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Drinking Water Quality Issues in Developing Countries: Challenges and Remedial Measures-An Overview

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ABSTRACT: Water issues in developing countries include scarcity of drinking water, poor infrastructure for water and sanitation access, water pollution, and low levels of water security. Over one billion people in developing countries have inadequate access to clean water. The main barriers to addressing water problems in developing nations include poverty, costs of infrastructure, and poor governance. The effects of climate change on the water cycle can make these problems worse.

The contamination of water remains a significant issue because of unsanitary social practices that pollute water sources. Almost 80% of disease in developing countries is caused by poor water quality and other water-related issues that cause deadly health conditions such as cholera, malaria, and diarrhea.[1] It is estimated that diarrhea takes the lives of 1.5 million children every year, majority of which are under the age of five.[2][3]

KEYWORDS-drinking,water,,quality,challenges,remedial,measures,developing,countries

I. INTRODUCTION

Access to freshwater is unevenly distributed across the globe, with more than two billion people live in countries with significant water stress.[4] According to UN-Water, by 2025, 1.8 billion people will be living in areas across the globe with complete water scarcity.[5] Populations in developing countries attempt to access potable water from a variety of sources, such as groundwater, aquifers, or surface waters, which can be easily contaminated. Freshwater access is also constrained by insufficient wastewater and sewage treatment. Progress has been made over recent decades to improve water access, but billions still live in conditions with very limited access to consistent and clean drinking water.

Problems

Water scarcity

People need fresh water for survival, personal care, agriculture, industry, and commerce. The 2019 UN World Water Development report noted that about four billion people, representing nearly two-thirds of the world population, experience severe water scarcity during at least one month of the year.[6] With rising demand, the quality and supply of water have diminished.[7]

Water use has been increasing worldwide by about 1% per year since the 1980s. Global water demand is expected to continue increasing at a similar rate until 2050, accounting for an increase of 20–30% above 2019 usage levels.[6] The steady rise in use has principally been led by surging demand in developing countries and emerging economies. Per capita water use in the majority of these countries remains far below water use in developed countries—they are merely catching up.[6]

Agriculture (including irrigation, livestock, and aquaculture) is by far the largest water consumer, accounting for 69% of annual water withdrawals globally. Agriculture's share of total water use is likely to fall in comparison with other sectors, but it will remain the largest user overall in terms of both withdrawal and consumption. Industry (including power generation) accounts for 19% and households for 12%.[6]

Water scarcity (closely related to water stress or water crisis) is the lack of fresh water resources to meet the standard water demand. There are two types of water scarcity namely physical and economic water scarcity.[8]:560 Physical water scarcity is where there is not enough water to meet all demands, including that needed for ecosystems to function. Arid areas for example Central and West Asia, and North Africa often experience physical water scarcity.[9] Economic water scarcity on the other hand, is the result of lack of investment in infrastructure or technology to draw water from

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rivers, aquifers, or other water sources. It also results from weak human capacity to meet water demand.[8]:560 Much of Sub-Saharan Africa experience economic water scarcity.[10]:11

There is enough freshwater available globally and averaged over the year to meet demand. As such, water scarcity is caused by a mismatch between when and where people need water, and when and where it is available.[11] The main drivers of the increase in global water demand are the increasing world population, rise in living conditions, changing diets (to more animal products),[12] and expansion of irrigated agriculture.[13][14] Climate change (including droughts or floods), deforestation, water pollution and wasteful use of water can also cause insufficient water supply.[15] Scarcity varies over time as a result of natural variability in hydrology. These variations in scarcity may also be a function of prevailing economic policy and planning approaches.

