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Philippines: Implementing Proper Sewage System and Environmental Education to Resolve Water Crisis

Although the Philippines is an archipelago of over 7600 islands surrounded by the waters of the Western Pacific, clean water is under threat. The potable water available needs to support a rapidly growing population of over 109 million people on a land area approximately 300,000 square kilometers, an area smaller than the U.S. state of California. Large, growing cities, such as the capitol of Manilla and Quezon on the Island of Luzon concentrate millions of people.(Central Intelligence Agency). The Philippines consists of mostly mountainous geography with a tropical climate. As in other southeast Asian countries the climate of monsoon winds blows northeast from November to April, and southeast from May to October (GOVPH). The average farm size per household in the Philippines is 1.29 hectares, and the primary agricultural products of the Philippines are sugar cane, rice, coconuts, maize, bananas, and cassavas (Philippine Statistics Authority). The Philippines, along with a few other East Asian countries has been suffering from severe water pollution, caused by improper sewage networks. Although more than 95 percent of the Philippine population has access to improved drinking water, it is the polluted groundwater that has become potentially dangerous to the population. Due to improper sewage networks, more than 58% of the Philippines' groundwater has been polluted (Philippine Department of Environment and Natural Resources). Groundwater pollution could cause devastating impacts because when these polluted waters are under agricultural lands, the products produced will potentially inherit the pollutants and in turn harm the heath of local populations. It is essential for the Philippine government to cut the source of pollution before it develops into further harm, and a possible way to prevent water pollution is to create a system of sewage networks across the Philippines.

In the Philippines, a typical family could be constructed in two main ways, a nuclear family, or a family with three generations. In 2015, the average household population was 4.4 people (Philippine Statistics Authority). This could be seen as a gradual transition from larger family units into smaller nuclear families. Although family sizes have decreased over time, bonds between kinship groups are still very close. With the concept of Filial Piety deeply embedded in the Filipino culture, elderly members of a family are respected greatly by the other family members, and they are normally the ones in charge of important decisions that families encounter (Scroope).

The average Filipino eats three main meals and two snacks every day. Along with rice, a typical meal would be served with local vegetables and seafood. Rice is such a central source of carbohydrates in the Philipino diet that a meal without rice is considered a snack. The style of Filipino food is similar to other East Asian food styles except it possesses a unique, sour taste. There isn't any official dietary requirement because the population mainly consists of Christians (Hays).

According to the Philippine government's department of education, education is mandatory for 13 years, following a system known as the K to 12 basic education curriculum. This includes one year of kindergarten, six years of elementary school, three years of junior high school, and three years of senior high school. Higher education institutes such as universities and colleges are also present for those who seek further knowledge (Republic of Philippines Department of Education).

According to the "CIA Factbook", more than 95 percent (97.7 urban and 92.7 rural) of the Philippine population has access to an improved source of drinking water (Central Intelligence Agency). Although

from this data, it seems like that the Philippines' water sources are in great condition, the actual situation is quite the opposite. The data above only presents the availability of drinking water, and this is only a tiny part of the water consumption. The waters of the Philippines have been heavily polluted, and according to the Philippine Department of Environment and Natural Resources, 58 percent of the Philippine groundwater has been contaminated with bacteria (Philippine Department of Environment and Natural Resources). With water filters and purifiers, it is possible to purify tiny amounts of water that could satiate hydration; however, when meeting the demands of agriculture, it is almost impossible to purify such huge amounts of water. When contaminated water is used for agriculture, remnants of the contaminants would become stuck in the soil and potentially affect the crops planted in the soil. "People who consume fruit or vegetables that were exposed to contaminated water are at risk of developing a foodborne illness." According to the CDC, "Some of the bacteria that are spread through the water within the United States include E.coli, Salmonella spp., Shigella spp., Cryptosporidium, Giardia, Toxoplasma, norovirus, and hepatitis A virus." (CDC). Disease causing bacteria are also prevalent in water in the Philippines. Water pollution has definitely been a serious cause of diseases in the Philippines. Due to the lack of water sanitation, 31 percent of the monitored disease in the Philippines are caused by water-borne sources. (Water Environment Partnership in Asia)

