

Hyunsoo Lee Pella  
Community High School  
Pella, Iowa Vietnam, Water  
Shortage

Vietnam: the thirteenth most populated country in the world with two-thirds of its population residing at its riverbanks. A countrywide challenge is being met by the residents, and that is water scarcity. Ironically enough, Vietnam has an astounding 3,000 plus miles of coastline, yet the country faces this particular issue. Water scarcity affects roughly 700 million people in 43 different countries. Although Vietnam has dozens of rivers that surpass at least 6 miles, the sustainability of Vietnam's water usage and supply has been challenged for the past century. Only 39% of the rural population is said to have safe, drinkable water and sanitation. Adding to that, pressures from population growth, economic growth, and increasing water demand have put water resources at risk. This will inevitably lead to economic downfalls, with yearly economic losses projected to be some of the highest by 2100.

Access to clean, safe water is something that is available to the majority of the world. In 2017, 71% of the world had access to a clean drinkable water service, accessible when needed, and free from contamination. Of course, this means that the other approximately 29% of the global population most likely do not even have access to drinking water at all, and need to travel to the nearest groundwater well. This is an unfortunate reality for much of the population, where access to water is seen as a privilege, not a right. Population increase, failure to manage resources, drought, and uneven distribution of rainfall (like in Vietnam) are factors that affect a country's ability to obtain a reliable source of water.

According to Britannica, there are two broad types of water scarcity: physical and economic. Physical water scarcity refers to countries where groundwater and surface water are not sufficient enough to supply the country's demands and needs. Simply put, it is when the demand for water surpasses the amount of available water to a country. Although mostly associated with arid and dry regions (as expected), some recent trends have shown that an ever increasing number of these issues are man made. An example would be the Colorado River Basin located in the United States. Because of severe overuse and over management through damming and diverting, the flow of the Colorado River has decreased and resulted in serious water scarcity downstream.

Economic water scarcity is caused by lack of investment in water and mismanagement of optimal supplies. Usually this is an issue started by poor governance which lets this issue persist. Failure to utilize a water source is the main issue, and this is true to many countries that have

inadequate water sources. This type also encompasses uneven distribution of resources, including water. Economic water scarcity is actually more common in most countries. However, due to its unpredictable, random rainfall in certain areas, and droughts from time to time, Vietnam is affected by both physical and economic water scarcity. However, the management and distribution of (primarily drinkable) water is very inefficient, forming a more prominent issue of economic water scarcity. An isoline map given by the Vietnam Water Resources Atlas clearly shows uneven distribution of rainfall in different regions. Cities were also labelled along with a graph that showed monthly rainfall in those cities, and those also proved to be different in terms of rainfall patterns. For instance, the coastal city of Nha Trang has an annual rainfall of 800 to 1400 millimeters. Lau Chau, on the other hand, has an approximate 2000 to 2800 millimeters of yearly rainfall. While these statistics show differences in rainfall between cities, the monthly rainfall graphs prove uneven distribution across the country. Nha Trang has around three-fourths of its rainfall in the last four months of the year, whereas Lau Chau's annual rainfall forms a pyramid shape, where the middle months have the most rainfall. It is not something one can call regional difference because the distribution is very erratic.

Continuing on, drought has affected Vietnam in the past, but the drought that hit Vietnam in 2016 was the worst since the 20th century. According to an article by the European Commission, 18 provinces declared a state of emergency and the drought mostly impacted one of the most poor regions, the Central Highlands of Vietnam. Since 2016, however, the drought has persisted along with a build-up of salinity. Salinity is not something to be looked over. Osmosis is the process of soil water moving into plant roots and this is controlled by the levels of salts in water. When water has high levels of salinity, water may flow back out from the plant roots. This leads to dehydration and thus inadequate development for the plant. Salinity also interferes with nitrogen uptake, stopping the reproduction of plants and reducing growth. Thus, the quality of the water for irrigation and drinking is affected and leads to serious economic, social, and physical consequences. For example, the province of Tien Giang has been severely affected by drought and higher levels of salinity. Five provinces of Vietnam's rice bowl (including Tien Giang) have been in a state of emergency. Nguyen Thien Phap, head of the water resources department in Tien Giang said, "This year's drought and salinity have been way more devastating than what we saw four years ago [around the time when the drought struck] (Drought drives)." The fruit trees which take up roughly 80,000 hectares are at risk and the rice fields which take up about 24,000 hectares are projected to produce below-average yields. Salinity of 4 grams per liter is spreading through the Delta, with another server salinity problem looming in the near future. Connecting on with the uneven distribution of rain, the affected areas are already using lots of water on river tributaries (a river/stream that flows into a larger river/stream) and increasing water storage on dams, so the effects of the drought will persistently continue and salinity issues will last longer and become more and more severe. Vietnam's government estimates that 362,000 hectares of rice and 136,000 hectares of fruit trees will be

