IRC + water for people

Climate Change, Water Resources, and WASH Systems

IRC and Water For People Working Paper

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Contents

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Key Messages

- **WASH system strengthening is climate action.** Water, Sanitation, and Hygiene (WASH) has not been adequately addressed in international and national decision-making on climate action. The WASH sector can deliver short and long-term wins. Safe and reliable WASH services rapidly improve the resilience of communities and households. Strengthening the systems that deliver WASH services helps combat climate change and other key threats, such as population growth and urbanization. Access to high-quality WASH services is a human right, and strong WASH systems address the urgent needs of vulnerable and excluded population groups.

- **WASH must be a core component of climate financing and adaptation strategies.** Climate adaptation policies, strategies, and financing must prioritize the reform and strengthening of WASH systems. There are major funding gaps in the WASH sector, and we are lagging far behind the progress needed to achieve Sustainable Development Goal (SDG) 6 - access to universal WASH services. In low- and middle-income countries with weak WASH systems, it is difficult to “add on” climate activities. Financing that encourages groundwater recharge, for example, will be ineffective when pumps are broken and pipes leak due to lack of maintenance. An approach that integrates WASH in climate financing would be more efficient in filling the gaps in core systems and optimize returns.

- **We cannot face the challenge of climate change alone.** The climate crisis demands collective action and aligned commitments across organizations, sectors, and nations and requires us to extend beyond the WASH sector and understand the goals, capacities, and opportunities for partnerships with the broader water and conservation sectors. WASH organizations can deliver improved services that directly contribute to broader efforts to protect and better manage water resources, while also contributing to climate change mitigation and adaptation. The systems that deliver WASH services can also benefit greatly from the expertise, innovation, data, and financing in the water resources management (WRM) and climate change domains.

- **Water For People and IRC will walk the talk.** As organizations, we will reduce our own carbon footprint, promote appropriate mitigation strategies related to new technologies, champion the role of WASH systems in climate adaptation, and recognize that water-related climate action will strengthen the WASH system. WRM is a building block of the WASH system. We cannot achieve universality or sustainability of services without more strategic protection efforts. Implementing nature-based solutions in source recharge areas and aligning WASH decision-making to broader catchment and aquifer management strategies can result in more cost-effective service delivery that does not rely so heavily on expensive treatment and water quality testing.

Acronyms

CapManEx	Capital Maintenance Expenditure	NAPA	National Adaptation Plans for Action
COP	Conference of the Parties	NDC	Nationally Determined Contribution
FCFA	Future Climate for Africa	O&M	Operation and Maintenance
GCF	Green Climate Fund	SDG	Sustainable Development Goals
GDP	Gross Domestic Product	SIDS	Small Island Development States
GHG	Greenhouse Gases	SWA	Sanitation and Water for All
GWP	Global Water Partnership	UN	United Nations
IPCC	Intergovernmental Panel on Climate Change	UNFCCC	United Nations Framework Convention on Climate Change
IWRM	Integrated Water Resources Management	US	United States
JMP	Joint Monitoring Programme	VWSS	Village Water Safety and Security
LDC	Least Developed Country	WASH	Water, Sanitation, and Hygiene
NAP	National Adaptation Plan	WRM	Water Resources Management

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1 Introduction

IRC's and Water For People's mission is to ensure that everyone has access to safe, reliable, and sustainable water and sanitation services and practices safe hygiene behaviors. Our health, dignity, and livelihoods depend on these services, and as a sector, we address them together as (WASH). The COVID-19 pandemic has provided a stark reminder of how accessing services like a shared water tap or toilet can expose us to disease, and how handwashing can help protect us by providing a barrier to infections.

IRC and Water For People are working with local and national governments in low- and middle-income contexts to achieve Sustainable Development Goal (SDG) 6.[1] Improvements in water and sanitation services and hygiene behaviors – in these contexts and everywhere else - can only be achieved with strong systems that deliver high quality services that are accessible, affordable, reliable, and sustainable.[2]

The systems that deliver water and sanitation services are intimately linked to and reliant on a broader water resources system. Quality and continuity requirements for domestic water use are very high, though quantity demands are typically much smaller than for other uses such as irrigated agriculture - unless you are living in a big city. Water resources management (WRM) seeks to ensure that pollution, competing demands, and other risks to water resources are managed so that aquifers, rivers, and lakes can sustainably provide freshwater for different uses.

In addition to universal and equitable access to WASH services, SDG 6 targets seek to improve WRM through use efficiency, source protection, water quality management, capacity building, and participation of local communities. As we seek to achieve universal services, improve sustainability, and increase domestic water supply service levels toward safely managed services, the links to broader WRM become more and more important.

We live in a world with a changing climate, and we all must adapt. While several planned international WASH events focused on links with climate change, they were overshadowed by the COVID-19 pandemic in 2020. In 2021, climate change is back on the agenda and the link between climate change, WASH and public health are more visible than before.

We see the impacts of climate change on WASH services in the countries where we work and recognize an increasing need to help service providers and authorities manage the risks associated with less predictable and more extreme weather patterns and events. This paper examines the links between climate change, WRM, and WASH services and how those links affect our mission, the way we implement our impact model, and the need to integrate climate action in our work as organizations and as a sector.

This working paper seeks to:

- Provide an accessible resource for Water For People and IRC teams and partners on the links between climate change, WRM, and WASH systems,

[1] https://sdgs.un.org/goals

[2] We define systems broadly as all social, technical, institutional, environmental, and financial factors, actors, motivations, and interactions that influence WASH service delivery in each context (Huston and Moriarty, 2019).

- Guide our advocacy on climate issues, identifying key messages based upon our experiences in the contexts where we work, and
- Influence our programming and actions, including through annual and strategic plans.

This paper is based on the current global context described in the subsequent sections and a reflection on the experiences and learnings in the 12 countries where we work in Asia, Africa, and Latin America. Annex 1 includes summaries of each country context in terms of climate trends and impacts on water resources, impacts on WASH infrastructure and services, national climate and WASH policies, program activities aligned to climate mitigation and adaptation, and discussion of key challenges.

1.1 Climate Science and Impacts of Global Warming

Climate change includes global warming and its effects, such as changes in precipitation and sea level rise. The world is warming up, with average temperatures rising by around 1 degree Celsius (°C) over the last century.[3] Current rates of increase are about 0.1°C per decade. About 90% of the energy involved has gone into ocean warming.

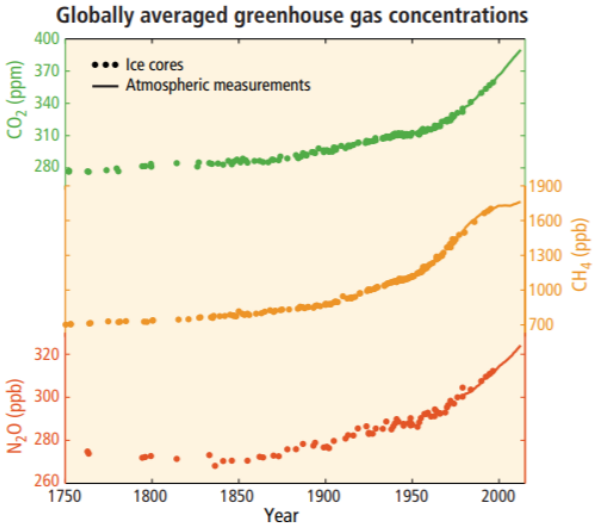

Figure 1: Increase in GHG over time (IPCC, 2014)

Global warming has happened many times before, but this time humans are the cause and change is happening fast. Greenhouse gases (GHG) - carbon dioxide, methane, nitrous oxide, and ozone - make up only a small fraction of the atmosphere around us, but they play a big role in trapping the Earth's radiant heat. This heat would otherwise escape into space, but the trapping of these GHG warms the planet. This process and warming effect are what make the Earth habitable. But the levels of these gases have been increasing as a result of human activities such as industrialization since 1750. In the 21st century, emissions have been higher than ever. The atmospheric concentrations observed are now higher than anything in the past 800,000 years (see Figure 1).

