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Eritrea, Factor 9: Water & Sanitation

Solving the Water and Sanitation Crises in Eritrea

Eritrea is a country situated in the Horn of Africa, neighboring Ethiopia and bordered by the Red Sea with a coastline of nearly 600 miles. Located in one of the driest areas of Africa, the country is subject to severe climactic shocks, such as recurrent droughts, low annual rainfall, and locust and pest infestations. Eritrea has only one perennial river, the Setit River, along the border with Ethiopia. All other rivers in the country are seasonal, containing water only after rainfall, and dry for the rest of the year. Also, there are no natural fresh surface water bodies in the country, and underground water reserves are very low (“Reverse Osmosis & Water Treatment in Eritrea”). Due to such low availability of water and the country’s rocky and mountainous terrain, crop yields are very low. With good rains the country can produce up to 60% of its food requirements, however, with bad rains the productivity decreases to as low as 25% of national food requirements. As a result, an estimated two-thirds of the households are impacted by food insecurity and malnutrition. About 59% of the Eritrean population consumes less than the daily calorie requirement and 44% are underweight. Women are most affected by food insecurity and malnutrition, which can increase the risks of complications during pregnancy and childbirth. (“Food Security and Sustainable Livelihood Programme in Zoba Maekel”). Separately, the minimally available clean water supply is contaminated due to open defecation practices by a majority of the population. I believe that addressing the two fundamental human rights problems around clean water supply and sanitation practices will not only meet the United Nations’ Sustainable Development Goal 6, but also is critical in solving the food security crisis in Eritrea.

Eritrea is one of the youngest countries in the world having regained self-rule in 1991 and full independence in 1993. The country enjoyed seven years of stabilization, reconstruction and development, before the onset of a border war with Ethiopia in 1998. The brunt of hostilities ended in 2000 and a UN Eritrea-Ethiopia Boundary Commission (EEBC) ruled in favor of Eritrea in 2002, but the border zone remained militarized. UN Security Council sanctions were imposed in 2009 and reinforced in 2011. Eritrea remained in a state of mobilization for almost two decades under transitional political arrangements focused on national security with a suspension of traditional checks and balances. The development model has been changed to favor greater self-reliance and a more state-led planned economy (“The World Bank In Eritrea”). Since independence, Eritrea has had only one leader: the current president, Isaias Afwerki. Eritrea has no democratic institutions, its political parties are banned, and the national and international non-governmental organizations (NGOs and INGOs) operate in a highly restricted space under the direct control of the government (“Mobile Africa: Human Trafficking and the Digital Divide.”).

An average Eritrean household consists of about 4.8 persons, with an average life expectancy in the mid-50s for men and about 60 for women—about a decade shorter than the world average for each sex. Over 60% of Eritrea’s population of four million lives in rural areas and consists of several ethnic groups, each with its own language and cultural tradition. The two main ethnicities are the Tigrinya/ Tigray (about 55% of the population), and the Tigre (about 30%). In addition to the languages spoken by the different ethnic groups, Arabic and English are widely understood. About 50% of the population is Sunni Muslim, 40% being Eritrean Orthodox, and the rest being various other beliefs. A little over two-thirds of the population is under the age of 30 and the population growth rate of 1% is amongst the lowest in the world (“CIA - The World Factbook”). The country also suffers from low education levels - primary education enrollment is the third-lowest in the world at an estimated 33.5% (“4 Causes of Poverty in Eritrea”). Only 45% of those enrolled complete primary education, and further, only 30% of these complete secondary education (“Eritrea: Investing in rural people”). Such poor literacy levels impact the potential progress across several fronts especially in reversing long-held beliefs/habits about water and sanitation practices.

