?	210.2	31.8	34.4
121	Improvements to the design and implementation of WASH in crises programmes	Delivery	Interview	What is the relationship between poor WASH conditions and mental health outcomes, and the effect of improvements to WASH conditions on mental health among people affected by crises?	207.8	26.4	34.0
122	Improving management of wastewater and faecal sludge	Development	Interview	What factors affect the ability to make faecal sludge management (FSM) profitable for refugee/internally displaced person (IDP) camp settings?	212	22.9	33.7
123	Improving dead body management and safe funeral practices	Development	Interview	How do body bag technologies compare in performance, safety and appropriateness to the local context?	209.2	0.0	26.9
124	Promotion or distribution of disinfection and cleaning of households and community spaces and/or materials	Delivery	Interview	How efficacious is chlorine on different types of surfaces found in low-resource households and healthcare settings against SARS-CoV-2, Ebola and other viruses?	206	17.5	25.6
125	Improvements to the design and implementation of WASH in crises programmes	Delivery	Literature review	Can individual or combined WASH interventions contribute to lower prevalence, intensity and reinfection rates of soil-transmitted helminths (STHs) among children affected by crises?	207.8	32.2	23.6

126	Burden of and risk factors for WASH-related health and non-health outcomes	Description	Literature review	What is the prevalence and characterisation of multidrug-resistance and other antimicrobial resistance (AMR) in environmental samples (eg, water, faecal sludge, wastewater, food) collected from camps for refugees/ internally displaced people (IDPs)?	204.2	19.4	12.5
127	Improving dead body management and safe funeral practices	Development	Other CHNRI	What are the optimal strategies, including behaviour change strategies and engaging religious leaders, for delivering interventions related to safe burial practices and funeral hygiene during disease outbreaks?	208.6	41.6	1.1
128	Improving dead body management and safe funeral practices	Delivery	Interview	What are the minimum requirements for safe and culturally appropriate dead body management for outbreak-prone diseases (eg, Ebola, cholera, plague, other haemorrhagic fevers)?	209.2	34.3	0.0

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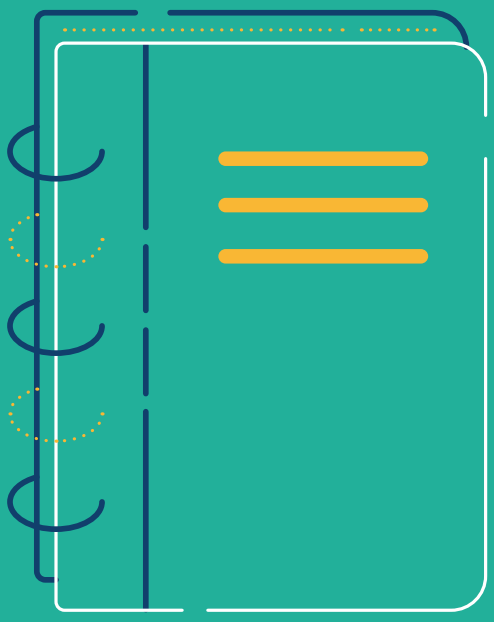

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