The water crisis in the Philippines is caused by various factors; the most significant cause is the lack of proper sewage systems within local communities. Only 5 percent of the total Philippine population has proper sewage networks (Environmental Management Bureau). And according to the WHO, in 2015, more than 7 million Filipinos are still using local rivers for human waste disposal. In suburban regions, household wastes are flushed down into local rivers and lakes without treatement (World Health Organization). Similarly, in urban areas, while most Philippine cities have drainage systems (for storm waters), they do not actually have a separate sewer for wastewater. Thus, along with the normal rainwater, wastes and contaminants will flow directly into nearby rivers and lakes (Carol). Without proper processing, the wastewater will severely pollute the water bodies into which it is dumped. One example of pollution caused by improper sewage systems is the situation in the Pasig river beside Manila. Due to improper sewage networks, household wastes have been constantly dumped into the river and have become 65 percent of the total pollution in the river. Another 30 percent is appointed to industrial waste which could also be attributed to the poor sewers (Carl). According to the Environmental Management Bureau, out of the 127 freshwater bodies being sampled in the Philippines, 40% have fair water quality, while 13% showed poor water quality (Environmental Management Bureau).

In order to address this severe issue, the Philippine government has developed multiple strategies to counter water pollution. Among the most significant, was the Clean Water Act in 2004. The Clean Water Act aims to evaluate and preserve the water quality of major Philippine water bodies. It includes largescale testing of water quality within the Philippines. After locating major polluted rivers and lakes, local government agencies come up with specific plans for rehabilitation. The Clean Water Act also created multiple laws regarding waste disposal which regulate the discharge of materials into water bodies. Violation of the law can result in up to 12 years of imprisonment (Aquino et al.). This act has to an extent helped to improve the water quality of some lakes and rivers, and it also provides the Philippine population with larger amounts of clean drinking water. However, the Clean Water Act could not be considered as a solution to the water crisis. The primary factor that caused the water pollution is improper sewage systems, and this has not been addressed by the Clean Water Act. Although there are laws regulating disposal, without a proper system of disposal, applying the contents of the law is impossible. Also, though local governments such as the one in Manila organized programs to clean polluted rivers like the Pasig, the actions were not organized with high frequency. Instead of aiming to remove pollutants, these movements are likely organized to benefit the personal reputation of political leaders (Maletsky). Even if on some occasions, massive amounts of pollutants are cleaned from the river, it would not last long as more pollutants continue to flow into the water systems. Thus, despite the Clean Water Act leading to some improvements, it is not enough to resolve the water crisis entirely.

In 2005, following the Clean Water Act, the Philippine government initiated a plan known as the Manila Third Sewage project. This plan is funded by the World Bank and aimed to construct sewage systems in the eastern section of Metro Manila (Department of Environment and Natural Resources). Between the years 2005-2012, this plan has helped approximately 3.3 million people in east Manila by providing them with improved sewage and a waste disposal system (The World Bank). Although the Manila Third Sewage project has an impact on sanitation in east Manila, its relatively small scale has not resolved the water crisis in any significant way.

Building sewage systems could be a very challenging task for the Philippine government because it has a very high cost. As a developing country, the Philippine government has used most of its economic power on building cities. Without any government funds, it is very challenging to build large sewage systems. It is almost impossible to let the Philippine citizens pay for their own share because they are not educated about the importance of preserving water sources, and the benefits of proper sewage systems.
In order to solve this problem, there must be a sophisticated plan that addresses multiple sides of the crisis. First, the government must find sponsors or collect funds to support the plan. A possible way would be to reach out to the World Health Organization for human and economic resources. The World Health Organization has been collaborating with countries all over the world aiming to improve the public's health conditions (World Health Organization). As a member state of WHO in the Western Pacific region, it is likely that along with economic funding, the WHO will also assist the Philippines by providing officials that could help to strategize and monitor the project's implementation.

The Philippine government could also reach out to the World Bank for further funding. The Philippine government has been working with the World Bank on its rural development project and has received more than 500 million dollars of funding; however, less than 1 percent of the total funding was aimed to build drainage systems. According to the World Bank, the Philippines' economy has been recovering from the COVID-19 pandemic and could soon return to its normal growth as in previous years. With its relatively healthy economy and good credibility from the World Bank, receiving additional funding for the construction of sewage systems should be possible (World Bank).

Moving on to a possible selection for the sewage system, a very effective choice would be to create a sewer system known as the sludge-to-waste system. Sludge-to-waste processing plants are waste processing plants that convert waste into energy and materials that could be used for plant cultivation and landfill (Schwandorf). As waste enters a plant, it experiences a stage of thermal hydrolysis. During this stage, the waste first becomes sterilized and then treated with high temperature and pressure (160-180C and 6bars) which prepares the sludge for anerobic digestion. After approximately 20-30 minutes of thermal hydrolysis, the processed materials enter the stage of anerobic digestion where biogases such as methane are extracted and parts of it is used to power the plant's facilities. After anaerobic digestion, the remaining materials will become dewatered, and Biochar (charcoal resulted from previous stages) will be collected to enrich soil fertility in needed landscapes. Finally, the remnants of all the previous stages are filtered for recyclable materials (metal) and then transferred to landfills (Fu, Schleifer and Zhong).

