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Water, Sanitation and Hygiene Manuscript for a Research proposal

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ABSTRACT
This chapter focuses on water supply, excreta disposal, and hygiene promotion and considers the costs and benefits of each in turn. Water supply and sanitation can be provided at various levels of service, and those levels have implications for benefits. Water supply and sanitation offer many benefits in addition to improved health and those benefits are considered in detail because they have important implications for the share of the cost that is attributable to the health sector. From the point of view of their effect on burden of disease, the main health benefit of water supply, sanitation, and hygiene is a reduction in diarrheal disease, although the effects on other diseases are substantial. In the concluding sections, the percentage reductions arrived at in the discussion throughout the chapter are used together with data on existing levels of coverage to derive estimates of the potential effects of water supply and excreta disposal on the burden of disease, globally and by region, and with cost data to derive cost-effectiveness estimates.

I. INTRODUCTION

Nigeria's water, sanitation, and hygiene (WASH) sector has reached an alarming state of decline, with nearly one-third of the population lacking access to improved drinking water sources and approximately two-thirds living without adequate sanitation facilities. With one of the fastest-growing urban populations in the world, Nigeria's municipal centers in particular are likely to face increasing difficulty in meeting the water and sanitation service needs of their citizens.

Nigeria has a population of more than 203 million people - 71 million do not have access to clean water and 130 million do not have access to basic sanitation. This lack of water, sanitation, and hygiene services exacerbated by accelerated urbanization, poor cost recovery, and weak governance and institutional frameworks adversely affects Nigerian citizen's health, as well as their access to educational and economic opportunities and their work efficiency and labor productivity.

Further complicating the issue, Nigeria is divided into 36 states, each of which operates with different institutional structures, power dynamics, and little or no regulatory oversight. In most states, a State Water Board (SWB) is responsible for providing water and sanitation services. Overall, however, SWBs are hobbled by nonexistent or weak incentives for better performance, aging infrastructure, inadequate or ineffective operations and maintenance, weak institutional capacity, and little accountability to consumers.

1.1 The Problem Statement

Poor access to improved water and sanitation in Nigeria remains a major contributing factor to high morbidity and mortality rates among children under five. The use of contaminated drinking water and poor sanitary conditions result in increased vulnerability to water-borne diseases, including diarrhea which leads to deaths of more than 70,000 children under five annually. 73 percent of the diarrhea and enteric disease burden is associated with poor access to adequate water, sanitation and hygiene (WASH), and is disproportionately borne by poorer children. Frequent episodes of WASH related ill-health in children; contribute to absenteeism in school, and malnutrition. Only 26.5 percent of the population use improved drinking water sources and sanitation facilities. Also, 23.5 percent of the population defecates in the open.

The use of contaminated drinking water and poor sanitary conditions result in increased vulnerability to water-borne diseases, only 26.5 per cent of the population use improved drinking water sources and sanitation facilities. Sources: "Mortality rate attributable to unsafe water, sanitation, and hygiene (WASH)". Our World in Data Retrieved 5 March 2020".

1.2 Water Scarcity in Africa

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Water scarcity in Africa is predicted to reach dangerously high levels by 2025. It is estimated that about two-third of the world's population may suffer from fresh water shortage by 2025. The main causes of water scarcity in Africa are physical and economic scarcity, rapid population growth, and climate change. Water scarcity is the lack of fresh water resources to meet the standard water demand. Although Sub-Saharan Africa has a plentiful supply of rainwater, it is seasonal and unevenly distributed, leading to frequent floods and droughts. Additionally, prevalent economic development and poverty issues, compounded with rapid population growth and rural-urban migration have rendered Sub-Saharan Africa as the world's poorest and least developed region.

The 2012 Report by the Food and Agriculture Organization of the United Nations indicates that growing water scarcity is now one of the leading challenges for sustainable development. This is because an increasing number of the river basins have reached conditions of water scarcity through the combined demands of agriculture and other sectors. Impacts of water scarcity in Africa range from health (women and children are particularly affected) to education, agricultural productivity, sustainable development as well as the potential for more water conflicts.

To adequately address the issue of water scarcity in Africa, the United Nations Economic Commission for Africa emphasizes the need to invest in the development of Africa's potential water resources to reduce unnecessary suffering, ensure food security, and protect economic gains by effectively managing droughts, floods, and desertification.[4] Some suggested and ongoing efforts to achieve this include an emphasis on infrastructural implementations and improvements of wells, rainwater catchment systems, and clean-water storage tanks.

II. CAUSE OF WATER SCARCITY IN AFRICA

2.1 Physical and economic scarcity

Water scarcity is both a natural and human-made phenomenon. It is thus essential to break it down into two general types: Economic scarcity and physical scarcity. Economic scarcity refers to the fact that finding a reliable source of safe water is time-consuming and expensive. Alternatively, physical scarcity is when there simply is not enough water within a given region.

