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Reimagining WASH

WATER SECURITY FOR ALL

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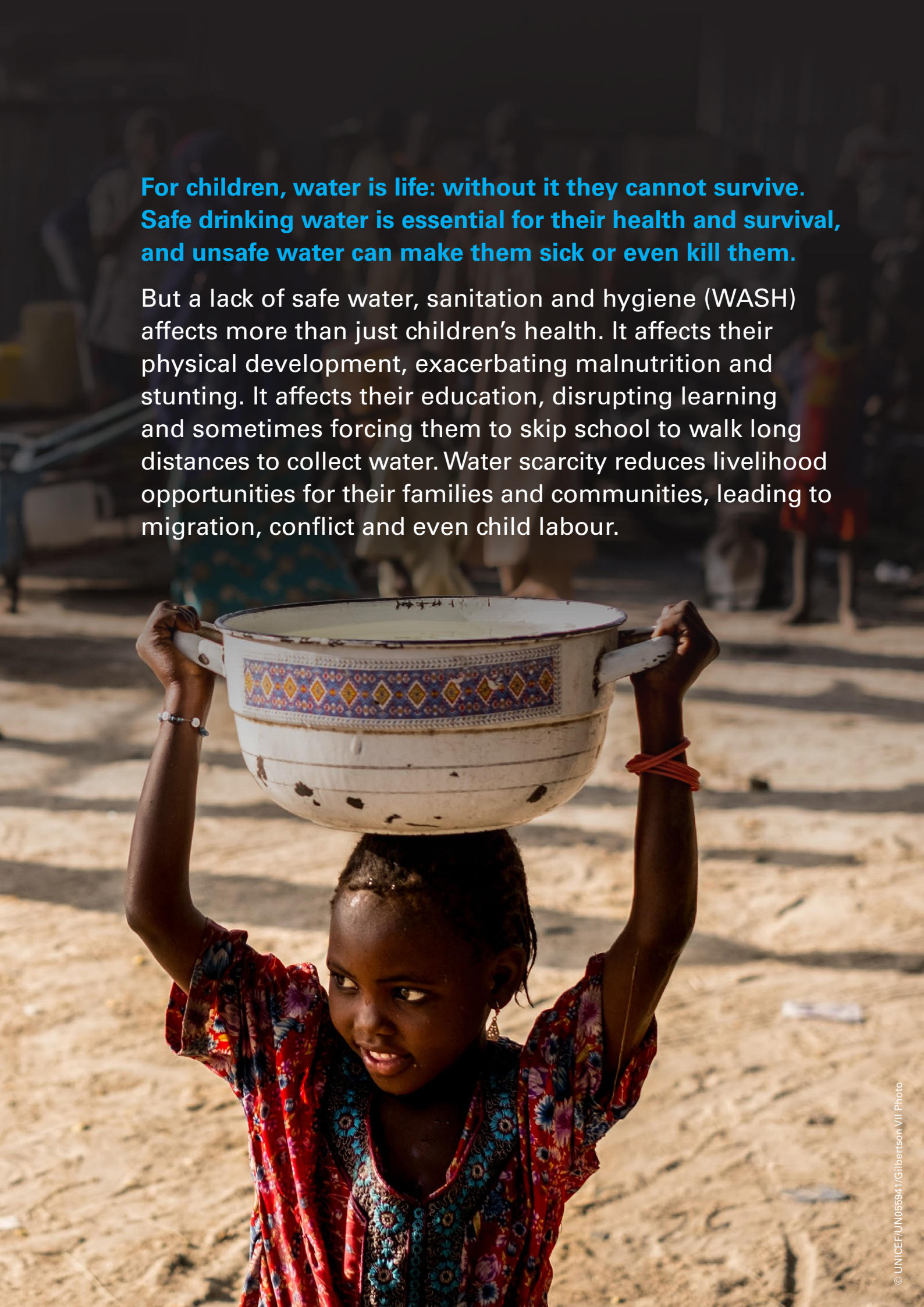
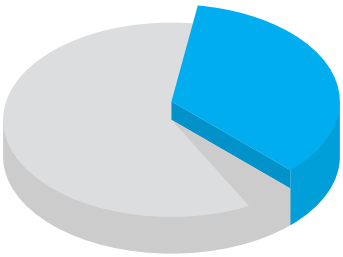
For children, water is life: without it they cannot survive. Safe drinking water is essential for their health and survival, and unsafe water can make them sick or even kill them.