Burning fossil fuels and industrial processes are responsible for most CO_2 emissions. Methane levels are rising due to energy production, gas from landfills, animal raising, and rice farming. The increase in nitrous oxide is particularly associated with increased use of chemical fertilizers in agriculture. Ozone forms high in the atmosphere as sunlight reacts with pollutants.

On the other hand, there are also "carbon sinks" that absorb GHG and have the opposite effect. For example, wetlands and peatlands where plants grow that absorb CO_2 from the atmosphere.

[3] Average warming of the land and ocean surfaces of 0.85°C has been observed over the period 1880-2012 (IPCC, 2014): https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_full.pdf

In the end, it is ultimately about water. The most important and abundant GHG is water vapor. Paradoxically for us, human activities have little effect on water vapor levels in the atmosphere. These levels are mainly driven by temperature. A warmer atmosphere can hold more water vapor which leads to further warming. As such, we would expect more rainfall on average with global warming. This could be a benefit in some areas, but with more energy in the atmosphere and a faster hydrological cycle, we are also seeing more extreme events, such as storms and floods. It is very likely that these extreme events will be more frequent and severe (IPCC, 2014).

Sea level rise, linked to flooding and rising salinity in aquifers, is a major threat to island states, low-lying cities, and deltas like large parts of Bangladesh and the Netherlands.

While temperature trends are clear, there is still tremendous uncertainty about the impacts of climate change on water resources, especially at local levels. While current drought trends are uncertain, climate change models project reduced renewable surface water and groundwater resources in most dry subtropical regions during this century. This could lead to more competition for water with other sectors, such as agriculture. Climate change is also expected to reduce economic growth, make poverty reduction more difficult, and increase the displacement of people (IPCC, 2014).

1.2 Water, Energy, and WASH Facilities

The WASH sector is working for tremendous growth in water and sanitation services by 2030. In 2017, the Joint Monitoring Programme (JMP) estimated that while 5.3 billion people used safely managed drinking water services, 1.4 billion used at least basic services, 206 million used limited services, 435 million used unimproved sources, and 144 million still used surface water.[4] This means 2.2 billion people need substantial improvements in their drinking water infrastructure, especially in the Least Developed Countries (LDCs) and rural areas. Additionally, some of the existing infrastructure providing good services will need to be replaced before 2030.

In sanitation, the challenge is bigger. While 3.4 billion people used safely managed services in 2017, an additional 2.2 billion used at least basic services, 627 million used limited services, 701 million used unimproved facilities, and 673 million still practiced open defecation. Up to 4.3 billion people need improvements in their sanitation infrastructure. There are also schools, hospitals, and other institutions that need an improved sanitation infrastructure.

Water and sanitation services use and depend upon energy. This means that these necessary services are part of the climate change problem. However, they can also be part of the solution. Data from the US illustrates just how much energy is needed for water and sanitation services.[5] After labor, energy is the second-highest budget item for municipal drinking water and wastewater facilities, with US utilities spending about US$4 billion a year. Electricity is the main energy source and used for pumping. The smaller utilities use more electricity and pay more for

[4] United Nations Children's Fund (UNICEF) and World Health Organization, 2019. Progress on household drinking water, sanitation and hygiene 2000-2017: Special focus on inequalities. NY.

[5] Most people in the US receive water from and depend on wastewater treatment facilities provided by public utilities, and private sector participation is relatively limited (Copeland and Carper, 2017): https://fas.org/sgp/crs/misc/R43200.pdf

it. Energy consumption by drinking water and wastewater utilities can comprise 30%-40% of a municipality's total energy bill.

A 2013 Electric Power Research Institute study showed increasing electricity use for water and wastewater, reaching 1.8% of total US electricity use in 2011.[6] That might sound small, but it is 1.8% in a large country with very high rates of electricity consumption per capita (over 12,000 kWh per person per year, compared to an average 65 in Ethiopia or 340 in Ghana). The study reported a 39% increase in electricity use for public drinking water systems and a 74% increase for the municipal wastewater industry (compared to a 2002 study), likely due to population growth and implementation of more energy-intensive advanced treatment technology.

Energy use does not always have an associated carbon footprint, but it likely does in the US where renewable energy and nuclear power (that do not emit CO_2) make up a little over 20% of all energy. By contrast, Ethiopia generates 90% of its electricity from hydropower. The considerably high energy consumption of WASH services requires the sector to embrace more efficient and greener energy. It also makes the case for combining water and energy initiatives, such as solar pumps and micro-financing.

1.3 Global and National Climate Action

The 2015 Paris Agreement is the world's response to climate change. It was agreed by almost all countries (Iran and Turkey are two substantial emitters that did not sign). The US withdrew from the Agreement under President Trump but rejoined in 2021 under President Biden.

Under the United Nations Framework Convention on Climate Change (UNFCCC), the agreement entered into force in 2016 (UNFCCC, 2015). It seeks to keep global temperature rise below 2°C compared to pre-industrial levels (mitigation) and strengthen the ability of countries to deal with the impacts of climate change (resilience and adaptation). The Agreement provides a framework for high-income countries (who have caused most pollution) to provide funding to low- and middle-income countries to minimize growth in emissions (e.g., through technology transfer) and strengthen climate adaptation. Nationally Determined Contributions (NDCs) are national plans highlighting climate targets, policies, and measures that participating governments will implement as a contribution to global climate action.

National Adaptation Plans for Action (NAPAs) were prepared by LDCs to identify needs and priorities and secure funding from the LDC Fund.[7] More than 70% of all LDCs included water as a key vulnerable sector. Since the 2015 Paris Climate Conference (COP 21), this process has evolved into ongoing National Adaptation Planning (NAP). Currently, 22 countries have submitted to UNFCC, including Burkina Faso, Ethiopia, and Honduras. All other focus countries are developing the plans with approved support, except for Bolivia (Table 1).[8] It is a slow process, and the financing will take many years to materialize.

[6] S. Pabi, A. Amarnath, and R. Goldstein, et al., 2013., Electricity Use and Management in the Municipal Water Supply and Wastewater Industries, Water Research Foundation and Electric Power Research Institute.
[7] A database of NAPAs can be found at: https://unfccc.int/topics/resilience/workstreams/national-adaptation-programmes-of-action/napas-received
[8] Updated March 2021: https://unfccc.int/sites/default/files/resource/NAP-progress-publication-2020.pdf

The 25 pages of the Paris Agreement never mention the words 'water,' 'sanitation,' or 'hygiene.' An ongoing study of 31 NDCs shows that 58% do not mention water and sanitation, 32% have general statements on water and sanitation, and only 10% have specific goals.[9] This points to a critical challenge that it focuses disproportionately on mitigation over adaptation. Of countries where Water For People and IRC work, Bangladesh, Ethiopia, Honduras, Nicaragua, Peru, and Rwanda have submitted revised NDCs in 2020 or 2021 (Table 1).

Following the Paris Agreement, water sector organizations have been working to explicitly recognize the role of water in climate change response, particularly in adaptation strategies. The World Bank has said, "*Water is to adaptation what energy is to mitigation, and the challenges the world will face in adapting to water issues are enormous*" (World Bank Group, 2016).[10] The response to climate change must be global, with engagement across all sectors of economy and administration.

1.4 Challenges to Date

Whilst there is growing recognition of, and attention to, the issues of climate change in the media and at international meetings, WASH sector actors have been slow in tackling the issues. The following challenges (adapted from Batchelor, 2011[11]), complemented by the challenges noted in the country cases in Annex 1, help us understand why this persistent disconnection between acknowledgement and action exists.