The 2006 United Nations Economic Commission for Africa estimates that 300 million out of the 800 million who live on the African continent live in a water-scarce environment. Specifically in the very north of Africa, as well the very south of Africa, the rising global temperatures accompanying climate change have intensified the hydrological cycle that leads to drier dry seasons, thus increasing the risk of more extreme and frequent droughts. This significantly impacts the availability, quality and quantity of water due to reduced river flows and reservoir storage, lowering of water tables and drying up of aquifers in the northern and southern regions of Africa

2.2 Impacts of water scarcity in Africa

2.2.1 Health

The most immediately apparent impact of water scarcity in Africa is on the continent's health. With complete lack of water, humans can only live up to 3 to 5 days on average. This often forces those living in water deprived regions to turn to unsafe water resources, which, according to the World Health Organization, contributes to the spread of waterborne diseases including typhoid fever, cholera, dysentery and diarrhea, and to the spread of diseases such as malaria whose vectors rely on such water resources, and can lead to diseases such as trachoma, plague, and typhus. Additionally, water scarcity causes many people to store water within the household, which increases the risk of household water contamination and incidents of malaria and dengue fever spread by mosquitoes.

These waterborne diseases are not usually found in developed countries because of sophisticated water treatment systems that filter and chlorinate water, but for those living with less developed or non-existent water infrastructure, natural, untreated water sources often contain tiny disease-carrying worms and bacteria. Although many of these waterborne sicknesses are treatable and preventable, they are nonetheless one of the leading causes of disease and death in the world. Globally, 2.2 million people die each year from diarrhea-related disease, and at any given time fifty percent of all hospital beds in the world are occupied by patients suffering from water-related diseases. Infants and children are especially susceptible to these diseases because of their young immune systems, which lends to elevated infant mortality rates in many regions of Africa. Water scarcity has a big impact on hygiene.

When infected with these waterborne diseases, those living in African communities suffering from water scarcity cannot contribute to the community's productivity and development

because of a simple lack of strength. Additionally, individual, community and governmental economic resources are sapped by the cost of medicine to treat waterborne diseases, which takes away from resources that might have potentially been allocated in support of food supply or school fees. Also, in term of governmental funding, the Water Supply and Sanitation Collaborative Council (WSSCC) estimates that in Sub-Saharan Africa, treatment of diarrhea due to water contamination consumes 12% of the country's health budget. With better water conditions, the burden on healthcare would be less substantial, while a healthier workforce would stimulate economic growth and help alleviate the prevalence of poverty.

Along with waterborne diseases and unsafe drinking water, malnutrition is also a major cause of death in Africa. Some of the malnutrition is caused by reduced agricultural production in some regions of Africa due to water scarcity. According to a 2008 review an estimated 178 million children under age 5 are stunted, most of whom live in sub-Saharan Africa. The cause of stunting is under-nutrition in children.

2.2.2 Women

African women and men's divergent social positions lead to differences in water responsibilities, rights, and access, and so African women are disproportionally burdened by the scarcity of clean drinking water. In most African societies, women are seen as the collectors, managers, and guardians of water, especially within the domestic sphere that includes household chores, cooking, washing, and child rearing. Because of these traditional gender labor roles, women are forced to spend around sixty percent of each day collecting water, which translates to approximately 200 million collective work hours by women globally per day and a decrease in the amount of time available for education. Water scarcity exacerbates this issue, as indicated by the correlation of decrease in access to water with a decrease in combined primary, secondary, and tertiary enrollment of women.

For African women, their daily role in clean water retrieval often means carrying the typical water jar that can weigh over 40 pounds when full for an average of six kilometers each day. This has health consequences such as permanent skeletal damage from carrying heavy loads of water over long distances each day, which translates to a physical strain that contributes to increased stress, increased time spent in health recovery, and decreased ability to not only physically attend educational facilities, but also mentally absorb education due to the effect of stress on decision-making and memory skills. Also, in terms of health, access to safe and clean drinking water leads to greater protection from water-borne illnesses and diseases which increases women's capabilities to attend school.

The detriment water scarcity has on educational attainment for women, in turn, affects the social and economic capital of women in terms of leadership, earnings, and working opportunities. As a result of this, many women are unable to hold employment. The lost number of potential school days and education hinders the next generation of African women from breaking out of the cycle of unequal opportunity for gainful employment, which serves to perpetuate the prevalence of unequal opportunity for African women and adverse effects associated with lacking income from gainful employment. Thus, improved access to water influences women's allocation of time, level of education, and as a result their potential for higher wages associated with recognized and gainful employment.