The Eritrean economy is the third worst in the world with a GDP of \$396 per capita in comparison to \$63,700 for the US ("Country comparison Eritrea vs United States"). Like the economies of many African nations, agriculture is the mainstay accounting for about 24% of GDP and almost all rural employment - nearly 80% in Eritrea is engaged in subsistence farming and animal herding. Eritrea has 26% arable land, but only four per cent is under cultivation. Eritrea's climate is semi-arid with rainfall ranging between the lows of 50 mm in the Eastern Lowlands to the highs of about 700 mm in the Northern/Central Highlands. This allows various production systems to develop such as crop farming (rain fed: sorghum, finger millet, teff, maize, barley, wheat and beans; and irrigated cropping: banana, citrus cropping, onions, potatoes, tomatoes, pepper, lettuce, cabbage etc.); agro-pastoralism (in addition to crops: dairy, small stock, and poultry); pastoralism (cattle, small stock, camels, donkeys and poultry), and marine fisheries. Eritrean cuisine includes injera, a chewy flatbread made of teff, wheat, or sorghum flour, and kitcha, an unleavened bread. Meals typically are served on a communal platter, and diners use bread, rather than utensils, to serve themselves portions of such dishes as zigni (a stew made of fish, vegetables, and meat), ful (baked beans), and shiro (lentils) ("Eritrea: Investing in rural people"). In summary, the economy is primarily farm-based with highly uncertain production resulting in very low per capita GDP.

According to the International Fund for Agricultural Development, (IFAD), Eritrea's crop and livestock productivity is low compared to potential yield because of a combination of challenges, such as the low and erratic rainfall, limited soil fertility and land degradation, weak agricultural services, poor access to modern inputs, inadequate technical skills, limited access to information and technologies, and limited capacity of facilitating public institutions. As a result, Eritrea imports 40% of its food products (mainly wheat, pasta and soybean oil). The problems faced by Eritrea require a wide range of solutions including the adoption of proven and affordable technologies, production and distribution of improved seeds, expanded and improved irrigation, innovative approaches to soil and water management, and promotion of sustainable natural resource management ("Eritrea: Investing in rural people). Of these needed solutions, I chose to further research water management, specifically, the topics of clean water supply and good sanitation because the country ranks amongst the worst in the world on these most basic of human rights.

Challenges of Clean Water Supply and Poor Sanitation

Eritrea suffers from chronic water shortages due to droughts and lack of year-round rainfall. On the "metric of access to water close to home" (defined by WHO/UNICEF as longer than 30 minute travel to the source of water supply), Eritrea ranks the worst in the world – only 19% of its population has such access ("The Water Gap."). Overall, 42% of Eritreans are estimated to live without access to improved drinking water and an inventory of water supplies found that between 40-90% were contaminated. Lack of access to clean water sadly impacts daily lives of Eritreans in many other ways: infants who rely on breastfeeding are susceptible to these same diseases passed from the mother, doctors use the same water that is rife with diseases to clean medical tools used in healthcare and people use the same dirty water to clean dishes and cook food ("The Eritrea Water Crisis: All You Need to Know.").

Research suggests that the key reason for water contamination is poor sanitation practices. Since independence, Eritrea has consistently ranked the worst or in the top three countries for percentage of population that practices open defecation ("People practicing open defecation (% of population) - Country Ranking."). About 85% of the country's population uses unimproved sanitation facilities, which range from improper toilets to defecating in the open. In both school and health facilities the condition, functionality and accessibility of latrines is questionable. For example, latrines are locked or used for other purposes and are not gender segregated. Lack of water combined with poor management of latrines is resulting in many facilities being too unhygienic and filthy to use. ("Water, Sanitation and Hygiene Bottleneck Analysis"). As a result of improper latrines, fecal matter winds up in local groundwater contaminating wells and watering holes. Contamination due to open defecation impacts children in particular; half of Eritrean children under the age of five are stunted in growth ("A Place to Go.").