Water scarcity assessments need to incorporate information on green water (soil moisture), water quality, environmental flow requirements, globalization, and virtual water trade.[12] There is a need for collaboration between hydrological, water quality, aquatic ecosystem science and social science communities in water scarcity assessment.[12] "Water stress" has been used as parameter to measure water scarcity, for example in the context of Sustainable Development Goal 6.[16] Half a billion people live in areas with severe water scarcity throughout the year,[11][12] and around four billion people face severe water scarcity at least one month per year.[11][17] Half of the world's largest cities experience water scarcity.[17] There are 2.3 billion people who reside in nations with water scarcities, which means that each individual receives less than 1 700 m3 of water annually. However, 380 billion m3 of municipal wastewater are produced globally each year.[18][19][20]

Water pollution

Women fetching polluted water in Ghana

After accounting for availability or access, water quality can reduce the amount of water for consumption, sanitation, agriculture, and industrial purposes.[21] Acceptable water quality depends on its intended purpose: water that is unfit for human consumption could still be used in industrial or agriculture applications. Parts of the world are experiencing extensive deterioration of water quality, rendering the water unfit for agricultural or industrial use. For example, in China, 54% of the Hai River basin surface water is so polluted that it is considered un-usable.[22]

Safe water is defined as potable water that will not harm the consumer.[23] It is one of the eight Millennium Development Goals: between 1990 and 2015 to "reduce by half the proportion of the population without sustainable access to safe drinking water and basic sanitation." Even having access to an ‘improved water source’ does not guarantee the water's quality, as it could lack proper treatment and become contaminated during transport or home storage.[24] A study by the World Health Organization (WHO) found that estimates of safe water could be overestimated if accounting for water quality, especially if the water sources were poorly maintained.[25]

Runoff from development along the river in Pune, India could contribute to reduced water quality.

Polluted drinking water can lead to debilitating or deadly water-borne diseases, such as fever, cholera, dysentery, diarrhea and others.[24] UNICEF cites fecal contamination and high levels of naturally occurring arsenic and fluoride as two of the world's major water quality concerns. Approximately 71% of all illnesses

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in developing countries are caused by poor water and sanitation conditions.[26] Worldwide, contaminated water leads to 4,000 diarrhea deaths a day in children under 5.[27]

Child standing next to a well pump in a Bangladeshi Village. Many such wells have naturally high levels of arsenic.

However, gaps in wastewater treatment (the amount of wastewater to be treated is greater than the amount that is actually treated) represent the most significant contribution to water pollution and water quality deterioration. In the majority of the developing world, most of the collected wastewater is returned to surface waters directly without treatment, reducing the water's quality.[28] In China, only 38% of China's urban wastewater is treated, and although 91% of China's industrial waste water is treated, it still releases extensive toxins into the water supply.[29]

The amount of possible wastewater treatment can also be compromised by the networks required to bring the wastewater to the treatment plants. It is estimated that 15% of China's wastewater treatment facilities are not being used to capacity due to a limited pipe network to collect and transport wastewater. In São Paulo, Brazil, a lack of sanitation infrastructure results in the pollution of the majority of its water supply and forces the city to import over 50% of its water from outside watersheds. Polluted water increases a developing country's operating costs, as lower quality water is more expensive to treat. In Brazil, polluted water from the Guarapiranga Reservoir costs $0.43 per m^3 to treat to usable quality, compared to only $0.10 per m^3 for water coming from the Cantareira Mountains.[29]

Water pollution (or aquatic pollution) is the contamination of water bodies, usually as a result of human activities, so that it negatively affects its uses.[30]:6 Water bodies include lakes, rivers, oceans, aquifers, reservoirs and groundwater. Water pollution results when contaminants mix with these water bodies. Contaminants can come from one of four main sources: sewage discharges, industrial activities, agricultural activities, and urban runoff including stormwater.[31] Water pollution is either surface water pollution or groundwater pollution. This form of pollution can lead to many problems, such as the degradation of aquatic ecosystems or spreading water-borne diseases when people use polluted water for drinking or irrigation.[32] Another problem is that water pollution reduces the ecosystem services (such as providing drinking water) that the water resource would otherwise provide.

Sources of water pollution are either point sources or non-point sources. Point sources have one identifiable cause, such as a storm drain, a wastewater treatment plant or an oil spill. Non-point sources are more diffuse, such as agricultural runoff.[33] Pollution is the result of the cumulative effect over time. Pollution may take the form of toxic substances (e.g., oil, metals, plastics, pesticides, persistent organic pollutants, industrial waste products), stressful conditions (e.g., changes of pH, hypoxia or anoxia, increased temperatures, excessive turbidity, changes of salinity), or the introduction of pathogenic organisms. Contaminants may include organic and inorganic substances. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers.