2.2.3 Education

In addition, the issue of water scarcity in Africa prevents many young children from attending school and receiving an education. These children are expected to not only aid their mothers in water retrieval but to also help with the demands of household chores that are more time-intensive because of a lack of readily available water. Furthermore, a lack of clean water means the absence of sanitary facilities and latrines in schools. This affects more female children as they hit puberty. In terms of lost educational opportunity, it is estimated that this would result in 272 million more school attendance days per year if adequate investment were made in drinking water and sanitation.

2.2.4 Agriculture

Ethiopia's move to fill the Grand Ethiopian Renaissance Dam's reservoir could reduce Nile flows by as much as 25% and devastate Egyptian farmlands. The Human Development Report reports that human use of water is mainly allocated to irrigation and agriculture. In developing areas, such as those within Europe, agriculture accounts for more than 80% of water consumption. This is due to the fact that it takes about 3,500 liters of water to produce enough food for the daily minimum of 3,000 calories, and food production for a typical family of four takes a daily

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amount of water equivalent to the amount of water in an Olympic-sized swimming pool. Because the majority of Africa remains dependent on an agricultural lifestyle and 80% to 90% of all families in rural Africa rely upon producing their own food, water scarcity translates to a loss of food security. Water, agriculture, nutrition, and health have always been linked but recently became recognized and researched as a cause and effect loop. More than 70% of agriculture practiced in Sub-Africa is rain-fed agriculture.

With the increasing variability of current weather patterns the crops and harvests are more prone to being affected by droughts and floods. Food and nutrition security is defining the development agenda in Sub-Saharan Africa. According to the UN Economic Commission for Africa and New Partnership for Africa's Development, "irrigation is key to achieving increased agricultural production that is important for economic development and for attaining food security". Most of the rural African communities are currently not tapping into their irrigation potential. Irrigation agriculture only accounts for 20% of agriculture types globally. In Sub-Saharan Africa the governments have historically played a large part in irrigation development. Starting in the 1960s donors like the World Bank supported these African governments in the development of irrigations systems. However, in the years since, irrigation agriculture has produced a lower than expected crop yield. According to the World Bank the agriculture production in Sub-Saharan Africa could nearly triple by 2050. But for many regions, there is a lack of financial and human resources to support infrastructure and technology required for proper crop irrigation. Because of this, the impact of droughts, floods, and desertification is greater in terms of both African economic loss and human life loss due to crop failure and starvation. In a study conducted by the World Bank, they found that, on average, individuals who suffer from malnutrition lose 10% of their potential lifetime earnings. They also found that countries lose 2%-3% of their GDP due to under nutrition.

Additionally, lack of water causes many Africans to use wastewater for crop growth, causing a large number of people to consume foods that can contain chemicals or disease-causing organisms transferred by the wastewater. Greywater constructed wetlands and modified sand filters are two methods of greywater filtration that have been proposed. These methods allow for greywater to be purified or filtered to remove biological hazards from the water that would not be safe to use in agriculture. Thus, for the extremely high number of African areas suffering from water scarcity issues, investing in development means sustainably withdrawing from clean freshwater sources, ensuring food security by expanding irrigation areas, and effectively managing the effects of climate change. The sustainable development goal report aims at increasing safe wastewater use to contribute to increasing food production and improved nutrition.

2.2.5 Conflict

The population growth across the world and the climate change are two factors that together could give rise to water conflicts in many parts of the world. Already, the explosion of populations in developing nations within Africa combined with climate change is causing extreme strain within and between nations. In the past, countries have worked to resolve water tensions through negotiation, but there is predicted to be an escalation in aggression over water accessibility.

Africa's susceptibility to potential water-induced conflict can be separated into four regions: the Nile, Niger, Zambezi, and Volta basins. Running through Egypt, Ethiopia, and Sudan, the Nile's water has the potential to spark conflict and unrest. In the region of the Niger, the river basin extends from Guinea through Mali and down to Nigeria. Especially for Mali one of the world's poorest countries the river is vital for food, water and transportation, and it's over usage is contributing to an increasingly polluted and unusable water source. In southern Africa, the Zambezi river basin is one of the world's most over-used river systems, and so Zambia and Zimbabwe compete fiercely over it. Additionally, in 2000, Zimbabwe caused the region to experience the worst flooding in recent history when the country opened the Kariba Dam gates. Finally, within the Volta river basin, Ghana is dependent on its hydroelectric output but plagued by regular droughts which affect the production of electricity from the Akosombo Dam and limit Ghana's ability to sustain economic growth. Paired with the constraints this also puts on Ghana's ability to provide power for the area, this could potentially contribute to regional instability. At this point, federal intelligence agencies have issued the joint judgment that in the next ten years, water issues are not likely to cause internal and external tensions that lead to the intensification war. But if current rates of consumption paired with climatic stress continue, levels of water scarcity in Africa are

predicted by UNECA to reach dangerously high levels by 2025.