affected in the Mekong Delta alone. This is an issue because Vietnam is a key rice-grower (following India and Thailand plus some other countries), and losses are estimated to be greater than those of 2016 (384 million dollars).

Trends of the past and predicted trends show that uncontrolled overexploitation of the water in Vietnam is another factor of this severe water shortage. An analysis shows that more than 75% of the water in most of the southeastern river valleys is being exploited. Exploitation, or overexploitation in the case of Vietnam, can be defined as using the available source of water at a rate faster than they can get water back. Keep in mind that Vietnam's many provinces have different shortage levels, so the amount of water gained in many of these areas cannot keep up with how much is being used. For instance, exploitation rates are at an even higher rate of 80% in the Ma River Basin. Up to now, Vietnam has annually been using around 80.6 billion cubic meters of water for various purposes, but just in 2020, usage is projected to rise forty-eight percent, which puts usage levels at approximately 120 billion cubic meters. Vietnam's primary water source consists of the Red River and the Mekong River (Water resources), but as one can see in the next upcoming paragraph, rivers can potentially be put down as a water source. It is a pinch because water shortage affects Vietnam as the country is estimated to use more and more water even though pollution can be seen in much of Vietnam's rivers.

Failure to manage pollution of Vietnam's rivers is the leading factor of why economic scarcity highly affects the country of Vietnam. In the northern region of Hanoi, the drinking water is polluted by arsenic, which can lead to serious health issues such as cancer, neurological problems, and skin problems. The Water Project states that some 7 million people in the region have a high risk of getting poisoned, and the chances of these hazardous problems makes this a serious issue. Researchers have found and reported that in an approximately 500 square mile area in Hanoi, arsenic levels averaged triple of Vietnam's standard of health (which is 50 microgram per liter). The levels peaked up to 3000 microgram per liter, which is sixty times the standard, which is something to be very concerned about. This is also a real obstacle because much of the rural population, unaware of the toxic levels of arsenic in their drinking wells, which means millions are already at risk of poisoning. The United States of America, a developed country, does not exceed the 50 microgram per liter standard for more than ninety-nine percent of its groundwater. On the other hand, Vietnam, a developing country, has peaks up to 3000 micrograms per liter just in one area and "... in one particularly affected rural area, the average arsenic level was 430 micrograms per liter (Graham, Sarah)."

Adding onto Hanoi (although this relates to the rest of Vietnam), this region alone has six polluted rivers running through it. Dao Trong Tu, vice-chairman of Vietnam Irrigation and Drainage Association and head of Vietnam Rivers Network, said that along with the six polluted rivers, wastewater from common households, industrial zones, and trade villages are being

untreated by the government. He said, “Vietnamese people usually used groundwater for drinking, but now, the groundwater resources are polluted and exhausted because of improper management (Water Shortage).” This is a dilemma because the untreated wastewater is flooding into rivers, impacting citizens’ health. Economic water scarcity is evident, and this is indirectly stated by Dao. “... the enforcement [to maintain sustainable water levels] is not as good as it should be (Water Shortage).” This prevailing crisis needs to be addressed quickly in the best manner.

But here is a question: what are the exact impacts and consequences of these problems? First of all, as it has been in the past, the population is most likely going to be impacted with health issues due to the polluted water. Many citizens have contracted illnesses like typhoid, cholera, dysentery, and malaria. This matters because the prevalent contaminated water is a hurdle for the upcoming generations. UNICEF reported that more than nine million Vietnamese still excrete and urinate in their surroundings, adding more pollution to the water supply with the unmanaged wastewater. This does not develop childrens’ immune systems so they cannot cope with the damage sustained from this unsanitary practice.