More immediate challenges and limited funding. Many WASH professionals and practitioners continue to struggle with the more immediate challenges of improving WASH service provision. The current low levels of WASH services occur under conditions of a rapidly increasing demand for WASH services linked to population growth, increasing inter-sectoral competition for limited water resources, and slippage of WASH service levels due to factors such as inadequate operation and maintenance (O&M). Investing in water-related climate action can be viewed as diverting investments away from needed WASH service improvements, when instead climate action could be considered a way to reduce WASH costs or open the door to new funding options as part of payment for ecosystem services.

Governance constraints. Governance systems facilitate allocation of funds for WASH and engineering plans using standard specifications and procedures. These standard procedures often put time-bound, place-specific constraints on WASH professionals and practitioners who might want to adopt a more evidence-based and/or adaptive approach to WASH service delivery that considers a longer time horizon and more adaptive approaches.

Lack of political will. There is a tendency for politicians (and even WASH professionals) to blame the problems of WASH service delivery on climate change, often with no clear

[9] As presented during UNFCC global workshop on building climate resilience through improving water management and sanitation at transboundary levels, 29-31 March 2021: https://unece.org/sites/default/files/2021-03/2_session_2.Rapid_research_Timmerman.pdf

[10] World Bank, 2016. High and Dry: https://www.worldbank.org/en/topic/water/publication/high-and-dry-climate-change-water-and-the-economy

[11] IRC, 2011. Adaptation of WASH services delivery to climate change. Thematic Overview Paper: https://www.ircwash.org/sites/default/files/Batchelor-2011-Adaptation.pdf

justification. Similarly, climate change has also become a convenient “scapegoat” for WASH service providers in explaining poor service delivery. Paradoxically, these same politicians often lack the will to approve expenditure on climate change adaptation.

Policy limitations. Even when policies that link climate, WRM, and WASH exist, they can be difficult to implement because of lack of enforcement and resources. In many contexts, the policies do not exist or are disjointed and difficult to implement at the local level.

Global trends and local action. Tying the global needs and trends to local action can be difficult. Concepts and global trends that overlap with a particular local geography might be clear, but identifying the most impactful local interventions, and measuring the impacts of those interventions as it relates to climate change is difficult if not impossible in some cases.

Not sure what to do. WASH sector actors tend to focus their energies on responding to the more “traditional” challenges of WASH service delivery. Taking on new responsibilities and delving into new analytical terrain could cause delays in meeting immediate targets. As a result, sector actors are not sure what they can do or how they can contribute to climate adaptation without compromising other activities. People struggle to define the “additionality” needed for climate change mitigation and adaptation and how to integrate it in ongoing sector improvements.

Increased demand for cross-sector coordination. Less predictable climate patterns and increased scarcity issues add pressure to competing demands between different sectors such as agriculture, industry, environment, and domestic uses. More collaborative decision-making processes and more deliberate sharing of data, expertise, and funding are needed to develop integrated approaches to reach shared goals across all sectors.

Increasing overlap with disaster relief work. WASH work and disaster-relief work are more likely to overlap as the frequency of extreme weather events and natural disasters increases. Disaster-relief work, which often includes handouts, can distract and undermine longer-term efforts to build strong WASH systems that are resilient to disasters.

Wait and see. Finally, there appears to be a significant number of WASH professionals and practitioners who assume a “wait and see” attitude in responding to the links between climate change and WASH services. Put another way, whilst they do not deny the potential risks posed by climate change, they fail to recognize the imperatives for taking immediate action or modifying existing procedures. This general attitude may be attributed to a range of factors including the evolving language of climate change that delays development of a common understanding, lack of awareness of effective strategies, resistance to change, and uncertainty linked to the professional risk of being an early adopter of new ways of working. While the “Greta Thunberg effect”[12] is galvanizing many northern-based organizations and governments, the “wait and see” dynamic is still dominant in many organizations and countries.

[12] https://climatecommunication.yale.edu/publications/the-greta-thunberg-effect/

1.5 Learning from Failure

The complexity of climate change, coupled with the desire to simplify and attribute efforts to climate change, have led to well-intended, but often-ineffective and sometimes counter-productive initiatives. The following lessons help the sector better integrate climate change mitigation and adaptation strategies into WASH programming.

Consider existing threats. A utility manager in Honduras indicated that he is struggling with 40% non-revenue water and is unsure if he can pay the power bill next month. In exasperation, he asks, “how can I prepare for climate change?” Addressing cash flow problems may help reduce climate impact, but that is not his primary concern. *Climate change approaches and recommendations must consider existing threats to WASH and avoid claiming climate change as the only risk.*

Integrate funding. Various donors make a split between climate adaptation funding and “conventional” development funding, which includes funding for WASH. As a consequence, the WASH sector is unable to tap into any of the climate funding. *Donors must integrate financing for climate adaptation and development and allow the WASH sector to access this funding to strengthen WASH systems.*

Include adaptive options now. An engineer in Uganda included a 30% surge capacity in his water system design. When he asked an external advisor how much additional surge capacity buffer to include for climate change (10%? 20%? 100%?), the advisor could not give an answer. *Uncertainty about the future cannot be an excuse for inaction today. Adaptive options should be included in system design where possible, particularly at the source.*

Avoid leaps of faith. In Bangladesh, there was an initiative to improve traditional ponds to increase recharge and make boreholes more sustainable. However, those boreholes tapped from an aquifer over 100 meters deep with ancient water with no connection to the surface ponds. *We need to avoid the “leap of faith” when linking WASH with WRM and climate change through clearer understanding of the hydrological and hydrogeological impacts of interventions.*

Limit cosmetic greening. Trees consume water as they grow. Planting trees around a borehole may look nice, and is not necessarily a bad thing, but this likely only has a cosmetic effect since the shallow water resources impacted by the trees will have no impact on deeper groundwater capacity and will have little impact on mitigating or adapting to climate change. *We need to remain honest and avoid greenwashing and overstating impacts of tree planting.*

Avoid over-selling. In 2000, a donor with climate change financing came to Mozambique to fund WASH projects. Since nobody knew what to do about climate change, the funding was ultimately used for standard handpump rehabilitation, sold to the donor as “improving resilience.” *We should not give in to the temptation to “brand” something as climate change adaptation when we are just improving infrastructure through unsustainable financing mechanisms.*

Ensure community participation. "In their anxiety to show that they have invented something out of the box, the government has gone ahead and implemented a program with no basic

understanding of the science of hydrology or even ecology," reflects an agricultural economist based in Maharashtra, India. The BBC[13] brought forward the perceived failure of the 2019 *Jalyukta Shivar* water conservation scheme in Maharashtra. Villagers complained that they were not consulted about the best methods to conserve water in their own communities. *Climate change requires both bottom-up and top-down engagement.*

Invest in maintenance and rehabilitation. In 2018, IRC participated in a tender for climate resilient WASH activities. Due to climate financing rules, the funds could only be used for climate resilience actions that were not already considered the business of the water sector. This excluded activities that would normally be required for resilience, like improved maintenance of rural water supply systems. Groundwater mapping and watershed protection activities were deemed additional and allowable, though they may also be funded through conventional water supply programs. This approach only makes sense if the water supply sector properly finances the maintenance and capital maintenance expenditure (CapManEx) costs required for normal resilience (but it does not). *One of the best uses of climate finance may be to invest in one of the biggest gaps in the water supply sector: maintenance and CapManEx*.

[13] https://www.bbc.co.uk/news/world-asia-india-46341433

2 Climate Action

Climate action falls under two categories: mitigation and adaptation. Both are described generally and how they relate to WASH in the subsequent sections.