But a lack of safe water, sanitation and hygiene (WASH) affects more than just children's health. It affects their physical development, exacerbating malnutrition and stunting. It affects their education, disrupting learning and sometimes forcing them to skip school to walk long distances to collect water. Water scarcity reduces livelihood opportunities for their families and communities, leading to migration, conflict and even child labour.





1.42 billion people

450 million children

live in areas of high or extremely high water vulnerability.

Today, 1.42 billion people – including 450 million children – live in areas of high or extremely high water vulnerability.[1]

Less than 3 per cent of the world's water resources is freshwater, and it is growing increasingly scarce.[i] Decades of misuse, poor management, over-extraction of groundwater and contamination of freshwater supplies have exacerbated water stress. At the same time, demand for water is rising due to rapid population growth, urbanization and increasing water needs from a range of sectors, notably agriculture, industry and energy.

Climate change is also compounding water scarcity through changing precipitation patterns and increased water demand. Many changes in climate are felt through water – droughts, floods and rising sea levels – and extreme weather events can damage vital water and sanitation infrastructure and services in homes, communities, schools, health-care facilities and food supplies. Rising sea levels can lead to saltwater intrusion, contaminating drinking water supplies. Rapid melting of glaciers changes the river flow patterns in the downstream areas, contributing to risks of flooding, damage to infrastructure (including dam bursts), as well as low flows in rivers, reducing the amount of water available.

Water scarcity and climate change are also drivers of conflict and migration, as communities and entire populations compete for shrinking water resources. Families may be forced to leave their homes in search of reliable water supplies and livelihood opportunities, often moving to urban areas and towns, putting even more pressure on already strained services.

The resulting impact on children's health, development, and safety threatens the significant progress made in child survival and sustainable development over the past several decades. It is putting children's lives at risk today and threatens future generations.

[1] Water vulnerability for this analysis relates to physical water scarcity risks (Baseline water stress; inter and seasonal variability; groundwater decline and droughts) and the water service level

KEY CONCEPTS

Water scarcity[2]

Water scarcity exists where the demand for water exceeds supply and where available water resources are approaching or have exceeded sustainable limits. Water scarcity can either be physical or economic.

Physical water scarcity

Occurs where water resources are over-exploited for different uses and no longer meet the needs of the population.

Economic water scarcity

Where poor governance, limited capacity, infrastructure and limited investments are among the drivers of economic water scarcity. This type of water scarcity may occur in countries with adequate water resources.

Water stress[ii]

Water stress is an outcome of water scarcity and refers to scarcity in terms of quality and accessibility. Water stress may manifest in conflict over water resources, over-extraction, or poor health and disease.

Extreme water scarcity[iii]

Occurs where annual water supply availability is less than 500 cubic metres per person per year. However, this metric has been developed as a global average, applied in varying contexts and includes different uses of water, not only domestic.

Water security

The capacity of a population to safeguard sustainable access to adequate quantities of and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against waterborne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability.[iv,3] Water insecurity occurs when any or all of these needs cannot be met.

Extreme water vulnerability

Extreme Water Vulnerability is the combination of the **highest** levels of physical water scarcity risks and **lowest** levels of drinking water service that affects a given population (surface water, unimproved or limited water service).[4,5]

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[2] Water scarcity is a relative, dynamic concept, and the local context will determine how and why supply is not meeting demand. Several different definitions for water scarcity exist, which include different methods of measuring levels of water scarcity. More recent methods are focused on determining levels of water stress based on temporal (spatial or geographic determinations of water availability within a country or region) and seasonal fluctuations in water resources at different times of the year. Primary indicators of water scarcity have typically focused on average exposure of water users in each country to baseline water stress, defined as the ratio of total withdrawals to total available supply.