Water security

The aim of water security is to make the most of water's benefits for humans and ecosystems. The second aim is to limit the risks of destructive impacts of water to an acceptable level.[34][35] These risks include for example too much water (flood), too little water (drought and water scarcity) or poor quality (polluted) water.[34] People who live with a high level of water security always have access to "an acceptable quantity and quality of water for health, livelihoods and production".[35] For example, access to WASH services (water, sanitation and hygiene) is one component of water security.[36] Some organizations use the term water security more narrowly for water supply aspects only.

Policymakers and water managers seek to achieve water security outcomes that address economic, environmental and social equity concerns. These outcomes can include increasing economic welfare, enhancing social equity and reducing water related risks.[37] There are interactions and trade-offs between the different outcomes.[36]:13 Planners often consider water security outcomes for different groups in society when they design climate change adaptation strategies.[38]:19–21

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Managing water safety

To address water scarcity, organizations have focused on increasing the supply of fresh water, mitigating its demand, and enabling reuse and recycling.[39]

Clean water plans

According to the WHO, consistent access to a safe drinking-water supply is attainable by establishing a system of WSPs, or Water Safety Plans, which determine the quality of water supply's to ensure they are safe for consumption.[40] The Water Safety Plan Manual, published in 2009 by the WHO and the International Water Association, offers guidance to water utilities (or similar entities) as they develop WSPs. This manual provides information to help water utilities assess their water system, develop monitoring systems and procedures, manage their plan, carry out periodic review of the WSP, and to review the WSP following an incident. The WSP manual also includes three case studies drawn from WSP initiatives in three countries/regions.[41]

Alternative sources

Utilizing wastewater from one process to be used in another process where lower-quality water is acceptable is one way to reduce the amount of wastewater pollution and simultaneously increase water supplies. Recycling and reuse techniques can include the reuse and treatment of wastewater from industrial plant wastewater or treated service water (from mining) for use in lower quality uses. Similarly, wastewater can be re-used in commercial buildings (e.g. in toilets) or for industrial applications (e.g. for industrial cooling).[29]

Reducing water pollution

Despite the clear benefits of improving water sources (a WHO study showed a potential economic benefit of $3–34 USD for every US$1 invested), aid for water improvements have declined from 1998 to 2008 and generally is less than is needed to meet the MDG targets. In addition to increasing funding resources towards water quality, many development plans stress the importance of improving policy, market and governance structures to implement, monitor and enforce water quality improvements.[42]

Reducing the amount of pollution emitted from both point and non-point sources represents a direct method to address the source of water quality challenges. Pollution reduction represents a more direct and low-cost method to improve water quality, compared to costly and extensive wastewater treatment improvements.[28]

Various policy measures and infrastructure systems could help limit water pollution in developing countries. These include:[43]

1. Improved management, enforcement and regulation for pre-treatment of industrial and agricultural waste, including charges for pollution
2. Policies to reduce agricultural run-off or subsidies to improve the quality and reduce the quantity needed of water polluting agricultural inputs (e.g. fertilizers)
3. Limiting water abstraction during critical low flow periods to limit the concentration of pollutants
4. Strong and consistent political leadership on water
5. Land planning (e.g. locating industrial sites outside the city)

II. DISCUSSION

Water treatment

Water treatment technologies can convert non-freshwater to freshwater by removing pollutants.[39] Much of water's physical pollution includes organisms, metals, acids, sediment, chemicals, waste, and nutrients. Water can be treated and purified into freshwater with limited or no constituents through certain processes.[7] The processes involved in removing the contaminants include physical processes such as settling and filtration, chemical processes such as disinfection and coagulation, and biological processes such as slow sand filtration.

A variety of innovations exist to effectively treat water at the point of use for human consumption. Studies have shown treatment to point of use sources reduces child mortality by diarrhea by 29%.[44] Home water treatments are also a part of the United Nations' Millennium Development Goals, with the goal of providing both clean water supply and sewage connection in homes. Although these interventions have been evaluated by the United Nations, various challenges may

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reduce the effectiveness of home treatment solutions, such as low education, low-dedication to repair, replacement, and maintenance, or local repair services or parts are unavailable.