This means that by 2022 there is the potential for a shift in water scarcity's potential to contribute to armed conflict. Based on the classified National Intelligence Estimate on water security, requested by Secretary of State Hillary Clinton and completed in fall 2011, after 2022 water will be more likely to be used as a weapon of war and potential tool for terrorism, especially in North Africa. On World Water Day, the State Department stated that water stress, "will likely increase the risk of instability and state failure, exacerbate regional tensions and distract countries from working with the United States on important policy objectives." Specifically referring to the Nile in Egypt, Sudan, and nations further south, the report predicts that upstream nations will limit access to water for political reasons and that terrorists may target water-related infrastructures, such as reservoirs and dams, more frequently. Because of this, the World Economic Forum's 2011 Global Risk Report has included water scarcity as one of the world's top five risks for the first time**.**

III. SOLUTION TO THE SCARCITY OF WATER IN AFRICA

3.1 Technologies

The more basic solutions to help provide Africa with drinkable and usable water include well-digging, rain catchment systems, de-worming pills, and hand pumps, but high demand for clean water solutions has also prompted the development of some key creative solutions as well. Some non-profit organizations have focused on the aspect of drinking water contamination from sewage waste by installing cost-effective and relatively maintenance-free toilets, such as drop in the Bucket's "Eco-sanitation Flush Toilet" or Pump Aid's "Elephant Toilet". The Elephant Toilet uses community-sourced resources in construction to build a relatively simple waste disposal mechanism that separates solids from liquids to promote faster decomposition and lower the impact on ground water.

In comparison, the Eco-Sanitation Flush Toilet also uses no power of any kind, but actually treats sewage rather than just storing it so that the toilet's output is only water. Both solutions are then simple for residents of African communities to maintain and have a notable impact on the cleanliness of local water sources. Other solutions to clean water scarcity issues have focused on innovative pump systems, including hand-pumps, water for people's "Play Pumps" and Pump Aid's "Elephant Pumps". All three designs are built to aid communities in drawing clean water from wells. The hand pump is the most basic and simple to repair, with replacement parts easily found. Using a more creative approach, Play Pumps combine child's play with clean water extraction through the use of playground equipment, called a roundabout. The idea behind this is as children play on the roundabout, water will simultaneously be pumped from a reservoir tank to either toilets, hand-washing stations, or for drinking water. Some downsides to the Play-Pump, though, are its inability to address situations of physical water scarcity and the danger of exploitation when children's play is equated with pumping water. Alternatively, Elephant Pumps are simple hand water pumps.

After a well is prepared, a rope-pump mechanism is installed that is easy to maintain, uses locally sourced parts, and can be up and running in the time span of about a week. The Elephant Pump can provide 250 people with 40 liters of clean water per person per day. Moving beyond sanitary waste disposal and pumps, clean water technology can now be found in the form of drinking straw filtration. Used as solution by Water Is Life, the straw is small, portable, and costs US$10 per unit. The filtration device is designed to eliminate waterborne diseases, and as a result, provide safe drinking water for one person for one year.

Overall, a wide range of cost-effective, manageable, and innovative solutions are available to help aid Africa in producing clean, disease-free water. Ultimately what it comes down to is using technology appropriate for each individual community's needs. For the technology to be effective, it must conform to environmental, ethical, cultural, social, and economic aspects of each Africa community. Additionally, state governments, donor agencies, and technological solutions must be mindful of the gender disparity in access to water so as to not exclude women from development or resource management projects. If this can be done, with sufficient funding and aid to implement such technologies, it is feasible to eliminate clean water scarcity for the African continent by the Millennium Development Goal deadline of 2012**.**

Since that deadline has passed, the Sustainable Development Goals are what we are striving for by the year 2030.

SDGs are intersectional and interdependent, it's important to find modern solutions to save water through decreasing water

use in irrigation by using more treated wastewater and shifting to less water dependent crops in regions with water scarcity. Another solution that contribute to sanitation and water preservation is Eco-San technologies that aim to benefit from the human waste in agriculture and reduce water pollution. Natural-Based Solutions (NBSs) are suggested as a successful alternative towards achieving the sixth SDG, NBSs include means to improve access to water with high caliber.

3.2 Water permit systems

Some regions in African countries, like Tanzania, have attempted to address issues with water scarcity by instituting a water permit system. Under such a system, local rules are used to grant users access to a certain amount of water at certain locations. However, such systems often result in additional conflict, as water rights can be monopolized by large-scale irrigators at the expense of smallholder farmers in the region.