To understand these challenges, their causes and the impact better, I interviewed two Eritreans Ms. Azie and Mr. Assed. Ms. Azie, a homemaker who currently lives in Chicago, mentioned that “Growing up in a small village in Eritrea about 90 kms outside the capital city of Asmara, we did not have a sufficient water source. I remember when I was about 10 years old, I would leave at 5 am every morning and walk around a mile to fill a can of water for my whole family. I had to go at least two to three times right before I go to school. I used to collect the water from a natural spring well and if you don’t go early in the morning the water quality would get disturbed by others’ buckets and you wouldn’t be able to get clean water. I remember it being very heavy and uncomfortable, and this had a negative effect on my studies as well as I used to get tired in the morning. Lack of sufficient clean water used to make it unlikely that you would wash everything thoroughly or constantly. We did not wash our hands as much as well. Use of toilet in the open was challenging as we went mostly at night to protect our privacy but we were concerned about our safety as we got harassed at times. It was also unsanitary because the waste was not properly disposed of and would get washed into the river from where we collected water for drinking and cooking.” Mr. Assed, who grew up in Asmara and currently resides in Denver, remembered the challenges of (poor) water quality delivered through tankers and lack of clean water on his travels to his family’s ancestral home in Barentu, “We used to go to the river about a half hour away to fetch water from the nearby well using a girba (bucket) and carried about 60-80 liters on the back of a donkey. Most people did not boil the water as they held the mentality that as their ancestors were okay drinking the water directly, they too should follow the same practice. It makes me sick to even think about how we used to drink this dirty water without any treatment.” Both Ms. Azie and Mr. Assed confirmed that these challenges continue to trouble Eritreans even today.

In summary, the challenges from lack of clean water supply and poor sanitation in Eritrea include: low food productivity, diarrheal diseases leading to poor health of the population, malnutrition and stunting in children, safety and security for women and children due to long travel to water sources, loss of education for girls in particular, and inability for women work outside the home to earn income for the family.

Ongoing efforts to Improve Clean Water and Sanitation

To combat the challenge of clean water supply, the Eritrean government has adopted water harnessing and conservation measures as a prioritized national strategy. The measures promoted the construction of artificial water reservoirs and afforestation programs to enrich both surface and underground water reserves (“Assessment of fog-water collection on the eastern escarpment of Eritrea”). The government has also partnered with UNICEF to build and rehabilitate water supply systems, including boreholes and solar powered systems that provide clean drinking water and promote behavior change to adopt safe hygiene practices. In late 2007, the Eritrean government adopted a new initiative called Community-Led Total Sanitation (CLTS). Besides building communal latrines, education and communication were two of the initiative’s objectives in an effort to alter the cultural taboo tied to talking about the bathroom and toilets. By 2015, almost 30% of the rural population of Eritrea had access to proper sanitation and achieved open-defecation-free-status. Additionally, since the adoption of CLTS, the mortality rate for children under five has dropped from 89% in 2008 to 45% in 2016 (“Sanitation in Eritrea: Efforts to End Open Defecation”).

Thanks in part to the success of CLTS, the Eritrean government declared the goal of creating an open-defecation-free (ODF) state by 2022. However, much remains to be done – only 54% of communities have achieved such ODF status, only 50% of schools have access to safe drinking water and 50% of health facilities have access to improved water source - per the most optimistic government estimate from November 2020 (“Eritrea commits to providing access to clean water and sanitation for all”).

Dramatically increasing clean water supply and better sanitation practices in Eritrea will improve the health of the population and also increase food security. However, in my view, this requires creation of affordable micro-solutions supported by education and training to overcome social taboos (around defecation or water treatment) at the local community level. Specifically, the solutions should aim at increasing clean water

supply and improving sanitation practices in a sustainable manner, i.e., not worsening Eritrea's existing climate change issues.