Current point of use and small scale treatment technologies include:

- NaDCC, sodium dichloroisocyanurate
- Boiling water
- Solar disinfection (SODIS)
- Chlorine

Global programs

Central Asia Water and Energy Program

Central Asia Water and Energy Program (CAWEP) is a World Bank, European Union, Swiss & UK funded program to organize Central Asian governments on common water resources management through regional organizations, like the International Fund for Saving the Aral Sea (IFAS). The program focuses on three issues: water security, energy security and energy-water linkages. It aims to foster balanced communications between Central Asian countries to achieve a regional goal, water and energy security. To ensure their goal, the program works closely with governments, civil and national organizations.[45]

Most recently, the program helped organize The Global Disruptive Tech Challenge: Restoring Landscapes in the Aral Sea Region. This competition was created to encourage bright minds to come up with revolutionary solutions for land degradation and desertification in the Aral Sea Region, which used to be home to one of the largest lakes in the world and has since been reduced near to nothing. There were several winning projects that centered around agriculture and land management, sustainable forestry, socio-economic development and globally expanding people knowledge and access to information on the issue.[46]

Sanitation and Water for All

Aimed at achieving the United Nation's Sustainable Development Goal 6, Sanitation and Water for All (SWA) was established as a platform for partnerships between governments, civil society, the private sector, UN agencies, research and learning institutions, and the philanthropic community. SWA encourages partners to prioritize water, sanitation and hygiene along with ensuring sufficient finance and building better governance structures.[47] To ensure that these priorities remain so, the SWA holds "High Level Meetings"[48] where partners communicate the recent developments made, measure progress, and continue the discussion on the importance of Sustainable Development Goal 6.

The Water Project

The Water Project, Inc is a non-profit international organization that develops and implements sustainable water projects in Sub-Saharan Africa like Kenya, Rwanda, Sierra Leone, Sudan, and Uganda. The Water Project has funded or completed over 2,500 projects and 1,500 water sources that have helped over 569,000 people improve their access to clean water and sanitation.[49] These projects focus heavily on teaching proper sanitation and hygiene practices, as well as improving water facilities by drilling boreholes, updating well structures, and introducing rain water harvesting solutions.[50]

UN-Water

In 2003, the United Nations High Level Committee on Programmes created UN-Water, an inter-agency mechanism, "to add value to UN initiatives by fostering greater co-operation and information-sharing among existing UN agencies and outside partners." UN-Water publishes communication materials for decision-makers that work directly with water issues and provides a platform for discussions regarding global water management. They also sponsor World Water Day on 22 March [51] to focus attention on the importance of freshwater and sustainable freshwater management.[52]

India

India's growing population is putting a strain on the country's preciously scarce water resources. According to The World Bank, the population of India as of 2019 was roughly 1,366,417,750 people.[53] Although this number has increased since then, India's population count has made it the second-most populated country in the world, following close behind the first most populated country, China.[54] The country is classified as "water stressed" with a water availability of 1,000–1,700 m^3/person/year.[55] 21% of countries' diseases are related to water.[56] In 2008, 88% of the population had access and was using improved drinking water sources.[57] However, "Improved drinking water source"

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is an ambiguous term, ranging in meaning from fully treated and 24-hour availability to merely being piped through the city and sporadically available.[58] This is in part due to large inefficiencies in the water infrastructure in which up to 40% of water leaks out.[58]

In UNICEF's 2008 report, only 31% of the population had access and used improved sanitation facilities.[57] A little more than half of the 16 million residents of New Delhi, the capital city, have access to this service. Every day, 950 million gallons of sewage flows from New Delhi into the Yamuna River without any significant forms of treatment.[58] This river bubbles with methane and was found to have a fecal coliform count 10,000 times the safe limit for bathing.[58]

The inequality between urban and rural areas is significant. In rural areas, 84% can access safe water while only 21% for sanitation. In contrast, 96% of people in urban areas have access to water sources and sanitation which meet satisfying quality. Additionally, there are not enough wastewater treatment facilities to dispose of wastewater discharged from the growing population. By 2050 half of India's population will account for urban areas and will face serious water problems.[59]

Surface water contamination, due to lack of sewage treatment and industrial discharge, makes groundwater increasingly exploited in many regions of India.[58] This is aggravated by heavily subsidized energy costs for agriculture practices[58] that make up roughly 80% of India's water resource demand.[60]