2.1 Climate Change Mitigation

Climate change mitigation activities include replacing the use of fossil fuels in energy production, reducing the use of cars, building more efficient cities, and relying less on animals in food production, among others. There is also scope for mitigation activities within the WASH sector.

At first glance, nature-based solutions offer an attractive mitigation option for WASH infrastructure by reducing the carbon footprint related to WASH facilities. For example, wetlands can treat wastewater and at the same time act as carbon sinks. In 2018, the World Water Development Report[14] and World Water Day[15] focused on these nature-based solutions, and they are currently being showcased again in response to climate change[16], but they are no panacea.[17] Wetlands require a lot of land and can exacerbate climate change by releasing methane. While appropriate in some contexts where WASH infrastructure is largely in place, their impact on climate mitigation is much less in low- and middle-income contexts with significant infrastructure deficits, including in Africa. Nature-based solutions that include reforestation in the recharge areas are another example of a WASH mitigation strategy because of the increased carbon sinks provided by trees. The challenge, as noted previously, is that planting trees can also increase water demand and their impact in terms of water quality and quantity can be overstated if the hydrologic conditions are not well understood. Reforestation programs need to be designed with clear understanding of hydrologic impacts to ensure that the trees have positive impact in the recharge area by maintaining baseflows of springs and shallow sources in dry seasons and preventing sediment loading in rainy seasons.

Nevertheless, within conventional WASH service delivery, there are many opportunities to adopt good practices and technological advancements to mitigate the sector's impact on climate change. These include:

- Reducing non-revenue water to reduce energy demands for pumping and treatment,
- Reducing pollution of intake water, thereby reducing energy demands for treatment,
- Switching to renewable energy sources for water pumping, especially solar,
- Ensuring proper sizing and installation of water pumps to optimize energy efficiency and improve pump lifespans,
- Optimizing logistics, such as in the design of fecal sludge management systems that include fleets of trucks, transfer stations, and treatment facilities,
- Utilizing fecal sludge for composting and biogas production in agriculture and energy production, such as fecal sludge briquettes for fuel and biogas plants.

Expanding our view beyond WASH service delivery to consider our organizational responsibility to mitigate climate change, it is also relevant to include the reduction of travel as a key mitigation strategy.

[14] https://www.unwater.org/publications/world-water-development-report-2018/
[15] https://www.unwater.org/world-water-day-2018/
[16] For example: https://www.unwater.org/publications/un-water-policy-brief-on-climate-change-and-water/
[17] https://theconversation.com/why-unescos-nature-based-solutions-to-water-problems-wont-work-in-africa-93208

2.2 Climate Change Adaptation

Since mitigation may not be effective in time to reduce climate change impacts, adaptation provides a parallel strategy to help cope with the impacts. Water is central to this strategy. As the World Bank puts it, "Water is to adaptation what energy is to mitigation."[18] Most UNFCCC parties have included an adaptation component in their plans, and over 90% of NDCs with an adaptation component refer to water.

We believe that WASH systems – the systems that deliver WASH services to everyone as a human right – are at the heart of adaptation efforts. Where communities, institutions, and households have good WASH services, they are more resilient and more likely to cope with other changes, such as extreme weather events, an increase in peak temperatures, or being forced to move to another location. In many low- and middle-income countries the systems that deliver those services are weak.

To make WASH services more climate resilient and understanding the space in which adaptation needs to take place, sector actors must consider the following factors:

- **Climate change is not the biggest threat to WASH services**. In low- and middle-income country contexts, the key threats to water and sanitation services, and the water resources upon which those services depend, are related to population and economic growth, urbanization, industrialization, and the expansion of irrigated agriculture. While these processes present more immediate risks, climate change is already impacting WASH services. It makes water management more difficult and will have increasingly important impacts on WASH services over the longer term.
- **Only stronger systems can deliver the services needed to reach SDG 6**. Filling gaps in WASH service delivery will depend partly on developing new infrastructure - where there is an opportunity to mitigate the WASH contribution to GHG emissions. However, to achieve access and level of service targets, we must strengthen the systems (institutions, policies, financing, monitoring, etc.) that are needed to deliver high-quality, sustainable services. Only those systems, with governments providing leadership and actors aligning behind national plans and processes, can deliver change and services at the scale demanded by the SDGs.
- **The skills and resources that will allow governments, service providers, and other WASH actors to face climate change (in the longer term) are the same needed now to tackle the pandemic, urbanization, growing populations, and growing water demand (in the short term)**. Building capacity in WASH service provision, attracting the necessary finance, and ensuring strong performance in the delivery of WASH services should be our first steps in tackling the threats related to climate change.

In addition to recognizing entire WASH system strengthening as a climate adaptation strategy, other opportunities also exist to better adapt WASH services to climate-related risks. WRM is a key building block of strong WASH systems, and greater attention to climate-related risks impacting those resources and WASH infrastructure is needed to adapt to climate change.

[18] https://www.worldbank.org/en/topic/water/publication/high-and-dry-climate-change-water-and-the-economy

The following are examples of climate adaptation strategies relevant for WASH. Annex 1 expands on these examples and Section 4 connects these adaptation actions to the specific risks we are trying to address which generally fall into the categories of (1) **polluted water:** increased pollution from flooding and flashier rain events, (2) **too little water:** increased water scarcity from increased temperature and changing rainfall patterns, and (3) **too much water:** increased flooding, extreme weather events, and rising sea levels that cause infrastructure damage. Section 4 provides a deeper understanding of these risks, and the following examples align to these general risk categories:

- Ensuring infrastructure is well built and makes effective use of cement in construction to increase durability.
- Protecting water and sanitation infrastructure from natural disasters including flooding, landslides, and extreme winds (for example, raising borehole platforms above flood levels).
- Household-level financing and planning for disaster resilient bathroom facilities and other household infrastructure.
- Service delivery schemes and infrastructure that are more adaptable and able to respond to unpredictable changes in weather patterns and resulting source quantity.
- Source protection to prevent contamination from flashier rain events with physical measures.
- Community-level water safety and security planning to enable informed decision- making with clear understanding of risks.
- Catchment management planning and implementation including the full range of nature-based solutions that are most strategic given the local hydrology and can include reforestation, wetland restoration, transitioning to less degrading agriculture practices and household relocation.
- Aquifer management through better use and contribution to regional data sets and advocacy for development or enforcement of drilling permits.
- Sustainable financing of source protection and catchment management through payment for ecosystem services, environmental surcharges on the tariffs, or establishing financially sustainable nurseries in areas where reforestation is a priority.
- Community and district-level financing for capital replacement and repair considering increased risk of natural disasters.
- Participatory district-level WRM planning that considers longer-term time horizons and is based on localized risks.
- Establishment of district watershed committees to facilitate data- and consensus-based decision-making on protection priorities and associated investments.
- Water re-use programs to reduce overall demand for fresh supplies.
- Water metering to limit demand where supplies are limited.
- Use or establishment of sustainable monitoring systems focused on WRM to enable more informed WASH decision-making.

3 Climate Finance

The WASH sector has an enormous financing gap to meet the ambitious SDG 6. The World Bank estimates that it will cost approximately US$114 billion a year between now and 2030 just to achieve the first two (of six) targets.[19] This requires a three-fold increase in the level of financial commitment - from 0.12% to 0.39% of the Gross Domestic Product (GDP) of the 140 countries covered by the study.

