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Bolivia, Factor 9: Water & Sanitation

Bolivia: Filtering Contaminated Water

Soledad's feet ached as she stumbled up the steep and narrow path that connected a spring to the village of Yulo. The parsed plastic from the two buckets she carried clanged together as she climbed up and down the rocky terrain. Engineers from the University of La Paz had come with to test the water quality last year and found heavy contamination of arsenic, cadmium, and lead in the water supply of the entire region. Since then, parents asked their children to make the walk to the spring every day. Soledad's journey to the spring source forced her to miss school for several hours - but she had no choice. Clean potable water was important for cooking, drinking, and even washing clothes. Soledad and her family's narrative of travelling far distances in the quest for clean water isn't unique to the indigenous rural villagers of Bolivia. Scarcity of potable water is becoming a developing crisis and has direct and costly implications for rural indigenous populations in the country. Thus, adequate international and national resources must be invested by governments, NGOs and the international community at large to address this issue.

Soledad's family, like an average rural Bolivian family, consisted of three siblings and her parents. Her mother and older sister followed the norm, preparing the food, cleaning the house and tending to her younger brothers. Her father was a subsistence farmer who grew beans, corn, and potatoes. It was customary for the males in the family to travel out in the fields, tending to their crop from the break of dawn until sunset. Today, Soledad's visit to the spring was unfruitful - much of it had dried up due to regular droughts in the region affecting most farmers and villagers. Her meal that day would likely be raw, because clean water could not be obtained to cook. Her friends who had come with her largely were thinking the same thing - this was a common problem across rural villages.

Unlike in the big cities, the people who live in the rural areas of Bolivia speak the unique language of Quechua. Originating from the Inca Empire, Quechua is primarily spoken in the rural areas of South America. Nowadays many of the city folks don't speak Quechua, and speak Spanish. The exponential growth of Spanish has forced many of the children from the rural areas to learn Spanish. That is why every morning, kids like Soledad gathered around the tent of the interpreter to learn Spanish. Since the interpreter was the only person in the village who could speak fluent Spanish, his skills came in handy when it came to making deals with the other communities around them. Education issues were exponentially worse in rural areas. According to the Foundation for Sustainable Development, most of the children who live in the rural areas averaged about 4.2 years of education, 4.6 years worse than the average person living in the urban area. Education has been a struggling point for rural areas because of the expectations set on children to help out in the fields, and support their family.

Due to the lack of education, many rural citizens tend to work on farms. For instance Soledad's family also owns a farm. Their farm consists of many animals that graze on the nearby grasslands. These animals include alpacas, sheep, cattle, and llamas. Traditionally, the animals resembled wealth, and prosperity. However, due to the lack of clean water, many of the animals are starting to refuse to drink the contaminated water (Shahriari 2012).

As time went on, more and more people are becoming sick from drinking the contaminated water. The village of Yulo is lucky to have a physician who could take care of their needs. Many rural villages in Bolivia don't even have access to a physician. In fact according the CIA World Factbook, the average physician to citizen ratio is just under 0.48/1000. This number ratio is even lower for rural villages. The Majority of the illnesses that the physician treats relates to heavy metal contamination in the water from

the nearby river. Even though the village of Yulo had a community doctor, they would receive limited support from the government to provide adequate medical attention to the members of their community. Big hospitals typically existed in major cities, several hours away from Yulo to make much difference if someone had an emergency medical condition.

As heavy metal contamination was becoming worse and worse, the village of Yulo has been struggling with another agricultural problem. As a consequence of El Niño this year, the fields in Yulo are very much eroded. Every few years, the water currents in the Pacific Ocean, which are typically cold, bring warm water. This water evaporates more quickly than usual and precipitates closer to South American shores bordering the Pacific Ocean. This effect infamously causes a lot of flooding in the farms. The terrace farming technique used by Soledad's family had been used in the community for many generations. With the yearly droughts and heavy flooding due to the effects of El Nino, crop yields have been gradually decreasing. This year, the flooding has eroded most of the topsoil in the fields, damaging most of the crops. Even with the odds against them, Soledad's family farm, which was about two hectares big, was still able to produce a good amount of crops. However, it was becoming clear that the conditions on the fields were going to get worse. The El Niño effect decreases the crop yield of many of the farmers in Bolivia. Many farmers in this region don't earn enough money to pay for their basic necessities. In fact The CIA World Fact Book tells us that 45% of the Bolivian population earns below two dollars per day, living less than the international standard. This means that 45% of the country is under the poverty line.