In India, 80% of the health issues come from waterborne diseases.[61] Part of this challenge includes addressing the pollution of the Ganges (Ganga) river, which is home to about 400 million people.[62] The river receives about over 1.3 billion litres of domestic waste, along with 260 million litres of industrial waste, run off from 6 million tons of fertilizers and 9,000 tons of pesticides used in agriculture, thousands of animal carcasses and several hundred human corpses released into the river every day for spiritual rebirth. Two-thirds of this waste is released into the river untreated.[62]

Kenya

Kenya, a country of 50 million population, struggles with a staggering population growth rate of 2.28% per year.[63] This high population growth rate pushes Kenya's natural resources to the brink of total depletion. 32% of the population don't have access to improved water sources whereas 48% cannot access basic sanitation systems.[64] Much of the country has a severely arid climate, with a few areas enjoying rain and access to water resources. Deforestation and soil degradation have polluted surface water, and the government does not have the capacity to develop water treatment or distribution systems, leaving the vast majority of the country without access to water. This has exacerbated gender politics, as 74% of women must spend an average of 8 hours per day securing water for their families.[65]

Low income has worsened the situation. It is estimated that 66% of the total population lives to earn less than $3.20 per day. Despite its poor quality and unreliableness, costs for water in local areas are 9 times higher than that of safe water in urban areas. This regional inequality makes people in rural areas difficult to obtain water on a daily basis. Furthermore, even in urban areas, which are equipped with piped water systems, it's hard to produce a reliable constant flow of water. Practical solutions are needed in the entire country.[64] The Sand dam is one of the decentralized rainwater harvesting infrastructures to deal with this unbalanced water distribution.[66] This low-cost infrastructure has a simple and understandable structure, conserving surplus water for later use, increasing efficiency and rural regions' water access by saving people's time to gathering water on a long road.[67] There are already about 1,800 sand dams in Kitui County.[68]

The growing population and stagnant economy have exacerbated urban, suburban, and rural poverty. It also has aggravated the country's lack of access to clean drinking water which leaves most of the non-elite population suffering from disease. Around 240 million people suffer from schistosomiasis which occurs because of parasitic worms that may be contracted through drinking infested waters.[69] This leads to the crippling of Kenya's human capital.[70]

Private water companies have taken up the slack from Kenya's government, but the Kenyan government prevents them from moving into the poverty-stricken areas to avoid profiteering activities.[65] Unfortunately, since Kenya's government also refuses to provide services, this leaves the disenfranchised with no options for obtaining clean water.

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Bangladesh

With abundant water resources, Bangladesh faces various water contaminations mainly caused by pollutants, bacteria, and pesticides.[71] Historically, water sources in Bangladesh came from surface water contaminated with bacteria. Drinking infected water resulted in infants and children suffering from acute gastrointestinal disease that led to a high mortality rate.[72] According to UNICEF, 38.3% of Bangladeshis drink unsafe water from bacteria-contaminated sources.[73] Bangladesh is facing an acute reliable drinking water scarcity. Bangladesh's surface and ground water are highly saline due to rising sea levels.[74]

Available options for providing safe drinking water include deep wells, traditionally dug wells, treatment of surface water, and rainwater harvesting.[75] Between 2000 and 2010, the government installed those safe water devices in arsenic-affected regions of Bangladesh.[76] Between 2000 and 2012, the proportion of Bangladesh population who drink water with arsenic had decreased from 26.6% to 12.4%. There are 19.4 million Bangladeshis still drinking arsenic-contained water.[73]

III. RESULTS

Panama

Water supply and sanitation in Panama is characterized by relatively high levels of access compared to other Latin American countries. However, challenges remain, especially in rural areas. Panama has a tropical climate and receives abundant rainfall (up to 3000mm per year), yet the country still suffers from limited water access and pollution.[77] Intense El Niño periods, periodic droughts,[78] reduce water availability. Multiple factors like urbanization, impacts of climate change, and economic development have decreased water resources. The high frequency of floods in recent years and the lack of corresponding measures resulted in tension among the local population.[79] Rapid population growth in recent decades led to an unprecedented increase in freshwater demand. Regional inequality exists in water resources and water governance.[78] An estimated 7.5-31% of Panama's population lives in isolated rural areas with minimal access to potable water and few sewage treatment facilities.[77]