In some cases, the financing gaps are even bigger. In Ethiopia, estimates suggest that a six-fold increase to around US$3 billion is needed to meet SDG 6.[20] In Asutifi North, a district where IRC works in Ghana, there is a financing gap for capital investments to extend services, but the gaps for CapManEx (major capital repairs like a new pump) and direct support (activities to support service providers) are even bigger.[21]

Climate finance, aimed at both mitigating emissions that contribute to climate change and adaptive actions to minimize negative impacts of climate change, can help fill these gaps. WaterAid's Climate Policy Initiative found that climate finance flows reached US$574 billion per year on average in 2017 and 2018. Most funding supported mitigation (US$537 billion) rather than adaptation (US$42 billion). Of adaptation investments, US$13 billion funded water and wastewater.[22]

WaterAid describes three main climate finance mechanisms[23]:

- **Multilateral climate funds:** High-income country governments pay into these funds as part of their UNFCCC obligations; the largest is the Green Climate Fund (GCF).
- **Bilateral climate funds:** These funds flow from one government to another, usually through an existing development agency.
- **Private finance:** Private sources of climate finance are mainly used for renewable energy and green transport rather than climate adaptation.

The GCF is increasingly becoming a major source of adaptation finance. It was established at COP16 in 2010 and funded its first projects in 2015. This fund devotes 50% of its expected annual US$10 billion spend to adaptation activities, with half of that going to the Small Island Development States (SIDS), LDCs, and African States. Currently, there are only seven WASH projects (six in SIDS), but 15 additional WASH projects (of 47 total water projects) are in development. New guidelines will support the preparation of further proposals.

GCF WASH projects should be evidence based with quantifiable mitigation and/or adaptation potential that goes beyond 'business as usual' development projects. Projects are expected to transform the WASH sector in the country. Projects should include sanitation, cover the whole

[19] This total comprises the annual costs of safe water (US$37.6 billion), basic sanitation (US$19.5 billion), safe fecal waste management (US$49 billion), and hygiene (US$2.0 billion): https://www.worldbank.org/en/topic/water/publication/the-costs-of-meeting-the-2030-sustainable-development-goal-targets-on-drinking-water-sanitation-and-hygiene

[20] https://www.ircwash.org/resources/financing-universal-safe-and-sustainable-water-services-ethiopia

[21] https://www.ircwash.org/sites/default/files/costing_study_infographic.pdf

[22] https://www.climatepolicyinitiative.org/wp-content/uploads/2020/12/Updated-View-on-the-2019-Global-Landscape-of-Climate-Finance.pdf

[23] https://washmatters.wateraid.org/publications/short-changed-on-climate-change

water cycle (e.g., recharge and abstraction), be powered at least partly by renewable energy, and should not exacerbate water scarcity issues.

Unless it grows, the GCF can only make a small dent in WASH sector financing in low- and middle-income countries, even if all available funds were spent on WASH projects. In practice, projects cover multiple sectors (like hydropower in energy and irrigation in agriculture), as well as the four water sub-sectors of climate resilient WASH, integrated flood management, integrated drought management, and integrated water resources management (IWRM).

Climate resilient WASH projects are at risk of failure when 'resilience' is narrowly defined as something related to climate. This is too simplistic. In the WASH sector, limited resilience is a result of weak systems. For example, weak monitoring systems undermine the ability to make sensible decisions; strong systems enable the regular maintenance of facilities and ensure services are sustained. Even WASH components linked with climate change, such as water source protection and improved WRM, remain difficult to fund.

A compliance carbon market (called the Clean Development Mechanism[24]) was established as a result of the 1997 Kyoto Protocol. It allows for high-income countries to achieve some of their mandatory emission reductions by buying "carbon credits" from projects implemented in low- and middle-income countries (e.g., from renewable energy or reforestation projects). In addition, several voluntary carbon standards (e.g., Gold Standard and Verra) certify emission reductions which allow corporations to offset unavoidable carbon emissions and make "carbon neutrality" claims. In the WASH sector, projects can generate carbon credits by promoting access to household water treatment options that reduce emissions from boiling drinking water.

The future of the carbon standards (for compliance or voluntary) is uncertain, especially since countries now need to fulfill self-imposed targets under the Paris Agreement. However, it is likely that some forms of tradable carbon emission reductions will persist. Indeed, several countries explicitly plan to reduce part of their emissions abroad; for example, the aviation sector committed to offset any emissions above the 2020 baseline. Any WASH interventions with several 10,000 tons of expected emission reductions should assess the potential to generate carbon credits as a source of co-financing.

[24] https://cdm.unfccc.int/index.html

4 Understanding and Addressing Risks

As highlighted in IRC's 2011 paper on adaptation of WASH services delivery to climate change,[25] it is key that individual WASH actors identify risks within their sphere of influence, determine where they pose the biggest threat, and decide what we can do about them.

When reflecting on the risks identified in the country cases in Annex 1, three themes emerged which were introduced in Section 2 and expanded on here:

- **Polluted Water:** Flashier rain events and increased flooding can both cause increased pollution. For instance, flashier rain events on degraded lands can cause erosion and increased pollutant loads to nearby water resources. Flooding, especially in areas with limited safely managed sanitation services, can cause the spread of contaminants and disease. Extreme events can cause disease outbreaks, such as cholera. Handwashing is a key defense against disease, as evidenced by the COVID-19 response, and is even more critical when health services are disrupted.
- **Too Little Water:** Increased temperatures, decreasing rains, and less predictable rains can impact both the supply and demand of water. Supplies decrease as flows reduce, and demand cycles change as weather patterns change. Both the increased pressure and the unpredictability of water supply and demand present risks.
- **Too Much Water:** Extreme weather events such as floods and hurricanes, which can also come with extreme winds and landslides, can cause direct damage to WASH infrastructure. Other impacts such as rising sea levels are indirect, insidious, and uncertain in nature and severity and can damage infrastructure or lead to out-migration from coastal areas.

Table 2 in Annex 2 provides a summary of the risks that are most prevalent in the districts where we work across all 12 countries. Note that the results do not represent the entire countries. All countries, except Uganda, experience high risks in at least one of the three categories and no one risk category is more prevalent than others. Compared to other regions, perceived risks are highest in Central America.

The country cases also revealed themes in terms of the extent that programming focuses on these risks. Table 3 in Annex 2 shows that our most focused programming deals with excess water and the associated infrastructure damage. Overall, we do a lot of related work, but it is often not designed with a clear focus on adapting to specific climate risks.

Ideally where a country program is faced with high levels of risk, we are implementing focused programming to address those risks. Figure 2 presents a risk matrix that shows the results when we did a rapid mapping of the perceived risks from climate change and our programmatic response. The three risk categories and three degrees of intervention were mapped based upon the perception of team members working in each country.

This simplified approach allows us to discuss where to increase our efforts. For example, in the India programs, we have identified a risk of infrastructure damage, but do not yet have focused programming to address these risks. The risk matrix also shows that in most countries we have

[25] https://www.ircwash.org/sites/default/files/Batchelor-2011-Adaptation.pdf

high risks that are not matched with focused programming. The following sections provide more concrete examples of the specific risks and responses summarized in the matrix in Figure 2.