The struggling life of Bolivian citizens has become increasingly evident, despite the work from strong non-governmental organizations (NGOs), like Engineers Without Borders, UNICEF, and the Water Project. While their efforts have been incredible, community members still face issues of water contamination and water accessibility. For example heavy metal contamination has affected the lives of many households already. Since most of the families are using the river water to cook and farm, many villagers are ingesting these contaminants without their knowledge. In order to make the rural parts of Bolivia more hospitable, we need to do something to address this tantamount issue. I believe that the process of phytoremediation will work the best against heavy metal contamination because it is a cheap and efficient way to remove heavy metals from water. Furthermore, mechanisms, like inexpensive rainwater harvesting systems, will be effective in harvesting and storing water for communities.

It's important to realize that this is a complex issue which necessitates complex solutions. There is no silver-bullet, but it is possible to use modern scientific findings and infrastructure that has proven successful in other parts of the world to guide us in the right direction. First, strategic rainwater harvesting systems must be installed on housing of villagers and on general buildings. This solution will provide a temporary solution which will collect enough drinkable water for the rainy season and some of the dry season. As a more sustainable solution, however, the process of phytoremediation must be developed to combat against heavy metal contamination. Its cost-effectiveness and effectiveness makes this a profound solution. Once this water is collected, however, it is not sufficient to resort to traditional farming practices of flooding fields. Modern technologies like drip irrigation systems can prove to be successful to revitalize the declining yields in Bolivian farms, and ultimately lead to a prosperous rural countryside.

Rainwater Harvesting (RWH) systems have been widely used in many parts of the world that involve water shortages. Using the rainwater as a viable source for potable water is effective because it bypasses the need to use nearby streams or rivers which could potentially be contaminated - like the case of Yulo. Rainwater harvesting systems typically have several components. First, RWH systems require gutters on the roofing of houses. Instead of water typically falling off the roof and into the ground, the water is then redirected via piping. This water undergoes a first flush to eliminate large solid waste, and then a secondary process of filtration. This process allows small contaminants like rocks and other sand-like particles to be removed from the flowing water. Consequently, the water is stored in a holding tank.

Rainwater harvesting goes back centuries to the forts in the deserts of Rajasthan and Gujarat. When the soldiers in these forts needed water, they would rely on robust rainwater collection mechanisms. This would provide them enough water to get through the dry season despite not having access to groundwater and river water. Only until recently however, did RWH systems become more widespread. One prime example can be found is in 2001, when Chennai became one of the largest cities to use the method of Rainwater Harvesting. For many years, Chennai faced serious water scarcity. An article in the India Express reports that, to reduce the burden on groundwater, the Chennai local government made it mandatory for all houses to rely on the ample rainfall of over 1 meter on average that Chennai would receive by using RWH systems. In return, each household received approximately 2,000 gallons of potable water each month.

RWH systems will be particularly fruitful during the monsoon and El Niño. During the ceaseless rainy season between December and March, the average rainfall can be anywhere between 8 to 31 inches. By collecting the vast quantity of free water during this time, it may be possible to prepare for the dry season as well. During the dry season between May and October, the average rainfall can be anywhere from none to 2 inches. During the dry seasons, RWH systems will be less reliable, but can still provide some support.

Phytoremediation is a long term solution that does not rely on weather patterns. Phytoremediation is a process where living green plants are used to remove contaminants from soils, sediments, surface water and groundwater. During this process, the roots of the plants absorb the contaminants from the soil. The United Nations Environment Programme reported that at a U.S. Army testing facility in Maryland, hybrid poplar trees have been planted to over shallow ground water reservoirs. The poplar tree acted like a hydraulic pump to prevent spreading the contaminants into the nearby marsh land. After two seasons of growing, the poplar trees had successfully contained the contaminated groundwater at astonishing rates. Each tree had held back 2-10 gallons of contaminated water on a daily basis.

This verifies the potential utility of phytoremediation in rural Bolivia. The characteristics of a tree that can be efficiently used in the phytoremediation process include fast growth, long and thick roots, and easy to grow. Fortunately, trees like the *Tipuana Tipu* tree and the poplar tree are some of the most common trees found near the Andes Mountains. These trees have robust and adaptive growth cycles, making it easy for them to pollinate and grow. By planting the trees near the river bank, they will be able to absorb the heavy metal contaminants such as lead, cadmium, chromium and zinc through its roots.

While the solution of phytoremediation will address the need for more clean water, it doesn't promote the sustainable use of water. The communities in Bolivia still face droughts and other water scarcity crises. Perhaps, the most viable solution for Bolivia's water scarcity problem is to use novel, yet cost effective, water conservation techniques. Water conservation and avoiding waste are important in making sure that rural Bolivians have enough water. Currently, many Bolivian farmers are using traditional techniques to irrigate their farms. These techniques are ineffective and use excessive water, like flooding fields. Comisión para la Gestión Integral del Agua (CGIAB), a national consortium that works with the public and private sector to secure water and agriculture, quantifies this by showing that Bolivian farmers have a 18 to 30 percent efficiency rating which is substantially lower than the United States' 83% efficiency. In order for the rural villages to improve their efficiency, they can use drip irrigation as a way to improve yield while using substantially less water.