Proposed Solutions for Clean Water Supply

In terms of increasing clean water supply, two specific challenges are increasing supply of water, disinfecting it and reducing its turbidity. I propose that solutions to increase clean water should take advantage of the geographical terrain of Eritrea. Water from the Red Sea could be supplied to the coastal areas, and the fog in the mountains can be harvested for water supply. Additionally, low-cost and local solutions for treating turbidity and impurities in the water supply are required.

Sea water from the Red Sea can be desalinated to produce fresh water at a large scale and this is suitable solution to produce water for supply to coastal populations. Desalination is a process by which brackish or salt water is transformed into fresh water. Neighboring countries in Africa such as Egypt and Namibia have entered into public-private partnerships (PPP) to fund large desalination plants and the piping needed to transport the water from their coastal locations to the rest of the country ("Africa: Desalination, now a key component of water supply strategies"). Similar projects initiated by the Eritrean government and supported by loans and grants from multilateral agencies could supply clean water to Eritrean coastal populations.

Another source of drinking water can be tapped, namely harvesting moisture from the dense fog that is typical in many mountainous regions of Eritrea. Systems called fogcatchers consisting of large fog collector mesh nets and sedimentation tank can catch water and direct it into reservoirs with a distribution point and network of pipelines to deliver the harvested water by gravity. This solution has already been implemented in many parts of Africa, such as Ethiopia, Ghana, Uganda, and tested out in a few villages in Eritrea as well. There are limitations to collecting and piping water using a fogcatcher as it only works in mountainous regions, it's seasonal, and not yet economically viable to scale out ("Assessment of fog-water collection on the eastern escarpment of Eritrea"). However, with financial help from the local and federal governments, individuals and small communities can reap the benefits of fogcatchers to gain access to life giving water.

In wide swaths of the country, water turbidity and contamination are prevalent and low-cost products such as biosand filter, SODIS, and NirNal could be feasible solutions. A biosand filter utilizes natural materials found in and around a household, like gravel, sand, and mud. Forcing dirty water through layers of these materials will remove impurities and disease-causing organism such as protozoa and bacteria. These solutions are low-cost, low maintenance, and easy to build using local materials, although knowledge of building the systems may be lacking. ("Slow Sand Filtration"). Another low-cost solution increasingly used in tropical areas is SODIS or solar water disinfection. In essence, contaminated water is collected in clear plastic PET bottles, which are shaken to oxygenate, and placed on a roof or rack for a few hours in direct sunlight on sunny days. The combined effects of ultra-violet light (UV)-induced DNA damage, thermal inactivation, and photo-oxidative destruction inactivate disease-causing organisms in the water, making it potable. While simple to use and effective, challenges with SODIS include limited volume and time taken for disinfection as well as the need for pre-treatment ("Solar Disinfection"). However, SODIS can be a solution for small families and is effective against water-borne diseases.

In the last year, an innovative commercial portable water filter from India has gained popularity in Kenya and Tanzania. NirNal™ is a small, portable sediment filter that fits onto the top of any regular PET bottle. The standard product has a sieve and bottom filter mesh that screens out larger particulate matter upto 5 microns from the water and removes 99.9% of bacteria, viruses, and turbidity, while the dual-layer innovative carbon form provides a large surface area to act like a sponge to adsorb contaminants. As dirty water passes through the porous filter, chlorine (taste and odor) is adsorbed and broken down on the surface of the activated carbon, and clean, drinkable water comes out into the bottle. A single filter cleans up to 100 liters of water, only costs around 30 cents, is reusable, and durable. The more advanced version of the

filter that fits onto water taps lasts for 1500 liters, costs around \$20, and can screen impurities down to 0.2 microns (“Nirnal”). In my interview with the CEO, Mr. Niranjan Karagi, he shared that the company has sold over 200,000 filters in India last year and just started shipping filters to a few countries in Africa namely Algeria, Kenya, Mozambique, South Africa, Tanzania, and Zimbabwe. He also mentioned that the company is currently working on a low-cost filtration solution to create clean drinking water from sea water. Issues with the NirNal™ filter are availability and enough volume to be distributed across countries facing clean water issues. The Eritrean government could explore licensing the technology to produce NirNal™ locally at the needed scale for distribution to help reduce diseases and improve health of its population.