The sludge-to-energy technology has been present in multiple counties over the world including Germany, China, and Japan, and the method of waste processing has been proved to be one of the most energy-efficient and environmentally friendly ways to reduce waste (Zhang and Themelis) (Park). One of the most successful applications occurred in the Chinese city of Xiangyang, where the annual sludge production is beyond 80,000 metric tons in 2011. The construction project, known as the Xiangyang plan was completed in September of 2012, and its operation has brought significant benefits to the city. Because gasses emitted from the sludges are collected, the emission of greenhouse gasses have decreased greatly. Also, with the biogas harnessed, the energy generated was not only enough to power the sludge-to-energy plants, but also local taxis. According to a report conducted by the World Resource Institute,

the total annual operation cost of the sludge-to-energy plants is approximately 4.7 million USD (30.5 CNY) while the annual revenue brought by it was beyond 4.8 million USD (31.4 CNY). Using the social cost of Carbon, the environmental benefit of the Xiangynag project was estimated, and compared to its original investment. The total investment for the Xiangyang project was 20.7 million USD while its contributions in the reduction of carbon emission accounts for a climate benefit of 6.9 to 43 million USD; running local taxis with energy harnessed from the plants has created a benefit of over 34 million USD; the tree saplings grown in soils enriched by the Biochar have sequestered carbon and generated a benefit between 42 and 260 million USD (Fu et al.). With reference to the environmental benefits and the cost effectiveness of the Xiangyang project, it could be seen that the sludge-to-energy system is exceptionally effective and would be an ideal selection for the Philippines.

Even with funding more local efforts are necessary. It is important for local governments to implement a cycle of evaluation of the facilities and results brought by it. Local governments could organize a local department that monitors the water quality of nearby water bodies and evaluate the impact of the new sewage system. After identifying its impact, the department could create plans of adjustments to make the sewers more effective. The department could also organize annual renovation campaigns for the nearby sludge-to-energy plants and the sewers that lead to them.This will ensure that the nearby sewage systems will remain safe and fully functional. This will also open up temporary job openings because although it requires professional knowledge to evaluate the quality of the sewage system, it does not have any prerequisite for the process of renovation.

Finally, besides all of the actions that ensure the functionality of the new sewage system, it is essential to educate and provide information regarding the importance of preserving water sources in the educational system. This ensures the next generation will not only become aware of the importance of water quality of local water bodies but also capable of acting in an environmentally friendly manner throughout their lives. It is especially important to start this education early in the life of students because it will bring them the most impact. In the first six years of the education system, schools should organize seasonal field trips (using government funds) for the students to move into nature and understand its beauty. During the field trips, there should also be workshops involving environmental scientists who will teach the students information about the impact of polluted water and the sources of pollutants. In the later years of the education system, environmental science (or its information) should be included in the course catalogs of the junior and senior high school. Along with teaching the information, schools could organize competitions designing the most effective sewage system for which students could advance into sectionals, regionals, and eventually compete at a national level. Participation in such competitions will ensure that students have made a significant amount of effort coming up with solutions for the water crisis and give them the habit of constantly thinking about ways to prevent water pollution.

Water pollution due to improper sewage systems has been one of the most severe yet underestimated issues within the Philippines. With the continuation of pollution due to the lack of functional sewage systems, more and more water bodies would become polluted resulting in the worsening of the water crisis. With the implementation of a sewage system leading to sludge-to-energy plants, members of the Philippine population would receive the opportunity to dispose of waste in an environmentally friendly and energy-efficient manner. Most importantly, the improvement of water sanitation would decrease cases of water-borne diseases that directly affect human health and retention of nutrition. When wastewater is processed properly, harmful bacteria and virus such as Cryptosporidium and hepatitis A will be removed. Fewer contaminants and harmful chemicals that could leach into crops irrigated by local water sources can also improve agricultural production and have positive effects on long term human health. With safe sources of nutrition and water intake, people will not be consuming toxic chemicals. Thus, with the successful implementation of the sludge-to-energy system, millions of lives will be saved, and the public health of Philippine's population will improve significantly. Besides the improvement in quality of life, the education of students will also benefit the environment in a long-term perspective

because as the upcoming generation dominates the world, more and more individuals will devote their efforts into making their country cleaner and safer.

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