Drip irrigation is a technology that has been used with great success and impact in many parts of the developing world. The technology involves small piping which delivers particular quantities of water to fields only when the crops need irrigation. This prevents the need to use excessive water and results in cleaner bodies of water, as there is virtually no fertilizer carrying runoff. In Turkey, for instance, potato farmers were able to get the same yield while using 50% less water. Similar success stories can be

observed in countries throughout Africa and South America. While this technology can be expensive, it will lead to higher impact on accessibility and use of water resulting in an improved quality of life for rural Bolivians. Because the village will be spending less on water and will be receiving better crop yield, it will lead to a high return on investment.

However, these solutions cannot be implemented in isolation. In order to create the Rainwater Harvesting System and start this Phytoremediation process, there needs to be proper funding and education. The drip irrigation technology will necessitate subsidies from the government. While Bolivia is rich in minerals and energy resources, it is still one of the poorest countries in South America. Wealthy urban elites have dominated the economic domain, whereas most of the Bolivian population is made up of low-income farmers, artisans, miners, and small traders. That is why the Bolivian government must increase taxes on large private mining companies in the Andes such as Comibol. By doing so, the mining companies would be redeeming themselves for polluting the river water, while the government will also receive additional funding to help the rural population of Bolivia.

Educating the rural population of Bolivia is one of the most essential steps in implementing such solutions. It is important to keep in mind that most of the rural villagers in Bolivia have been getting their water from the local rivers for decades. The implementations of these solutions will require lifestyle changes that some villagers might not agree with. That is why the rural population needs to be educated about the problems occurring in their environment and they need to learn about the necessity of the solution. The rural people of Bolivia need to know that these solutions will only bring benefits. Educating the rural population can be tough. However, if the Bolivian government collects enough tax money from the mining companies, they will be able to pay for teachers who can educate them throughout the process. Educating the young people of a rural community can be very rewarding. After a while, the villagers can start teaching amongst themselves, and collaborate with other villages to educate neighboring rural community that is oblivious about the negative effects happening in their ecosystem.

However, the international community has a profound role to play in the development of rural Bolivia. International response can be mediated by both non-governmental organizations (NGOs) but also by organizations that are part of the United Nations and the World Health Organization. As NGOs are starting to realize these problems in Bolivia and work to improve them, conditions in Bolivia improved. Organizations like Engineers Without Borders (EWB) have been travelling to Bolivia every year to help rural villages gain easy access to clean water. In addition, organizations like UNICEF have been providing education for the children who live in rural parts Bolivia and do not have access to teachers. This also leaves tremendous scope. Implementing the novel ideas of phytoremediation, rainwater harvesting systems and drip irrigation will help these rural villagers who have been struggling to find clean water, but will also involve expert organizations to educate and communicate the efficacy of the technologies.

Organizations such as Engineers Without Borders are successful because of how well they have integrated into the rural Bolivian villages. EWB, for example, has had a lot of success in their projects in Bolivia. Over the past years, they have successfully created a piping system that is not affected by erosion and weathering, and helps the villagers get water from the water catchment system at a much faster pace. They have been successful largely due to the partnership nature of their implementations. They work closely with community members and educate them on the solution rather than simply implementing and leaving the community. This partnership model also necessitate communities to be financially invested in the project cycle. This ensures their commitment and allows for high compliance and participation. The long-term partnerships result in all parties benefiting, yielding an overall improvement in the quality of life.

Organizations like the World Health Organization and the United Nations also have an important role to play. The United Nations declaration of human rights indicates that the right to clean water is paramount. If treated like a human rights issue, nations could promote change in the national and local government within Bolivia to change their policies and laws to address these concerns. The recognition of this right in Bolivia will bring direct attention, because failing to do so will be considered a violation of human rights.

When Soledad found out about the Engineers Without Borders group was coming to Yulo to help out her village, she started jumping with joy. When the EWB team arrived at Yulo, they worked with the villagers to plant the tipuana trees, and install the rainwater harvesting systems on the roofs of the huts. Eventually, the village of Yulo was finally able to collect clean water without the fear of getting sick. The village of Yulo is just a small example of the vast expanse of the mountainous and rural Bolivia. Hopefully, multiple levels of government and international organizations can assist and improving the quality of life all.

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