Proposed solutions for Hygienic Sanitation

Similarly, a range of low-cost solutions are needed to improve sanitation practices in Eritrea. As in many other developing countries, perhaps the first step to move away from open defecation is to construct Pit Latrines. This most rudimentary form of a dry latrine consists of a building with a hole over a deep pit serving as a toilet to collect human feces. While beneficial by aggregating a local community’s sludge, a disadvantage is that if not properly contained, insects attracted by the feces can transport the matter up to a mile away, contaminating food and water. Another disadvantage is that people can easily harm themselves if they fall into the pit. Finally, it’s difficult for elderly and disabled community members to squat and use the pit latrine.

A different practical and affordable solution that is tried in Bangladesh is the SATO (SafeToilet), a blue plastic toilet pan which can be placed directly over a single pit. First launched in 2013, the SATO toilet pans feature an automatically closing trap door that blocks odors and insects. A small amount of water (0.2 to 1 liter) opens the trap door to eliminate waste, which shuts itself tightly after use. The SATO pan now come with a raised stool for easier use by the elderly and the disabled and is a more hygienic alternative for communities that lack access to sewage systems across urban slums and villages of Asia and Africa (“SATO Pans and Stools”).

An issue with pit latrines (and SATO) is the disposal of the collected waste periodically in a safe manner. In most developing countries, this disposal happens either manually (where a human takes the sludge out and pours it elsewhere, increasing their exposure to pathogens) or mechanically (where it is pumped into a collection truck, which usually disposes of it in a landfill or water body). The Otji toilet, already implemented in Namibia and Zambia, addresses the problem of sludge management by using a perforated bucket inside the pit to collect the waste- the liquids run through the perforations into the ground and leave the solids behind, which harden, giving off no odor. After about six months, the filled-up bucket can easily be exchanged for an empty one via a hook from the outside and the composted dry waste can either be disposed safely or be used as fertilizer, thus greatly reducing the risk of contamination. (“The 'Otji' Dry toilet system”).

A feasible way to serve the waste disposal needs of a larger community is the Omniprocessor, that has been implemented in Senegal recently. In this system, special trucks collect the waste from households or community pit latrines through a pump, and transport it to the micro sewage treatment system, where it is burned at high temperatures and converted to drinking water, electricity and ash. The Omniprocessor can handle waste from 100,000 people, and produce up to 86,000 liters of potable water a day, a net 250 kw of electricity and a solid ash by-product which can be used as a fertilizer for the soil. As the machinery has a high initial cost, the manufacturer Sedron Technologies hopes that development banks and investors both public and private can finance such projects. (“The Omni Processor: Turning Sewage Into Drinking Water in Senegal (and Beyond?)”). Organizations such as the Bill & Melinda Gates Foundation can be a valuable partner with the Eritrean government to fund and launch test projects to try out these various solutions.

Benefits of Clean Water supply and Hygienic Sanitation

If Eritreans had better access to clean water, they would benefit immensely. Due to the lack of a stable source of water supply in their homes, mainly women and children travel many miles daily to fetch water for the family. If abundant clean water were available, Eritrean children could instead attend school more regularly and women could work in other ways to support their families. Another benefit is from an agricultural standpoint. With cleaner water, crops yields will increase, the produce will be more nutritious enabling the family to eat healthier meals regularly and families will likely even be able to sell surplus in the market to generate more income. Raising levels of agriculture production will also reduce Eritrea's dependency on foreign countries for food imports. Furthermore, people's hygiene and health will improve with clean water supply as they can bathe, wash their clothes, and cook using the clean water.