3.3 Limitations

Africa is home to both the largest number of water-scarce countries out of any region, as well as home to the most difficult countries to reach in terms of water aid. The prevalence of rural villages traps many areas in what the UN Economic Commission for Africa refers to as the "Harvesting Stage", which makes water-scarce regions difficult to aid because of a lack of industrial technology to make solutions sustainable. In addition to the geographic and developmental limiting factors, a number of political, economic reasons also stand in the way of ensuring adequate aid for Africa.

Politically, tensions between local governments versus foreign non-governmental organizations impact the ability to successfully bring in money and aid-workers. Economically, urban areas suffer from extreme wealth gaps in which the overwhelming poor often pay four to ten times more for sanitary water than the elite, hindering the poor from gaining access to clean water technologies and efforts. As a result of all these factors, it is estimated that fifty percent of all water projects fail, less than five percent of projects are visited, and less than one percent have any long term monitoring.

3.4 US officials declare first-ever water shortage for Colorado River.

Officials called on populations served by the river to reduce water usage starting next year. Water levels at Lake Mead, the largest reservoir on the Colorado River, have fallen to record lows. United States officials declared the first-ever water shortage for the Colorado River, an arterial waterway that serves 40 million people in the country's west, and called on the population it serves to reduce their usage next year. Water levels at the largest reservoir on the Colorado River, Lake Mead have fallen to record lows, authorities said on Monday. Water basins along the river supply household water, irrigation for farms and hydropower to Arizona, California, Colorado, Nevada, New Mexico, Utah, Wyoming and parts of Mexico.

Along the perimeter of Lake Mead, a white bathtub ring of minerals outlines where the high-water line once stood, underscoring the acute water challenges for a region facing a growing population and drought being worsened by hotter, drier weather brought on by climate change. States, cities, farmers and others have diversified their water sources over the years, helping soften the blow of the upcoming cuts. However, the declaration from federal officials makes clear that conditions have intensified faster than scientists predicted in 2019 when some states in the Colorado River basin agreed to give up shares of water to maintain levels at Lake Mead. Like much of the West, and across our connected basins, the Colorado River is facing unprecedented and accelerating challenges, said Tanya Trujillo, an official with the federal water resources agency. The only way to address these challenges and climate change is to utilize the best available science and to work cooperatively across the landscapes and communities that rely on the Colorado River.

3.5 Israel's Chronic Water Problem

Water is considered as a national resource of utmost importance. Water is vital to ensure the population's well-being and quality of life and to preserve the rural-agricultural sector. Israel has suffered from a chronic water shortage for years. In recent years however, the situation has developed into a crisis so severe that it is feared that by the next summer it may be difficult to adequately supply municipal and household water requirements. The current cumulative deficit in Israel's renewable water resources amounts to approximately 2 billion cubic meters, an amount equal to the annual consumption of the State. The deficit has also led to the qualitative deterioration of potable aquifer water resources that have, in part, become either of brackish quality or otherwise become polluted.

The causes of the crisis are both natural and man-made. Israel has suffered from four

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consecutive years of drought. The increase in demand for water for domestic uses, caused by population growth and the rising standard of living, together with the need to supply water pursuant to international undertakings have led to over-utilization of its renewable water sources. The policy for the water sector, particularly in the past decade, combined with the absence of adequate action facing the impending water shortage situation, has contributed to the severity of the present crisis.

The agricultural sector has suffered most because of the crisis. Due to the shortage, water allocations to the sector had to be reduced drastically causing a reduction in the agricultural productivity. The current crisis has led to the realization that a master plan for policy, institutional and operational changes is required to stabilize the situation and to improve Israel's water balance with a long-term perspective.

IV. WATER RESOURCES AND WATER AVAILABILITY

4.1 Conventional Water Resources

The total average annual potential of renewable water amounts to some 1,800 MCM, of which about 95% is already exploited and used for domestic consumption and irrigation. About 80% of the water potential is in the north of the country and only 20% in the south.

Israel's main freshwater resources are: Lake Kinneret - the Sea of Galilee, the Coastal Aquifer - along the coastal plain of the Mediterranean Sea, and the Mountain Aquifer - under the central north-south (Carmel) mountain range. Additional smaller regional resources are located in the Upper Galilee, Western Galilee, Beit Shean Valley, Jordan Valley, the Dead Sea Rift, the Negev and the Arava. The long-term average quantity of replenishable water from major water resources amounts to about 1,800 MCM per year.