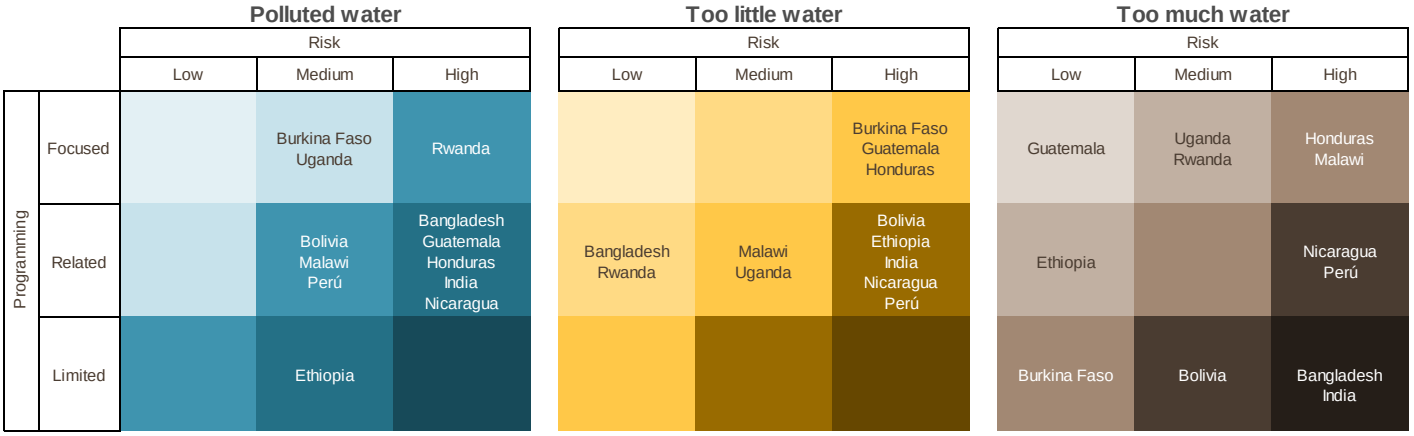

Figure 2: Rapid mapping risk matrix

4.1 Polluted Water

All country programs perceive the risks of polluted water as medium or high. Almost all have programming that is related to or focused on preventing pollution.

Colleagues in Malawi are concerned about the use of artificial fertilizers and soil erosion related to farming practices, leading to contamination of rivers and aquifers. In response, Water For People has recently partnered with Blantyre Water Board and The Nature Conservancy to establish a water fund, which is a sustainable financing mechanism to invest in catchment protection to prevent sediment loading and other pollution.

In Bangladesh and low-lying areas in Ethiopia, teams are concerned about pollution associated with flooding of latrines and poor drainage in urban areas. In response, together with the WASH SDG consortium in Bangladesh, IRC is financing disaster resilient latrines and improved borehole design with raised platforms. Similarly, in Malawi and India, Water For People is raising borehole handpump and standpipe aprons to reduce risks of submergence during floods.

In Honduras, springs are the primary source of water and increased pollution is a high risk. In response, Water For People set up and continues to strengthen a municipal watershed committee to collaborate with the forestry ministry and municipal technical teams to facilitate a process of delineating and protecting drinking water watersheds. A key function of the committee is to establish a financing mechanism that pools a portion of water tariffs to make priority investments in watershed protection.

4.2 Too Little Water

Water scarcity is considered a high risk in most country programs, and all countries are implementing activities that are related to or focused on that risk. While groundwater is relatively

well-buffered from climate fluctuations, some teams are concerned about decreasing levels, for example in the Sahel region of Burkina Faso. With the Green Revolution driving agriculture, the overextraction of aquifers is a prominent concern for the India team. Colleagues in Malawi report deeper drilling as water tables are lowering, requiring alternatives to the standard Afridev handpump (which can only be drilled up to 50m), such as life pumps or submersible pumps.

In drought-prone areas, some water supply points dry up seasonally while those that withstand the droughts may attract users beyond their carrying capacity. These points get over-pumped, thus increasing the frequency of infrastructure breakdown and related costs of O&M. In response, IRC is supporting Afar and Somali regions (working with USAID Lowland WASH and UNICEF, respectively) to establish monitoring networks for motorized boreholes and innovation in rural water supply maintenance models. Teams also challenge the assumption that deep boreholes and multi-village piped water schemes are necessarily resilient. While these technical solutions lend themselves to climate resilience, drawing on deeper reliable water supplies and distributing them across areas, they require higher levels of management than community managed schemes.

Other examples of adaptation in contexts with too little water include:

- Establishing borehole gardens to reuse wastewater at the water point for growing crops in Malawi. This allows communities to grow crops during the dry season or drought. It also helps water percolate back into the soil thereby recharging the water table.
- In Bolivia, drafting municipal regulation to standardize the drilling of wells, which is currently uncontrolled and is detrimental to the availability of water for human consumption.
- Engaging the private sector to construct and maintain rainwater harvesting systems in public institutions and households to increase storage capacity and enhance alternative water sources in Uganda.
- Reforestation with appropriate native species in micro-catchments that influence spring flows is a common activity across all five Latin American country programs. The increased tree cover helps retain water in the micro-catchment and sustains baseflows throughout the dry season.

4.3 Too Much Water

Figure 2 shows that the risk to infrastructure damage from flooding and extreme weather events is high in half of the country programs with varying response levels. Overall, this risk seems to offer the greatest opportunity for more focused programming.

Higher tides and storm surges lead to regular flooding in areas of Southern Bangladesh and India’s coastal zone. Increased flooding can wash away piped networks (especially when the network crosses rivers), submerge handpumps, and cause collapse of houses and latrines, forcing people to continually rebuild.

Urban settlements are supplied by larger piped networks, often depending on power to pump the water through the network. In Malawi, failing hydro-dams cause power shortages that leave water supplies vulnerable. In Odisha, India, cyclones are becoming more frequent (3), leading to

power outages, reducing pump functionality and water availability during and after such events. In Bangladesh, super structures are often damaged in strong winds, and high waves inundate the land with saline water, overflowing pits, infiltrating boreholes, and increasing salinity in shallow groundwater. According to Water For People's annual monitoring, high and intermediate levels of water service in Chikwawa, Malawi, dropped from 86% in 2018 to 66% in 2019 due to Cyclone Idai. In response, designs with pipes crossing rivers on pillars (which were prone to being washed away during flooding) were shifted to bury the pipes under the riverbed.

More resilient WASH infrastructure can be more expensive, which has led programs in Bangladesh, Malawi, and Rwanda to advocate for increased investment in infrastructure at the household and district levels.

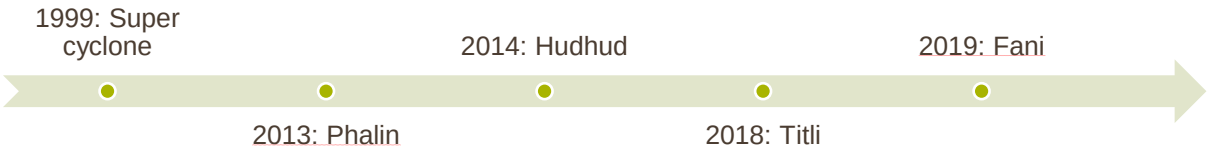

Figure 3: Increase in cyclones in Odisha

4.4 National Policies and Plans

Our rapid mapping exercise also covered national regulatory and planning frameworks for climate change and WASH in countries where we work (Table 1). All national governments include climate change aspects in policies and planning guidance, but only a few include specific WASH components in climate policy and plans. For example, Uganda has WASH-related climate indicators in the National Climate Change Policy, including "*M1: Percentage of government institutions with functional water facilities during drought.*"[26] Bangladesh has policies that favor people living in poverty that specifically recognize people affected by climate change.[27]

Using our systems approach, Water For People and IRC work with local governments to strengthen existing WASH and climate policies, including:

- The 2018 Water Rule in Bangladesh that IRC helps to operationalize by ensuring community members participate in IWRM committees.
- The Climate Resilient WASH approach in Ethiopia that IRC supports as part of the One WASH National Programme through various working groups.[28]
- Village Water Safety and Security (VWSS) Plans in India that are developed at the village and block levels in West Bengal, Bihar, and Maharashtra. The VWSS Plans are incorporated into *Gram Panchayat* Development Plans and aim to ensure sustainability of water sources and O&M systems and strengthen water quality monitoring systems and processes.