Along with clean water, proper sanitation can have a very positive impact on families. Families that defecate in open pits or out in the fields are more prone to diseases such as diarrhea and cholera, and the children could be stunted in growth. With a way to properly dispose of the fecal waste away from the house, the risks of contracting these illnesses is greatly reduced. Since the water supply can be contaminated when people openly defecate, good sanitation will improve the quality of crops and health of livestock too. Lastly, it will be a lot safer and more convenient for girls and women in particular to use such facilities at any time of their choosing.

Challenges in Adopting Clean Water supply and Hygienic Sanitation Practices

Although I laid out a range of proposed solutions to improve clean water supply and sanitation- two interconnected problems vexing Eritreans- there are challenges to adopting them. For one of the poorest countries in the world, the biggest challenges in adopting these technologies are getting the financial resources needed to make the capital investments as well as the energy and transportation costs. A 100 MGD (million gallons per day) seawater desalination plant alone can cost over \$500M which is about a quarter of the Eritrea's annual GDP. Financial aid in the form of loans or grants from other countries, large foundations (such as the Bill and Melinda Gates Foundation) or organizations such as UNICEF and IFAD will be needed. Eritrea's largest trade partners - China, the United Arab Emirates and Egypt – could potentially provide the financial support as well as technical know-how needed to implement these solutions. I believe that Public Private Partnerships, similar to that adopted by the Egyptian government for desalination plants or in rest of Africa for the Omniprocessor, would best help accelerate the construction, operation and ongoing maintenance of these solutions in Eritrea. With public body funding of the investments, private corporations can best leverage the technologies needed to bring about positive changes. To attract experienced operational partners, the Eritrean government should change its mindset and suspicions about the integrity and value of foreign collaboration in particular.

Even if the solutions are in place, I believe that the long-standing cultural taboos around toilets would create obstacles to behavioral changes in the populations. So, the second challenge would be to raise public awareness of the solutions and their benefits. In other African countries like Uganda, the government has partnered with many (thousands of) NGOs to spread the awareness in the local community. Dr. David Acker, the Director for the Center for Sustainable Rural Livelihoods at Iowa State University, shared with me “You always start by trying to understand the roots of the taboo: “Why do they do this?” In Uganda, we worked with local social scientists to develop this education/knowledge of the problem. We started out working with adults and found that they're not really able or willing to change practices around water and sanitation. Instead, our NGOs switched to working with elementary school students on the benefits of proper hand washing and not defecating in open. Soon, these children would go home and teach these lessons to their parents. Further, beyond awareness, community “buy in” is critical in the activity of digging the well or constructing a latrine. It's best when the community gets together, raises funds, elect people to carry out different construction tasks as well as maintenance of the solutions.” Replicating this model in Eritrea could likely yield good results although the lack of NGOs makes the process more challenging. The

role of the press which plays a critical role in educating the masses in other countries is likely to be harder in Eritrea, unless mandated by the government, because the country has no free press and is ranked third worst in the press freedom index in the world (“Democracy and Media Freedom in Eritrea.”).

Conclusion

Eritrea suffers from severe food insecurity due to climactic shocks such as droughts and low annual rainfall. Further, the limited water supply is contaminated due to poor sanitation practices causing disease and malnutrition, stunted growth in children, loss of education, and economic instability. These issues, combined with the government’s current focus on its border dispute with Ethiopia, continue to torment the daily lives of Eritreans. If the solutions highlighted above are implemented with urgency, then the population can grow healthier and stronger.

I reviewed a number of national and local projects to address availability of fresh clean water and proper sanitation, but it appears that the financial stability of the Eritrean government might limit the implementation. A combination of support from humanitarian aid organizations, the country’s major trade partners, and importantly, public private partnerships will be needed to finance the investments and educate the population. If the dire situation around clean water access and hygienic sanitation is improved, Eritreans will have food security, improved health, and better quality of life. Doing so will ensure that we heeded the warning of the famous water conservationist, Jacques Cousteau, “We forget that the water cycle and the life cycle are one.”

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