[3] This is a working definition based on UN-Water's Water Security and the Global Water Agenda report. UNICEF will contribute to four dimensions of water security solutions as outlined at the end of this brief.

[4] A limited water service is an improved source for which collection time exceeds 30 minutes for a roundtrip including queuing (JMP, Progress on drinking water, sanitation and hygiene 2000–2017)

[5] UNICEF's conceptualization based on analysis of the interplay between access and physical water risks.

Urban peacebuilding through WASH interventions in Tripoli, Lebanon

In 2014, Tripoli's WASH infrastructure and services were essentially destroyed as a result of conflict and prolonged neglect. The government water service provider tried to connect the water supply from the newly rehabilitated water networks in the predominantly Sunni neighbourhood of Quobbe to deliver water to Jabal Mohsen, predominantly Alawite. But Quobbe residents – motivated by simmering tensions and conflict – filled in the trenches dug by the contractor and pushed out the government water service provider.

Local groups, including the NGO Lebanese Relief Council (LebRelief), intervened by bringing Tripoli communities together to address gaps in water service, behaviour change, and building social cohesion. This included a WASH fair to raise awareness of the poor WASH conditions and their impact on community health and well-being. Young people played a central role in organizing the fair and promoting participation by both the Alawite and Sunni Muslim communities. They also organized a large community theatrical performance to communicate key WASH messages and address everyday experiences of Tripoli residents.

UNICEF brought together community leaders and government service providers to discuss water and sanitation infrastructure and improving services for all. Tripoli youth from the Alawite and Sunni Muslim communities were given skills training and employment opportunities, and many helped implement the WASH infrastructure improvements. Marginalized youth were also trained to rehabilitate spaces used as impromptu dumps and turn them into child-friendly green spaces, learning skills for future employment.

The changes not only brought social cohesion and trust, but also made the water services more sustainable. Residents of these communities started to pay affordable fees for their safe water supply for the first time in decades.

HOW DOES WATER INSECURITY AFFECT CHILDREN?

Access to safe water is not only paramount to children's survival, it is also an essential component for other areas of their development including health, nutrition, education, safety and eventually, employment.

Health and nutrition

Increasing water scarcity affects children's health. Every day, over 700 children under age 5 die from diarrhoea linked to unsafe water, sanitation and poor hygiene.[v] When children get sick with diarrhoea, they are unable to absorb the nutrients they need to grow. Over time this can lead to stunting and may irreversibly impact children's physical and mental development. About 144 million children under 5 worldwide are stunted.[vi]

Education, development and safety

When water sources dry up, children may be forced to drop out of school to be able to spend more time collecting water from sources that are farther away. Not only does this disrupt their schooling, it also places a great physical burden on children as they carry heavy loads of water. When schools do not have adequate water, children are ill equipped for learning, studying and practicing safe hygiene like handwashing.

Water scarcity can have an especially adverse effect on girls, as the task of collecting water most often falls on them. Not only does this cause them to miss school, or to drop out, but also potentially places them in harm's way when they are forced to walk long distances to water sources. During menstruation, girls may be less likely to attend school if it does not have adequate water and sanitation facilities to help them manage their periods. Data from rural Africa show that females born during severe droughts suffer the impacts their whole lives, growing up shorter.[vii]

Livelihoods and futures

Years of consecutive droughts can also have a significant impact on children and their families by limiting household income and the cost of basic household items. Of all jobs constituting the global workforce, 78 per cent are highly dependent on water.[viii]

In areas where the economy is sustained by water, gross domestic product and economic opportunities are necessarily impacted by water scarcity. Agriculture is a prime example, as water scarcity, fluctuating temperatures and rainfall patterns can reduce the productivity of the land.

As children grow into adulthood, water-scarce areas will pose more challenges for their economic opportunities, even forcing them to leave their homes. Water scarcity and youth unemployment together are among the root causes of migration.[ix]

Groundwater resource identification and Early Warning System for the South of Madagascar

The south of Madagascar has the country's lowest water service coverage and is strongly impacted by the effects of climate change, including more frequent and intense droughts. This has caused severe food insecurity and malnutrition crises, which mostly affect children.