4.1.1 Long-term Potential of Renewable Water

Resource	Replenishable Quantities (MCM/year)
The Coastal Aquifer	320
The Mountain Aquifer	370
Lake Kinneret	700
Additional Regional Resources	410
Total Average	1,800

4.2 Non-conventional Water Resources and Conservation

After drawing on nearly all its readily available water resources and promoting vigorous conservation programs, Israel has long made it a national mission to stretch existing sources by developing non-conventional water sources, while promoting conservation. These efforts have focused on the following: reclaimed wastewater effluents; intercepted runoff and artificial recharge; artificially-induced rainfall - cloud seeding; and desalination.

4.3 Water Conservation and Water Use Efficiency

Water conservation is the most reliable and least expensive way to stretch the country's water resources, and the challenge is being met in all sectors. Public water conservation campaigns coupled with technical and economic measures are being applied to reduce consumption and to increase awareness of water scarcity

In agriculture, the wide scale adoption of low volume irrigation systems (e.g. drip, micro-sprinklers) and automation has increased the average efficiency to 90% as compared to 64% for furrow irrigation. As a result, the average requirement of water per unit of land area has decreased from 8,700 cum/ha in 1975 to the current application rate of 5,500 cum/ha. At the same time agricultural output has increased twelve fold, while total water consumption by the sector has remained almost constant.

In the domestic and urban sectors, conservation efforts focus on improvements in efficiency, resource management, repair, control and monitoring of municipal water systems. Citizens are urged to save water. The slogan "Don't waste a drop" is known in every home in Israel. Parks have been placed under a conservation regime, including planting of drought-resistant plants and watering at night.

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4.4 Water Quality

Water quality is an issue of equal importance to water scarcity, and water quality degradation is a considerable issue in water management. The quality of supplied water in Israel varies from very low salinity water (10 mg/l of chlorides) from the Upper Jordan River, 200 mg/l from the Kinneret, and more than 1500 mg/l from groundwater sources in the south. Groundwater exploitation is controlled to prevent seawater intrusion to the Coastal Aquifer and movement of saline water bodies within the Karstic Limestone Aquifer.

Despite the limits on water withdrawal, due to global warming and frequent droughts, the regime of the natural flows is decreasing. At the same time, the influx of pollutants from human activity and negligence above the aquifers is increasing, resulting in the increase of mineral and other pollutants in the groundwater. Due to unbalanced exploitation and return flow from irrigation, an increase in the salinity of the groundwater has occurred in many wells.

The most advanced technology and practices are being applied to protect and minimize the pollution of water resources. Water conservation maps, restricting land use activities above groundwater resources, were produced to protect the underlying resources. Regular monitoring of water resources, including water recharge, water table levels, abstraction, salinity (chlorides) and pollution (nitrates) data are regularly monitored and reported. The data provides an effective tool for influencing the planning, the development process, and permissible emission of pollutants to the environment.

4.5 Water Management Policy

In 1959, a comprehensive water law was passed, making water resources public property and regulating water resources exploitation and allocation, as well as pollution prevention and water conservation. Under the law, all available water resources are made available for use by consumers, as directed by the Water Commissioner. The Water Commissioner is responsible for implementing the Government's policy, ensuring sufficient water supply of the required quality and reliability, while conserving and preserving water resources.

The Government of Israel has discussed a proposed master plan for the development of the water sector with the aim of solving the water crisis and has resolved to immediately implement a number of components thereof.

At this stage, the following has been authorized:

The construction of desalination plants with an installed annual capacity of 400 MCM for seawater and with an annual 50 MCM capacity for brackish water.

The rehabilitation of polluted and depleted wells with an annual total yield of up to 50 MCM.

The importation from Turkey of an annual quantity of 50 MCM fresh water.

To increase the amounts of treated sewage effluents suitable for irrigation up to 500 MCM.

By the second half of the year 2004 the impact of these projects ought to be felt, and all projects will be gradually completed by the end of the decade.

The amount of additional water produced and imported in accordance with these decisions is needed to close the gap formed in Israel's water balance caused by overexploitation and depletion of natural water sources on the one hand and the increased demand on the other. All activities in the water sector will be based on a new water sector policy that incorporates a development plan and is founded upon three basic components:

- ★ Ensuring water supply.
- ★ Social and economic requirements.
- ★ Environmental and ecological needs.