[26] http://ccd.go.ug/wp-content/uploads/2018/09/STANDARD-NATIONAL-CLIMATE-CHANGE-BOOKLET_2018-1.pdf
[27] www.psb.gov.bd/policies/ppse.pdf
[28] https://www.unicef.org/ethiopia/media/1111/file/OWNP%20Phase%20II.pdf

Strengthening the link between IWRM with WASH policies is central to making communities more resilient. The following provide examples of making that link through local level policies and planning. Examples include:

- In Peru, the team implements IWRM activities that address climate change and increase community resilience as part of local and regional WASH training. Adaptation activities include source conservation, equitable water distribution, efficient water use, and improved water quality. Mitigation efforts center around reforestation activities.
- In Uganda, the team supports development of catchment and sub-catchment plans led by the Ministry of Water and Environment and the Albert Water Management Zone and advocate for supporting the District Water and Sanitation Coordination Committee to implement water source protection guidelines.
- In Bolivia, the Municipal WRM Plan includes five activities: 1) formation of Municipal IWRM Committees, 2) identification of water sources and water recharge zones, 3) strengthening municipal nurseries, 4) water recharge zone afforestation, and 5) water source protection.
- In Rwanda, teams support the development of a WRM Plan to ensure sustainable water services. These plans have identified the need for year-round chlorination and pH regulators.

Table 1: Climate change policies and plans

Region	Country	NDC	Existence of NAP	National climate policy & plans	Extent WASH is included in policies & plans	Organization
Africa	Burkina Faso	2015	Yes	Limited	Small	IRC
	Ethiopia	2020	Yes	Some	Moderate	IRC
	Malawi	2017	No	Some	Large	Water For People
	Rwanda	2020	Yes	Comprehensive	Moderate	Water For People
	Uganda	2016	No	Comprehensive	Large	Water For People/IRC
Asia	Bangladesh	2020	No	Comprehensive	Moderate	IRC
	India	2016	No	Some	Moderate	Water For People/IRC
Latin America	Bolivia	2016	No	Comprehensive	Moderate	Water For People
	Guatemala	2017	Yes	Limited	Small	Water For People
	Honduras	2021	No	Some	Moderate	Water For People/IRC
	Nicaragua	2020	No	Some	Large	Water For People
	Peru	2020	Yes	Some	Moderate	Water For People

NAP

Yes	Country has NAP
No	Country does not have final NAP

Policy & plan rating

Comprehensive	Comprehensive set of updated policies & plans
Some	Some updated policies & plans
Limited	Limited to no policies & outdated plans

WASH inclusion rating

Large	WASH included in policies & plans to a large extent
Moderate	WASH included in policies & plans to a moderate extent
Small	WASH included in policies & plans to a small extent

5 Conclusion

Strengthening WASH systems should be at the heart of climate adaptation efforts in the low- and middle-income contexts where we work. Increasing droughts and floods pose a short-term risk that is difficult to prevent, and inadequate WASH systems must be addressed quickly to reduce the vulnerability to and impacts of such events. Good WASH systems and services increase the resilience of households and communities in the face of climate change. Put another way, it is hard to seek climate resilience, while ignoring a broader agenda that includes resilient WASH systems. How these things are done and financed should be central to our climate change response.

In addition to recognizing that WASH system strengthening is a climate adaptation strategy, other opportunities also exist to better adapt WASH services to climate-related risks. WRM is a key building block for strong WASH systems, and greater attention to climate-related risks impacting those resources and WASH infrastructure is needed to adapt to climate change. Investing in disaster-resilient infrastructure is a key response to increased risks from extreme weather events and flooding. Catchment management, including reforestation, and other nature-based solutions are a key response to increased risks of pollution from flashier rain events. Better monitoring and controls relating to boreholes and drilling are a key response to the increased risk of water scarcity. Many other adaptation strategies are also relevant depending on the prevalence of different risks in a program area.

The WASH sector can also mitigate climate change impacts. Simple measures, such as the proper sizing and installation of pumps, can optimize energy efficiency. There are opportunities to switch energy sources and use solar. In the construction sector where we hope to see massive growth, there are opportunities to ensure infrastructure is well built and makes good use of cement. There are opportunities to make sensible decisions related to logistics as new investments are made in transport (e.g., fleets of trucks).

Climate change finance should be a core source of finance for strengthening WASH systems and must build on WASH sector efforts. Understanding the current limits of sector financing is an important starting point. Available climate funds are small compared to the finance gaps in the WASH sector, but there is potential for growth.

Annex 1: Country Cases

Individual country cases have been produced to provide clear examples of the risks related to climate change, the impact on WRM and WASH, and the mitigation and adaptation strategies implemented in Water For People and IRC country programs.

Africa Region

Burkina Faso

Ethiopia

Malawi

Rwanda

Uganda

Asia Region

Bangladesh

India

Latin America Region

Bolivia

Guatemala

Honduras

Nicaragua

Perú

Annex 2: Climate Risk and Response Tables

Tables 2 and 3 provide an overview of the key climate risks within IRC and Water For People country programs and the responses to them.[29]

Table 2: Perception of key climate risks in country programs

		Risk			
Region	**Country**	**Polluted water** from intense rains	**Too little water** from increased temperature and reduced rains	**Too much water** from increased storms, flooding, and high tides	**Organization**
Africa	Burkina Faso	**Medium**	**High**	**Low**	IRC
	Ethiopia	**Medium**	**High**	**Low**	IRC
	Malawi	**Medium**	**Medium**	**High**	Water For People
	Rwanda	**High**	**Low**	**Medium**	Water For People
	Uganda	**Medium**	**Medium**	**Medium**	Water For People/IRC
Asia	Bangladesh	**High**	**Low**	**High**	IRC
	India	**High**	**High**	**High**	Water For People/IRC
Latin America	Bolivia	**Medium**	**High**	**Medium**	Water For People
	Guatemala	**High**	**High**	**Low**	Water For People
	Honduras	**High**	**High**	**High**	Water For People/IRC
	Nicaragua	**High**	**High**	**High**	Water For People
	Peru	**Medium**	**High**	**High**	Water For People

Risk rating

High	Most districts (where we work) and high level of threat
Medium	Some districts and/or medium level of threat
Low	Low level of threat across all districts

[29] For contextual information see also https://www.waterforpeople.org/the-data/ and https://www.ircwash.org/data-behind-our-work

Table 3: Perception of country program response to climate risks

		Program Response by Risk			
Region	**Country**	**Polluted water** from intense rains	**Too little water** from increased temperature and reduced rains	**Too much water** from increased storms, flooding, and high tides	**Organization**
Africa	Burkina Faso	**Focused**	**Focused**	**Limited**	IRC
	Ethiopia	**Limited**	**Related**	**Related**	IRC
	Malawi	**Related**	**Related**	**Focused**	Water For People
	Rwanda	**Focused**	**Related**	**Focused**	Water For People
	Uganda	**Focused**	**Related**	**Focused**	Water For People/IRC
Asia	Bangladesh	**Related**	**Related**	**Limited**	IRC
	India	**Related**	**Related**	**Limited**	Water For People/IRC
Latin America	Bolivia	**Related**	**Related**	**Limited**	Water For People
	Guatemala	**Related**	**Focused**	**Focused**	Water For People
	Honduras	**Related**	**Focused**	**Focused**	Water For People/IRC
	Nicaragua	**Related**	**Related**	**Related**	Water For People
	Peru	**Related**	**Related**	**Related**	Water For People

Program response rating

Focused	Focused programming
Related	Related activities
Limited	Limited attention

Annex 3: Key Resources

The takeaways from the 13 key resources related to climate change, water resources, and WASH systems that we found most useful in preparing this working paper are below.

Batchelor, C. Smits, S. and James, A.J., 2011. Adaptation of WASH services delivery to climate change and other sources of risk and uncertainty. Thematic Overview Paper 24. The Hague: IRC International Water and Sanitation Centre. Available at: https://www.ircwash.org/resources/adaptation-wash-services-delivery-climate-change-and-other-sources-risk-and-uncertainty-0
This paper points out that uncertainty and climate change go hand in hand. It argues that WASH sector professionals should treat climate change as one of many sources of risk and uncertainty that impact sustainable WASH delivery service and access. Adaptive WRM is proposed as a key adaptation approach.