In areas where traditional water sources can no longer provide enough water throughout the year, new water resources are required. To identify these, UNICEF collaborated with the European Union Joint Research Centre to identify potential areas of groundwater development using remote sensing data.

Equally important to finding new water resources is identifying long-term trends in groundwater including changes in water levels and quality, and understanding how these are impacted by seasonal variations in recharge. However, there is currently no national monitoring system in Madagascar to monitor groundwater and to try to predict the changes in water levels for better planning of water resources.

To address this, UNICEF developed a groundwater early warning system in association with the government to warn of possible drought conditions through an alert system, and rapidly communicate on possible water resource shortages and water quality and issues. This allows UNICEF, the government and partners to take timely actions to provide water services.

The monitoring network generates data from manual measurements as well as automated systems where data are transmitted over the phone network.

WHAT CAUSES WATER INSECURITY?

Climate change

Approximately 74 per cent of natural disasters between 2001 and 2018 were water related, including droughts and floods.[x] The frequency and intensity of these events are expected to increase due to climate change.[xi] When these disasters hit, they can destroy or contaminate entire water and sanitation infrastructure.

Rising temperatures and sea levels can lead to contamination of freshwater sources, compromising the water resources millions of people rely on. Changes in rainfall patterns and river flows, as well as increased demand, can contribute to increased frequency and severity of droughts. Furthermore, when rain does occur in drought-stricken areas, the soil cannot absorb the much-needed water, leading to floods, reduced aquifer recharge and contaminated water resources. Increased temperatures and unpredictable rainfall patterns can also lead to reduced rain-fed growing periods in agriculture, causing farmers to rely more heavily on groundwater for irrigation, which is often used inefficiently.

Population growth and increased demand

Global water demand is projected to increase by 20 to 30 per cent per year by 2050.[xii]

Population growth and higher living standards are contributing to a surge in water demand, as well as in food and energy demands, which require large amounts of water. Often, this population growth is concentrated in cities, which can deplete and contaminate water resources that supply urban areas. In less than 10 years, 45 major urban areas with more than 3 million people are projected to be under high or extremely high water stress.[xiii] Ironically, some of the increased urbanization is due to families moving from rural areas when their livelihoods were decimated by water scarcity.

Conflict and migration

Water scarcity can be both a driver and a result of conflict and migration.[xiv] Incidents of water-linked violence have more than doubled in the past 10 years,[xv] and water crises are ranked as the number one greatest concern in terms of societal risks.[xvi]

Water scarcity is one of the root causes of migration, and is estimated to remain a primary cause of displacement in the future.[xvii,xviii] When water resources are scarce, competition can elevate tensions and lead to conflict and migration. Tensions can be further exacerbated as large influxes of displaced people move to host communities and create new demands on water supply. And when governments and water utilities are unable to provide an adequate supply of drinking water, it can erode public confidence in these institutions and create civil unrest.

Water scarcity is compounded during periods of conflict when water and sanitation services are heavily interrupted. This often occurs when infrastructure is destroyed or damaged, or when access to power or chemical supplies is interrupted, or even when the conflict prevents the operators from operating the systems.

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In some cases, water and sanitation infrastructure has been deliberately damaged, restricted or contaminated by parties to conflict – further impacting communities' access to safe water supply.[xix]

Poor water management and misuse

When water is not perceived as being a scarce resource, or is not adequately regulated, water users are not incentivized to use it more efficiently.

Agriculture accounts for about 70 per cent of freshwater use, and in many parts of the world, agricultural water use is a major driver of water scarcity, particularly when it is used inefficiently. In several countries, the rate of water lost through the networks due to leakage is high, as is the number of illegal connections. This is a challenge for utilities, which must pump even higher quantities of water, sometimes double the needed amount, to compensate for the water lost, at substantial financial and energy cost.

Similarly, when countries have shared water resources like aquifers, lakes and rivers that straddle borders, inequitable use can cause water insecurity – particularly for those countries situated downstream. To date, 60 per cent of transboundary river basins lack a water use agreement.[xx] Even where they do exist, they are often not operational. In the absence of enforced governing treaties over these water resources, and the increase in dam construction, sharing water resources across multiple states can lead to further uncertainty in water availability, with the potential to heighten tensions.