4.5.1 Water Supply and Demand - Israel 1998-2020 MCM/year

Year	Population(million)	Surface Water	Ground Water	Water Effluents	Total
1998	6.0	640	1050	140260	102100
2010	7.4	645	1050	165470	1002430
2020	8.6	660	1075	180565	2002680

4.5.2 Table showing water demand from 1998 - 2020

Year	Urban Sector	Natural	Brackish	Water Effluents	Total
1998	800	920120	260	1300	2100
2005	980	75095	380	1225	2430
2010	1060	68075	490	1245	2680

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2020	1330	60060	640	1300	2680

Source: Israel Water Commission, 1998

4.6 Water Distribution

Mekorot Water Company Ltd. is a Government-owned company and, as Israel's national water company, is responsible for managing the country's water resources, developing new sources and ensuring regular delivery of water to all localities for all purposes. Mekorot is in charge of the wholesale supply of water to urban communities, industries and agricultural users. Mekorot produces and supplies about two-thirds of the total amount of water used in Israel. The remainder is provided through privately-owned facilities. In 1997, Mekorot supplied 1,380 MCM of water, of which 745 MCM were supplied for irrigation, 540 MCM for domestic use, 94 MCM for industry and 27 MCM to replenish over-pumped aquifers. Water was also supplied to Jordan and the Palestinian Authority, in accordance with the peace accord.

4.7 Israel National Water Supply System - National Water Carrier

The shortage of water in the southern, semi-arid region of Israel required the construction of an extensive water-delivery system that supplies water to this region from resources in the north. Thus, most of the country's fresh water resources were inter-connected into the National Water Carrier, commissioned in 1964. The National Water Carrier supplies a blend of surface and groundwater. Water not required by consumers is recharged into the aquifer through spreading basins and dual-purpose wells. Recharging of aquifers helps to prevent evaporation losses and, in the coastal area, intrusion of seawater. The National Water Carrier supplies a total of 1,000 major consumers, including 18 municipalities and 80 local authorities

4.8 Purpose

Clean water is essential not only to remain safe from disease but also to maintain good health. If the crops and grains are given contaminated water, the bacteria and disease will spread to those who consume the fresh produce. Therefore, water that is used for agriculture must also come from safe and clean resources.

Provision of equitable access to water, sanitation and hygiene services.
Strengthen government efforts to eradicate the practice of open defecation.
Strengthen tailored community approaches to total sanitation including Community-Led Total Sanitation (CLTS) in rural, peri-urban and riverine settings.
Strengthen national and sub-national bodies' capacity to develop and implement equitable and gender-sensitive WASH policies, strategies and guidelines.
Ensure sustainability of water services in rural communities

V. RESEARCH QUESTION/OBJECTIVES

The goal of the WASH Benefits study is to generate rigorous evidence about the impacts of sanitation, water quality, hand-washing, and nutrition interventions on child health and development in the first years of life. The study is designed as two, highly comparable cluster randomized trials in rural Bangladesh and Kenya. In each country, the study has seven arms
(6 treatment arms and a control arm).
The study has three primary scientific objectives:
Measure the impact of sanitation, water quality, hand-washing, and nutrition interventions on child health and development after 2 years of intervention.
Determine whether there are larger reductions in diarrhea when providing combined water, sanitation and hand-washing intervention compared to each component alone.
Determine whether there are larger effects on growth and development from combining a) daily supplemental nutrition with b) a combined water, sanitation and hand-washing intervention compared to each component alone.

The study has three secondary scientific objectives:

- ★ Measure the impact of nutritional supplements and household environmental interventions on environmental enteropathy biomarkers, and more clearly elucidate this potential pathway between environmental interventions and child growth and development.
- ★ Measure the impact of sanitation, water quality, hand-washing and nutritional interventions on intestinal parasitic infection prevalence and intensity.
- ★ Measure the association between parasitic infection and other measures of enteric health, including acute diarrhea and environmental enteropathy biomarkers.

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Measure the impact of sanitation, water quality, hand-washing, and nutrition interventions on the following tertiary outcomes:

- ★ Weight-for-age at 1 and 2 years
- ★ Weight-for-height at 1 and 2 years
- ★ Underweight at 2 years
- ★ Wasted at 2 years
- ★ Severely stunted at 2 years
- ★ Head circumference-for-age at 1 year and 2 years
- ★ Protozoan infection at 2 years
- ★ Verbal Communicative Development Inventory at 1 year
- ★ WHO motor milestones at 1 year
- ★ Acute respiratory illness
- ★ All-cause mortality.

VI. LITERATURE REVIEW

In general, the lack of WaSH access in extra-household settings disproportionately affects certain household members in different ways. For example, inadequate sanitation facilities for menstrual hygiene management (MHM) have been associated with poor school attendance by adolescent girls (Abrahams, 2006). The elderly face substantial challenges if WaSH facilities are not suited to their needs (Harris, 2012). Disabled persons make up 15% of the global population and include individuals living with physical, intellectual, sensory (e.g. blindness, deafness) or mental health impairments (WHO, 2011). They face technical and social barriers related to WaSH preventing them from attending school, seeking jobs, and gaining access to other public settings. When disabled persons are unable to attend school or take jobs, it places an additional economic burden on their families and compounds inequality (Groce, 2011).