Intergovernmental Panel on Climate Change (IPCC), 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Geneva, Switzerland, 151 pp. Available at: https://www.ipcc.ch/report/ar5/syr/
The IPCC produces authoritative reports on climate change. A new report will be launched in 2021, but the most recent is this Fifth Assessment Report. Using rigorous protocols, available scientific understanding is summarized and the level of confidence of changes assessed (from very low to very high).

Richard C. and Carter, A. P., 2009. Climate change, population trends and groundwater in Africa. Hydrological Sciences Journal, 676-689. Retrieved from: https://www.semanticscholar.org/paper/Climate-change%2C-population-trends-and-groundwater-Carter-Parker/435a133ebbe5183397063259428ccc429553d025
Climate change is a big problem, but unfortunately we have even bigger and more immediate problems with respect to providing water services: “climate change impacts are likely to be significant, though uncertain in direction and magnitude, while the direct and indirect impacts of demographic change on both water resources and water demand are not only known with far greater certainty, but are also likely to be much larger. The combined effects of urban population growth, rising food demands and energy costs, and consequent demand for fresh water represent real cause for alarm, and these dwarf the likely impacts of climate change on groundwater resources, at least over the first half of the 21st century.”

Calow, R. and MacDonald, A., 2009. What will climate change mean for groundwater supply in Africa? Background note. Available at: https://cdn.odi.org/media/documents/4120.pdf
This background note highlights that rural water supplies in Africa are overwhelmingly dependent on groundwater, and dependence is likely to increase. Climate modelling uncertainties, combined with rapid socio-economic change, make predicting water futures very difficult. While there is good confidence in temperature projections, rainfall scenarios remain much more uncertain, as do impacts on groundwater recharge. The background note states that climate change will not lead to the continent-wide failure of rural water sources because

groundwater-based domestic supply requires very little recharge. However, a significant minority of people – as many as 90 million – could be affected if rainfall declines significantly in those areas with limited groundwater storage, especially if the frequency of droughts increases. In most areas in Africa, the key determinants of water security will continue to be access rather than availability related.

United Nations (UN)-Water, 2019. Climate Change and Water: UN-Water Policy Brief. Available at: https://www.unwater.org/publications/un-water-policy-brief-on-climate-change-and-water/
This policy brief states that climate change will increase the variability in the water cycle, inducing extreme weather events, reducing the predictability of water availability, affecting water quality, and threatening sustainable development, biodiversity, and the enjoyment of the human rights to water and sanitation worldwide. Growing demand for water will increase the need for energy-intensive water pumping, transportation, and treatment and has contributed to the degradation of critical water-dependent carbon sinks such as peatlands. Some climate change mitigation measures, such as the expanded use of biofuels, can further exacerbate water scarcity. It calls for an integrated approach to climate change and water management, more investment in improved hydrological data, institutions, and governance, capacity development, risk assessment, and knowledge sharing. It offers some solutions to managing climate and water in a more coordinated and sustainable manner.

Timboe, I., Pharr, K. and Matthews, J. H., 2019. Watering the NDCs: National Climate Planning for 2020 and Beyond. Corvallis, Oregon. Alliance for Global Water Adaptation (AGWA). Available at: https://www.wateringthendcs.org/
This paper is intended primarily for creating or implementing national climate policies and planning, including NAPs. It offers guiding principles and recommendations on why and how to integrate water more centrally within national climate planning and implementation. It includes links to tools and approaches for more resilient water management.

World Bank, 2016. High and Dry: Climate Change, Water, and the Economy. Washington, DC. License: Creative Commons Attribution CC. BY 3.0 IGO. Available at: https://www.worldbank.org/en/topic/water/publication/high-and-dry-climate-change-water-and-the-economy
Water scarcity, exacerbated by climate change, could cost some regions up to 6% of their GDP, spur migration, and spark conflict. This report by the World Bank makes the financial case for investing in water management as water scarcity, exacerbated by climate change, could hinder economic growth. Urgent action is required, or water will become scarce in regions where it is currently abundant. Water insecurity could multiply the risk of conflict. The negative impacts of climate change on water can be neutralized with better policy decisions and investments.

Global Water Partnership (GWP) and United Nations Children's Fund (UNICEF), 2014. WASH Climate Resilient Development. Strategic framework for WASH Climate resilience. Available at: https://www.gwp.org/en/WashClimateResilience/
This framework provides guidance on the main considerations in the planning and execution of actions aimed at building climate resilient WASH services. Improvements in WRM will help manage climate risks now and in the future through better information, policy, regulation,

allocation, and cooperation. This reduces the vulnerability to current climate variability and paves the way for more proactive climate change adaptation. It presents climate resilience as a cross-cutting issue and the rationale and concepts for WASH climate resilient development.

WaterAid, 2020. Short-changed on climate change: Money, water and the people on the frontline. Available at: https://washmatters.wateraid.org/publications/short-changed-on-climate-change
WaterAid are calling for a rapid, ten-fold increase in climate finance to get sustainable, clean water to the people currently forced to live without, increasing their ability to cope with the effects of climate change.

Future Climate for Africa (FCFA). Available at: www.futureclimateafrica.org
The FCFA website shares new climate science focused on Africa. FCFA consists of five independent research consortia aiming to make infrastructure and urban and rural plans and investments more climate resilient. The website offers resources, such as publications and videos, on climate related research in Africa.

MacAllister, D.J., MacDonald, A.M., Kebede, S. et al., 2020. Comparative performance of rural water supplies during drought. Nat Communications 11, 1099. Available at: https://doi.org/10.1038/s41467-020-14839-3
Deeper groundwater sources will perform better during droughts as shown by UNICEF-led monitoring of water sources during the 2015/16 drought in Ethiopia. But functionality of handpumps was found to be better than motorized boreholes. This paper concludes that "prioritising access to groundwater via multiple improved sources and a portfolio of technologies, such as hand-pumped and motorised boreholes, supported by responsive and proactive O&M, increases rural water supply resilience."

Sanitation and Water for All (SWA), 2020. Adapting to climate change and fostering a low carbon water and sanitation sector. SWA Briefing Paper. Available at: https://www.sanitationandwaterforall.org/sites/default/files/2020-03/SWA%20Briefing%20Paper%203%20-%20Climate%20Change.pdf
This briefing note explores how SWA partners can address the risks and challenges presented by climate change through adaptation and mitigation measures. A framework offers concrete suggestions to integrate climate change considerations into planning and actions at global, regional, and national levels. The framework consists of guiding principles, collaborative behaviors and building blocks for strengthening integrity in the WASH sector.

UNESCO and UN-Water, 2020. UN World Water Development Report 2020: Water and Climate Change. Paris. Available at: https://en.unesco.org/themes/water-security/wwap/wwdr/2020#download
This report discusses that the bulk of the GHG) emissions related to water and sanitation either originate from the energy used to power the systems or the biochemical processes involved in water and wastewater treatment. Increasing water use efficiency and reducing unnecessary water consumption and water loss both translate into lower energy use and thus lower GHG emissions. Global water use has increased by a factor of six over the past 100 years and continues to grow steadily at a rate of about 1% per year due to increasing population, economic development, and shifting consumption patterns. Combined with more erratic and

uncertain supply, climate change will aggravate the situation of currently water-stressed regions and generate water stress in regions where water resources are still abundant. Water scarcity is often a seasonal phenomenon, rather than a chronic one, and climate change is likely to cause shifts in seasonal water availability throughout the year. Within the 2030 Agenda, water serves as an (often) unacknowledged but essential connecting factor for attaining the different SDGs. As such, failure to adapt to climate change jeopardizes the achievement of not only SDG 6, but most other SDGs.