Scaling up climate-resilient water services in Nigeria

Nigeria faces a range of climate risks including flooding, saline water intrusion, desertification and droughts. These extreme climate events have become more frequent throughout the country in the last two decades, and are expected to intensify.

Nigeria's rural communities are particularly vulnerable to climate change because of their remoteness, their dependence on natural resources for livelihoods, and their poor access to WASH services. Both droughts and flooding threaten food security and can cause crop failures, crop nutrient and yield reductions, and loss of livestock and agriculture land. Increasing aridity, low levels of rainfall and shrinking water levels in the Lake Chad basin have impacted sustainable agriculture and economic opportunities, contributing to the conflict in the region.

To address this, UNICEF worked with the government to increase climate-resilient WASH programming. This has included risk assessments in target areas, and incorporating these risks into the water and sanitation services. These interventions also included the installation of solar-powered water pumping systems for new water systems and to replace diesel-powered systems.

While solar systems are more expensive to install, the long-term operation costs and easier maintenance, and their increased reliability, have made them very popular.

In 2020, UNICEF-supported programmes provided climate resilient water services to 1.6 million people and climate resilient sanitation services to 2.5 million people. In addition, 436 solar-powered water systems were installed.

Using renewable energy (solar and wind) to increase access to water in remote areas of Colombia

The Department of La Guajira is considered particularly vulnerable to climate change and desertification. The rural population has one of the lowest rates of access, with 16 per cent reported to have access to 'at least a basic' water service in Colombia.

A seven-year drought between 2010 and 2017 affected a large portion of the population of La Guajira, and water shortages limited access to food, causing migration, malnutrition and even death for some children. Surface water reservoirs have dried up and the communities now rely on drilling progressively deeper boreholes to extract water of unknown quality. They also must travel farther to collect water – sometimes up to 7 hours round trip – increasing local tensions over water access.

UNICEF worked with Colombia's Ministries of Foreign Affairs and Public Works and Oxfam to improve and sustain the WASH infrastructure, expand access to WASH services and promote hygiene practices like handwashing.

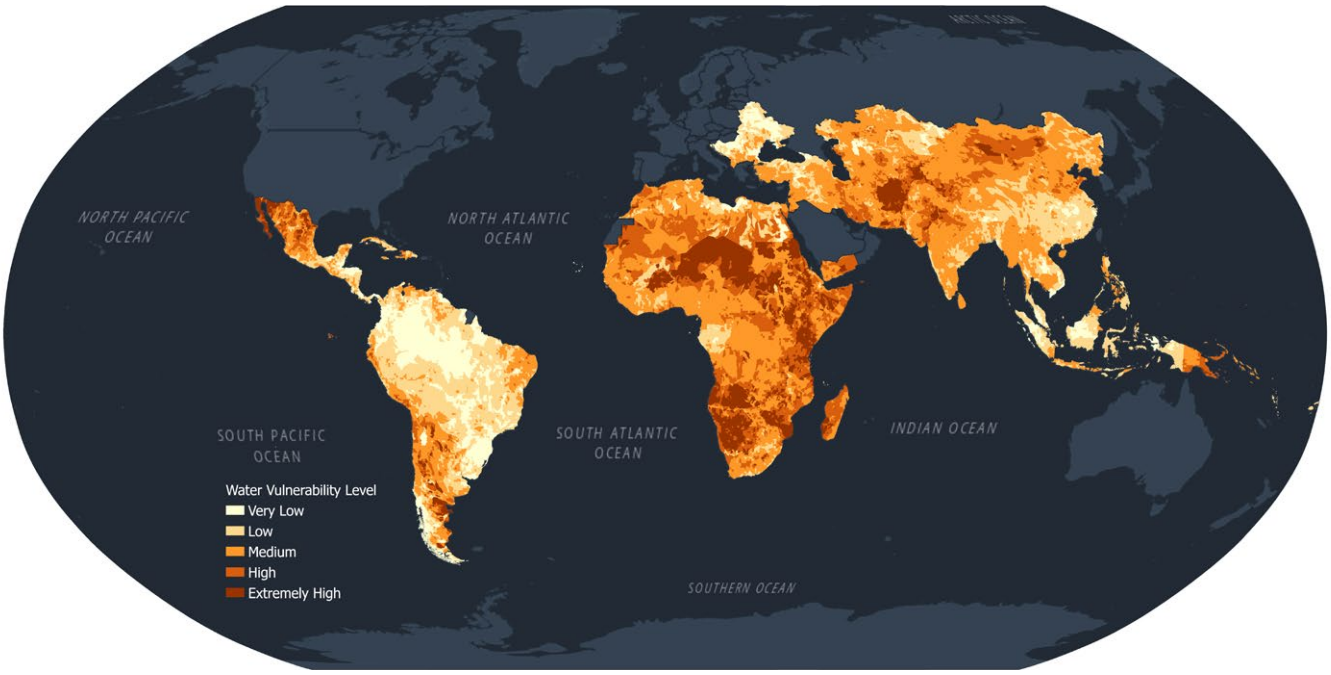
Solar- and wind-powered pumping systems were selected for the project because of their affordability and reliability and have increased the volume of water available. The work on the water systems was complemented by activities to promote key hygiene behaviours like handwashing.