Monitoring access to extra-household WaSH is important for purposes of informing investment in resources, supporting benchmarking and reporting, and measuring progress. A component of effective monitoring is a framework for data collection using a set of indicators. Examples of WaSH monitoring frameworks include the Human Right to Water (HRTW), the United Nations (UN) Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS), and the World Health Organization (WHO)/United Nations Children's Fund (UNICEF) Joint Monitoring Programme (JMP) which collects data used to track progress for the MDG target on drinking-water and sanitation. Despite the availability of multiple frameworks, none of them provide globally harmonized indicators or guidance for extra-household WaSH monitoring. Therefore, a new framework is required to monitor these settings.

This review summarizes the current state of WaSH in extra-household settings. We develop a typology to categorize extra-household settings. We catalog international standards, actors, and the current status of evidence about WaSH in these settings to identify literature gaps. We describe available monitoring initiatives that collect extra-household data and review other monitoring initiatives that could incorporate extra-household indicators in the future. Finally, we present a framework of extra-household indicators for monitoring in developing countries.

Hygiene and Sanitation Worldwide One third of the world's population some 2.5 billion men, women and children - do not use improved sanitation facilities; the World Health Organization (WHO) and UNICEF estimated that more than one billion people still defecated in fields, forests, bushes, plastic bags, rivers, lakes or other open spaces and were denied security and privacy of a hygienic toilet or latrine even in year 2014 (WHO/UNICEF, 2013). The majority of those one billion people who still practice open defecation are living in rural areas. It is now recognized that inadequate sanitation and hygiene have a major impact on health and are the main causes of preventable diarrheal and other diseases (i.e. cholera, dysentery, typhoid, hepatitis A, et al.), which kills 5,000 children and 1,000 adults per day (Wolfer, 2014). A recent study estimates that in 2012 in poor and developing countries, 280,000 deaths (DALY: deaths and disability-adjusted life years) are directly imputable to inadequate sanitation, representing 1.5% of the total disease burden and 58% of diarrheal diseases (Pruss-Ustun, et al., 2014).. Hence, inadequate sanitation is recognized as a cause and an effect of extreme poverty, a serious health risk for individuals, families and communities and one of the biggest challenge facing the world today (WHO/UNICEF, 2013; Wolfer, 2014). Thus, improving sanitation by sustained appropriate behavior is a target under Millennium Development Goals (MDG) (United Nations, 2015) and Sustainable Development Goals (SDG) draft (United Nations, 2015) , as well as one of the twelve essential family practices promoted by UNICEF, which aim at broader development gains for rural communities, particularly women and children (UN-Water/WHO, 2014). Moreover, adequate and maintained sanitation and hygiene practices help mitigate against extreme poverty and hunger, and increase primary education (Chambers,

2008). In addition, they improve maternal health, reduce child mortality, promote gender equality, and lead to female empowerment and aid in ensuring rural communities' environmental and economic resilience (Chambers R. , 2008; Mehta & Movik, 2011). It is also important to note that improved WASH-services support can have a positive effect on state-community relationships. Delivery and monitoring contribute to the improvement of state legitimacy by encouraging and reinforcing capacities of the governing institutions to respond to community's needs. This can encourage popular demand for accountability of governments, both national and local. In turn, this can lead to strengthening of inclusive links between local communities and the government. Thus, including all community members – men, women, youth, and vulnerable groups – in decision-making about sanitation management can reinforce communities infrastructure ownership and significantly contribute to long term adequate behavior change

VII. CONCLUSION

This review identified a gap in assessment of nutrition practices which is a key factor related to the various outcomes studied especially diarrheal infections and should therefore be given more attention in future research. The studies assessed the health and educational effects of WASH practices in schools on reducing absenteeism and diarrhea prevalence/infections among school-age children on a short term. However, there have been little or no empirical studies which examined the long term impact of WASH interventions on child health outcomes, and therefore limited data to support future interventions. This was noted as a limitation in various studies showing a high loss to followup, where followup was present. The positive effect of an education component in the intervention on the uptake and adherence to hygiene practices should be noted in future research. Knowledge was implicated in several studies in this review as a facilitator in the uptake of hygiene practices and interventions. Several key independent variables including age of the child, gender, grade level, socioeconomic index, access to hygiene and sanitary facilities use and prior knowledge of hygiene practices which were significantly associated with child health outcomes should be noted and controlled for in future interventions. The review concluded that the importance of access to safe water, hand washing facilities, and hygiene education cannot be underscored in abating water-borne illnesses, malnutrition, school absenteeism, and generally improving the quality of life and learning performance in children.

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