Given the large quantities of rainfall, rainwater harvesting has been implemented as a solution to increase water access. Still, the rainwater is subject to pick up any substances on the rooftops that it runs over before entering a collection tank. Water quality tests revealed that the collected water often contains coliforms or fecal coliforms, likely from running through animal droppings on roofs.[80]

WASH (or Watsan, WaSH) is an acronym that stands for "water, sanitation and hygiene". It is used widely by non-governmental organizations and aid agencies in developing countries. The purposes of providing access to WASH services include achieving public health gains, improving human dignity in the case of sanitation, implementing the human right to water and sanitation, reducing the burden of collecting drinking water for women, reducing risks of violence against women, improving education and health outcomes at schools and health facilities, and reducing water pollution. Access to WASH services is also an important component of water security.[1] Universal, affordable and sustainable access to WASH is a key issue within international development and is the focus of the first two targets of Sustainable Development Goal 6 (SDG 6).[2] Targets 6.1 and 6.2 aim at equitable and accessible water and sanitation for all. In 2017, it was estimated that 2.3 billion people live without basic sanitation facilities and 844 million people live without access to safe and clean drinking water.[3]

The WASH-attributable burden of disease and injuries has been studied in depth. Typical diseases and conditions associated with lack of WASH include diarrhea, malnutrition and stunting, in addition to neglected tropical diseases. Lack of WASH poses additional health risks for women, for example during pregnancy, or in connection with menstrual hygiene management. Lack of sanitation contributes to about 700,000 child deaths every year due to diarrhea, mainly in developing countries.[4] Chronic diarrhea can have long-term negative effects on children, in terms of both physical and cognitive development.[5] Still, collecting precise scientific evidence regarding health outcomes that result from improved access to WASH is difficult due to a range of complicating factors. Scholars suggest a need for longer-term studies of technology efficacy, greater analysis of sanitation interventions, and studies of combined effects from multiple interventions in order to better analyze WASH health outcomes.[6]

Access to WASH needs to be provided at the household level but also in non-household settings like schools, healthcare facilities, workplaces (including prisons), temporary use settings, mass gatherings, and for dislocated populations.[7] In schools, group handwashing facilities and behaviors are a promising approach to improve hygiene. Lack of WASH facilities at schools can prevent students (especially girls) from attending school, reducing their educational achievements and future work productivity.[8]

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Challenges for providing WASH services include providing services to urban slums, failures of WASH systems (e.g. leaking water distribution systems), water pollution and the impacts of climate change. Planning approaches for better, more reliable and equitable access to WASH include: National WASH plans and monitoring (including gender mainstreaming), integrated water resources management (IWRM) and, more recently, improving climate resilience of WASH services. Adaptive capacity in water management systems can help to absorb some of the impacts of climate-related events and increase climate resilience.[1]:25 Stakeholders at various scales, i.e. from small urban utilities to national governments, need to have access to reliable information about the regional climate and any expected changes due to global climate change.

Components

The concept of WASH groups together water supply (access to drinking water services), sanitation, and hygiene because the impact of deficiencies in each area overlap strongly (WASH is an acronym that uses the first letters of "water, sanitation and hygiene"). WASH consists of access to drinking water services, sanitation services and hygiene.

Drinking water services

Women line up at a bore hole to fill their containers with water (Labuje IDP camp, Kitgum, Kitgum District, Northern Region of Uganda)

A "safely managed drinking water service" is "one located on premises, available when needed and free from contamination".[9] The terms '"improved water source" and "unimproved water source" were coined in 2002 as a drinking water monitoring tool by the JMP of UNICEF and WHO. The term "improved water source" refers to "piped water on premises (piped household water connection located inside the user's dwelling, plot or yard), and other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs, and rainwater collection)".[10]

Access to drinking water is included in Target 6.1 of Sustainable Development Goal 6 (SDG 6), which states: "By 2030, achieve universal and equitable access to safe and affordable drinking water for all".[11] This target has one indicator: Indicator 6.1.1 is the "Proportion of population using safely managed drinking water services".[12] In 2017, 844 million people still lacked even a basic drinking water service.[3]:3 In 2019 it was reported that 435 million people used unimproved sources for their drinking water, and 144 million still used surface waters, such as lakes and streams.[13]

Drinking water can be sourced from the following water sources: surface water, groundwater or rainwater, in each case after collection, treatment and distribution. Desalinated seawater is another potential source for drinking water.