The systems were installed prior to October 2016, when Hurricane Matthew caused extensive damage in the area. The systems have withstood storms and extreme weather – including Hurricane Matthew – without any major damage or malfunction.

WHERE IS WATER INSECURITY A PROBLEM?

Though water scarcity is a problem in many parts of the world, water insecurity is overwhelmingly an issue among the most vulnerable populations. As some water services are more vulnerable to water scarcity than others, UNICEF undertook an analysis of where areas of physical water scarcity overlap with areas where people have a poor water service or even no service, meaning that they depend on untreated surface water, unimproved sources or it takes more than 30 minutes to collect water. This analysis was undertaken using water risk data from the World Resources Institute (WRI), United Nations Environment Programme (UNEP), WHO/UNICEF Joint Monitoring Programme (JMP) and population density maps using data from Gridded Population of the World version 4 (GPWv4) and WorldPop. The analysis revealed that 1.42 billion people – including 450 million children – live in such areas of high or extremely high water vulnerability.

Map of areas of high or extremely high water vulnerability[6]



[6] Water stress, interannual variability, seasonal variability, and groundwater table decline were derived from the WRI Aqueduct Water Risk Atlas, drought events derived from the UNEP Global Data Risk Platform, and drinking water service level data were derived from the JMP data set.

Analysing this data, in terms of the absolute numbers and proportion of children affected, has highlighted hotspot areas as follows:[7]

Table of countries with high or extremely high water vulnerability, by population and percentage of population

	# of children experiencing High Water Vulnerability	% of children experiencing High Water Vulnerability	# of children experiencing Extremely High Water Vulnerability	% of children experiencing Extremely High Water Vulnerability	Total # of children experiencing High/ Extremely High Water Vulnerability	Total % of children experiencing High/ Extremely High Water Vulnerability
Afghanistan	6,687,487	40%	8,886,947	53%	15,574,434	93%
Angola	5,550,422	41%	3,961,720	29%	9,512,142	70%
Botswana	406,600	48%	54,289	6%	460,889	54%
Burkina Faso	1,083,549	11%	7,557,283	80%	8,640,832	91%
Central African Republic	957,866	43%	7,721	0%	965,587	43%
Chad	1,094,801	14%	2,122,809	28%	3,217,610	42%
China	19,192,628	7%	589,675	0%	19,782,303	7%
Democratic Republic of Congo (the)	10,851,499	27%	2,624,010	6%	13,475,509	33%
Eritrea	1,221,506	48%	797,887	31%	2,019,393	79%
Ethiopia	24,262,676	50%	16,699,053	34%	40,961,729	85%
Ghana	2,568,343	21%		0%	2,568,343	21%
Haiti	2,173,797	52%		0%	2,173,797	52%
India	91,413,134	20%	20,478,554	5%	111,891,688	25%
Iran (Islamic Republic of)	9,147,315	42%	188,516	1%	9,335,830	43%
Kenya	9,568,499	43%	10,812,863	49%	20,381,361	92%
Lesotho	532,173	58%	325,533	35%	857,706	93%
Madagascar	7,151,523	61%	850,234	7%	8,001,757	68%
Mali	1,710,727	18%	403,889	4%	2,114,616	22%
Mexico	8,367,244	20%	4,379,260	10%	12,746,503	30%
Micronesia, Federated States of	29,173	74%		0%	29,173	74%
Morocco	6,658,968	61%	466,457	4%	7,125,426	65%
Mozambique	8,201,300	57%	2,303,474	16%	10,504,774	72%
Namibia	286,928	27%	386,199	36%	673,127	63%
Niger	1,058,210	9%	8,740,074	77%	9,798,284	86%
Nigeria	21,792,972	24%	4,737,867	5%	26,530,839	29%
Pakistan	20,162,891	26%	5,906,927	8%	26,069,818	34%
Papua New Guinea	1,401,423	42%	213,778	6%	1,615,201	49%
Somalia	3,344,434	58%	226,116	4%	3,570,549	62%
South Sudan	1,511,368	25%	1,715,946	29%	3,227,314	54%
Sudan	3,629,703	19%	6,463,924	34%	10,093,627	53%
Tajikistan	1,849,807	53%	134,283	4%	1,984,090	57%
Tanzania, United Republic of	12,715,149	46%	4,905,911	18%	17,621,060	64%
Togo	1,695,557	48%	16,452	0%	1,712,009	48%
Uganda	3,695,747	17%	2,183,730	10%	5,879,478	27%
Yemen	4,371,814	35%	361,850	3%	4,733,664	38%
Zambia	2,899,141	34%	1,910,548	22%	4,809,690	56%
Zimbabwe	2,505,042	33%	3,009,912	40%	5,514,953	73%

[7] Hotspots countries are those in which UNICEF has programmatic response, which also meet any one of the following criteria: ≥ 60% High Water Vulnerability; ≥ 40% Extremely High Water Vulnerability; ≥ 40% children in High and Extremely High Water Vulnerability; ≥ 2M people in High and Extremely High Water Vulnerability

Protecting communities from saline intrusion of groundwater in coastal areas of Bangladesh

Climate change is leading to rising sea levels and more extreme weather events in Bangladesh, which can destroy WASH facilities and cause saltwater to flow into freshwater aquifers (saline intrusion). In coastal areas of Bangladesh, approximately 20 million people are exposed to the threats of increasing saline intrusion of surface and groundwater sources.

In response to the crisis, UNICEF and partners have piloted and scaled-up Managed Aquifer Recharge (MAR), a technique which collects and treats water from ponds and roofs (rainwater) and injects it underground for storage and future use. Each MAR system can serve hundreds of people and can be maintained by the communities themselves with periodic support and maintenance from partners. This scalable, resilient technology option is an ideal solution in particular geological contexts to ensure sustainable access to safe water in coastal communities affected by climate change.

ACHIEVING WATER SECURITY FOR ALL

The world's water crisis is one of the greatest risks to society. And climate change, urbanization and increasing competition for water are only exacerbating water insecurity with each passing year. For children, water insecurity is putting their lives at risk today, and putting their futures at risk tomorrow.

To address this, UNICEF has set an ambitious goal to reach 450 million children and their families (1.42 billion people) living in areas of high or extremely high water vulnerability with resilient solutions by 2025. And by 2030, for all children to have access to a safe and affordable water supply and to live in water secure communities.

Addressing climate change and water insecurity globally is not only the right thing to do for children, it is also the smart thing to do for society. Climate-resilient WASH will allow communities to access water and sanitation now and in the future, while adapting to climate change and mitigating its effects. These climate-resilient solutions also reduce the cost of services – particularly those that depend upon water resources and energy – and offer enormous opportunities for sustainable livelihoods.

We can only achieve water security for every child when families and communities have access to water that is safe, reliable and affordable, and resilient to threats like water scarcity, extreme weather events and climate shocks.

To accomplish this, we urgently need to reimagine our approach to water: from supply to usage, infrastructure, governance and management.