People without access to safe, reliable domestic water supplies face lower water security at specific times throughout the year due to cyclical changes in water quantity or quality.[14][15] For example, where access to water on-premises is not available, drinking water quality at the point of use (PoU) can be much worse compared to the quality at the point of collection (PoC). Correct household practices around hygiene, storage and treatment are therefore important. There are interactions between weather, water source and management, and these in turn impact on drinking water safety.[16]

Groundwater

Groundwater provides critical freshwater supply, particularly in dry regions where surface water availability is limited.[17] Globally, more than one-third of the water used originates from underground. In the mid-latitude arid and

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semi-arid regions lacking sufficient surface water supply from rivers and reservoirs, groundwater is critical for sustaining global ecology and meeting societal needs of drinking water and food production. The demand for groundwater is rapidly increasing with population growth, while climate change is imposing additional stress on water resources and raising the probability of severe drought occurrence.[17]

The anthropogenic effects on groundwater resources are mainly due to groundwater pumping and the indirect effects of irrigation and land use changes.[17]

Groundwater plays a central role in sustaining water supplies and livelihoods in sub-Saharan Africa.[18] In some cases, groundwater is an additional water source that was not used previously.[15]

Sanitation services

Sanitation systems are grouped into several types: The ladder of sanitation services includes (from lowest to highest): open defecation, unimproved, limited, basic, safely managed.[19]:8 A distinction is made between sanitation facilities that are shared between two or more households (a "limited service") and those that are not shared (a "basic service"). The definition of improved sanitation facilities is: Those facilities designed to hygienically separate excreta from human contact.[19]:8

With regards to toilets, improved sanitation includes the following kind of toilets: Flush toilet, connection to a piped sewer system, connection to a septic system, flush or pour-flush to a pit latrine, pit latrine with slab, ventilated improved pit latrine, composting toilet.[20]

Access to sanitation services is included in Target 6.2 of Sustainable Development Goal 6 which is: "By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations."[11] This target has one indicator: Indicator 6.2.1 is the "Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water".[11]

In 2017, 4.5 billion people did not have toilets at home that can safely manage waste despite improvements in access to sanitation over the past decades.[3] Approximately 600 million people share a toilet or latrine with other households and 892 million people practice open defecation.[3]

There are many barriers that make it difficult to achieve "sanitation for all". These include social, institutional, technical and environmental challenges.[21] Therefore, the problem of providing access to sanitation services cannot be solved by focusing on technology alone. Instead, it requires an integrated perspective that includes planning, using economic opportunities (e.g. from reuse of excreta), and behavior change interventions.[22][23]

Fecal sludge management and sanitation workers

Sanitation services would not be complete without safe fecal sludge management (FSM), which is the storage, collection, transport, treatment, and safe end use or disposal of fecal sludge.[24]:3 Fecal sludge is defined very broadly as what accumulates in onsite sanitation systems (e.g. pit latrines, septic tanks and container-based solutions) and specifically is not transported through a sewer.[24]:5 Sanitation workers are the people needed for cleaning, maintaining, operating, or emptying a sanitation technology at any step of the sanitation chain.[25]:2

Hygiene


A school girl using a Veronica Bucket in Ghana for handwashing.

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| Volume 5, Issue 10, October 2022 |

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Hygiene is a broad concept. "Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases."[26] Hygiene is can comprise many behaviors, including handwashing, menstrual hygiene and food hygiene.[19]:18 In the context of WASH, handwashing with soap and water is regarded as a top priority in all settings, and has been chosen as an indicator for national and global monitoring of hygiene access. "Basic hygiene facilities" are those were people have a handwashing facility with soap and water available on their premises.[19]:18 Handwashing facilities can consist of a sink with tap water, buckets with taps, tippy-taps and portable basins.[19]:18

In the context of SDG 6, hygiene is included in the indicator for Target 6.2: "Proportion of population using [...] (b) a hand-washing facility with soap and water"[11]

In 2017, the global situation was reported as follows: Only 1 in 4 people in low-income countries had handwashing facilities with soap and water at home; only 14% of people in Sub-Saharan Africa have handwashing facilities.[3] Worldwide, at least 500 million women and girls lack adequate, safe, and private facilities for managing menstrual hygiene.[27]

Approximately 40% of the world's population live without basic hand washing facilities with soap and water at home.[28] According to the World Health Organization, over half of the people who live in rural areas in developing countries do not practice hand washing methods due to a severe lack of water and soap.