We envision four dimensions to achieve this goal:

1. Safe and affordable drinking water services. Provide access to a safe and affordable water service that is sustainable, close to home and managed professionally.
2. Climate-resilient WASH services and communities. Ensure that all WASH services withstand climate-related events, strengthen the resilience and adaptive capacities of vulnerable communities, and operate using low-carbon energy sources, such as solar power.
3. Prevention of water scarcity crises through early action. Avert water scarcity crises through water resources assessments, sustainable water withdrawal, efficient use, and early warning and early action to prevent situations where water supplies are fully depleted.
4. Water cooperation for peace and stability. Work with communities and key stakeholders so that equitable management of water resources and WASH services contribute to increased social cohesion, political stability and peace; and in conflict zones to prevent attacks on water and sanitation infrastructure and personnel.

But we cannot do it alone. Achieving water security for the most vulnerable populations requires effort from all of society and sectors, working with governments, donors, international and national organizations, research institutions, the private sector and critically, communities themselves.

The efforts need to galvanize other key United Nations agencies and UN-Water efforts to accelerate progress across Sustainable Development Goal 6.[8] This will require the following four strategies:

- Advocate for political commitment and policy change. Governments to integrate WASH priorities into climate policies, strategies and plans such as the National Adaptation Plans and Nationally Determined Contributions. Promote improved water cooperation between different users and integrate conflict sensitivity into plans for water supply systems.
- Accelerate financing and capacity development. Scaling up action on water security will require additional financial and human resources. Support is needed to build local capacity to better identify climate risks, develop and manage resilient WASH services and develop project pipelines to attract financing, including climate finance sources.
- Mobilize business and innovations. The private sector can be a key partner to test and scale innovations and to professionalize the services. Technology innovations in hotspots can improve both water use efficiency, quality and treatment, and reuse as well as early warning and early action systems to avert water scarcity crises and help find new sources of water to bring more equitable and affordable solutions. Philanthropists, corporations, foundations and other private sector partners can support UNICEF by investing in flexible funds for water and sanitation, or funding specific 'hotspot' country programmes.
- Activate young people as champions and agents of change. Young people are powerful advocates and agents of change for sustainable use and management of water, protection of the environment, and brokers of peace building and conflict-prevention. Future WASH volunteers and workforce can be expanded with skilled, energized young people acting to strengthen local social and human capital. Environmental clubs in schools can help raise awareness and foster individual behaviour change for more efficient water use at the household level.

[8] As described in the Sustainable Development Goal 6 Global Acceleration Framework.

Safeguarding vulnerable island water supplies from the impacts of climate change in the Pacific Islands

Given their small size, unique geography and fragile water resources, Pacific Island communities face significant challenges in terms of water and sanitation. Climate change poses further risks by increasing the frequency and severity of natural hazards such as cyclones and rising sea levels.

In Fiji and Vanuatu, UNICEF is working with each respective government to roll out the Drinking-Water Safety Planning approach. UNICEF and partners have trained communities to prepare climate-resilient water safety plans, which allow them to identify, prioritize and reduce risks to water supply. Once the village committees have made improvements and are engaged in management activities agreed upon by the community, UNICEF and partners support them to develop an investment plan to ensure that enough safe water can be provided for everyone throughout the year. When required, training is also provided to enhance operation and water system maintenance skills.

In Vanuatu, the Department of Water Resources and its NGO partners used the same approach to 'build back better' following Cyclone Pam, a Category 5 tropical cyclone. The water safety planning process led to rehabilitated or replacement water supply systems that were more resilient, thus ensuring climate resilience in some of the islands' most vulnerable communities.

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IGME, Levels & Trends in Child Mortality: Report 2019
Diarrhoeal deaths: 8.1% (0.081382) of under-five deaths are due to diarrhoeal diseases in 2017
MCEE-WHO Child Causes of Death 2000-2017
Fraction attributable to WASH: 62.2% of under-five diarrhoeal deaths
Source: Prüss-Ustün et al (2019) Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: An updated analysis with a focus on low and middle-income countries International Journal of Hygiene and Environmental Health.

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