IV. CONCLUSION

National WASH plans and monitoring

UN-Water carries out the Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) initiative. This work examines the "extent to which countries develop and implement national policies and plans for WASH, conduct regular monitoring, regulate and take corrective action as needed, and coordinate these parallel processes with sufficient financial resources and support from strong national institutions."[140]

Many countries' WASH plans are not supported by the necessary financial and human resources. This hinders their implementation and intended outcomes for WASH service delivery.[140]

As of 2020, it is becoming more common for countries to include "climate change preparedness approaches" in their national WASH plans. Preparedness in this context means working on mitigation, adaptation and resilience of WASH systems.[141]:11 Still, most national policies on WASH services do not set out how to address climate risks and how to increase the resilience of infrastructure and management.[141]:vii


Families collecting water from a water well in Niger.

Gender mainstreaming

The Dublin Statement on Water and Sustainable Development in 1992 included "Women Play a central part in the provision management and safeguarding of water" as one of four principles.[142] In 1996, Worldbank published a Toolkit on Gender in Water and Sanitation.[143] Gender-sensitive approaches to water and sanitation have proven to be cost effective.[144] Water supply schemes in developing nations have shown higher success when planned and run with full participation of women in the affected communities.[145]

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The United Nations Interagency Network on Women and Gender Equality (IANWGE) established the Gender and Water Task Force in 2003. The Task Force became a UN-Water Task Force and took responsibility for the gender component of International Water for Life Decade (2005-1015).[146] The task force's mandate ended in 2015.

History

The history of water supply and sanitation is the topic of a separate article.

The abbreviation WASH was used from the year 1988 onwards as an acronym for the Water and Sanitation for Health Project of the United States Agency for International Development.[147] At that time, the letter "H" stood for health, not hygiene. Similarly, in Zambia the term WASHE was used in a report in 1987 and stood for Water Sanitation Health Education.[148] An even older USAID WASH project report dates back to as early as 1981.[149]

From about 2001 onwards, international organizations active in the area of water supply and sanitation advocacy, such as the Water Supply and Sanitation Collaborative Council and the International Water and Sanitation Centre (IRC) in the Netherlands began to use WASH as an umbrella term for water, sanitation and hygiene.[150] WASH has since then been broadly adopted as a handy acronym for water, sanitation and hygiene in the international development context.[151] The term WatSan was also used for a while, especially in the emergency response sector such as with IFRC and UNHCR,[152] but has not proven as popular as WASH.

Society and culture

Awards

Important awards for individuals or organizations working on WASH include:

- The Stockholm Water Prize since 1991, with a wide-ranging view of water-related activities, along with the Stockholm Junior Water Prize and the Stockholm Industry Water Award.
- The Sarphati Sanitation Awards since 2013, for sanitation entrepreneurship.

United Nations organs

- UNICEF - UNICEF's declared strategy is "to achieve universal and equitable access to safe and affordable drinking water for all".[153] UNICEF includes WASH initiatives in their work with schools in over 30 countries.[154]
- UN-Water - an interagency mechanism which "coordinates the efforts of UN entities and international organizations working on water and sanitation issues".[155]

Global Handwashing Day celebrations in Indonesia

Awareness raising through observance days

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The United Nation's International Year of Sanitation in 2008 helped to increase attention for funding of sanitation in WASH programs of many donors. For example, the Bill and Melinda Gates Foundation has increased their funding for sanitation projects since 2009, with a strong focus on reuse of excreta.[156]

Awareness raising for the importance of WASH takes place through several United Nations international observance days, namely World Water Day, Menstrual Hygiene Day, World Toilet Day and Global Handwashing Day.

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