Secondly, this is an issue because Vietnam is going to suffer economically as a result of the water scarcity/pollution. All of the results of this water crisis listed above and more have been taken into account. This matters, because as of right now, Weforum (an information website) estimates losses that are supposed to be a continuous 1.5 percent annually, but by 2050 the losses are projected to be 3 percent per year. By 2100, if things continue, losses are going to be up to 7 percent annually, which is possibly one of the highest losses in its time. If there are no policy or law changes regarding the management of the water as it is, all but five of the river basins in all of Vietnam will face water shortages by 2030. This especially matters because the four main river basins that make up eighty percent of Vietnam’s gross domestic product are projected to face water shortages. Vietnam is also one of the higher producers of rice, just falling out of the top 5, and that is huge because rice is arguably the most important crop of them all. Although it is the third most grown crop in the world, it has the highest gross production value at 225 billion dollars.

All of these things could potentially see improvement, but to date there has been no consistent, reliably working method that the government, companies in Vietnam, or public services in Vietnam have used in order to overcome this hurdle. So how can this country get out of such a predicament?

To answer this question, there are other countries that have faced similar issues and although not quite the same, they have combated their water scarcity problems in their own working methods.

Some states and cities that have secured a steady source of water include Singapore, and Israel. These countries have found solutions to various water issues that Vietnam can use for their salinity, wastewater, and more. For example, Singapore has been able to keep and utilize a sustainable supply of water for 40 years. They have “harnessed recycled water and desalinated seawater in addition to local catchments and imported water (Drought solutions).” This means that they are able to maintain a supply with these types of waters, which would be huge for Vietnam, as it faces mismanagement of wastewater and salinated rivers. Of course, while Singapore desalinates ocean water, Vietnam would have to desalinate its oceans and/or rivers, because as mentioned above, there were traceable salinity levels in the rivers. Now, the desalination of the oceans/rivers could be for public demand (drinking water) and Vietnam could potentially desalinate oceans for agriculture, as it has over 3,000 miles of coastline. This would make sense because according to Britannica, most of Vietnam’s agriculture happens in the Mekong and Red River Deltas. The city-state of Singapore has been able to keep going with its supply even though climate change has periodically increased the number of droughts. Recycled/desalinated water is so popular in Singapore that 65 percent of water demand is fulfilled by these two types of water. Many countries and companies “have taken the know-how gained from building recycling and desalination plants in Singapore to implement sustainable water solutions on a global scale (Drought solutions).” Vietnam should look into this method for desalination (particularly in this city-state), as Singapore potentially did it the best, housing some of the biggest companies in desalination such as Hyflux, Sembcorp, Veolia, and Nitto Denko.

Israel has practiced the same methods and more. The Middle Eastern state has utilized desalination (to a lesser extent than Singapore) and focused a lot on recycling sewage and making it usable again. More than half of the water used in agriculture comes from treated sewage. One big thing that Israel took advantage of was setting quotas for citizens and farmers. Quotas were set by the Israel Water Authority and anyone who went over the quota were simply given a higher tax rate. It is a very simple method but usable. Many organizations and schools in Israel also are raising awareness of the importance of conservation and practical techniques.

I am proposing that Vietnam needs to implement a combination of laws/regulations and the construction of systems to sustain this particular resource. To begin, it is imperative that Vietnam sets the groundwork for a sustainable source of water, and that can be done by adding laws and regulations in terms of wastewater management. Rapid industrialization and urbanization led to 200 plus industrial zones without sustainable wastewater treatment. By setting laws to limit industries and the common folk from just dumping their wastewater, the already polluted rivers of Vietnam can be treated through recycling the water. Also setting laws to ban unhygienic practices can further improve water quality so that river water may one day be usable. Quotas are something I cannot agree with because Vietnam has its dry seasons at (sometimes) unpredictable

times of plain drought. Promising a fixed amount of water might not be easy with this challenge. But, I believe taxes can be enforced at this time. With these laws, I suggest that higher taxation should be used as a penalty, which leads to my next part of the solution: constructing desalination and wastewater management plants. There needs to be adequate funding. By taxing the people as a penalty for breaking the laws and putting in money from the government itself, Vietnam can construct multiple plants in the locations that need help the most.

Of course, the need for this infrastructure is something that needs to be done as soon as possible, and there are possible methods that could be viable and make instant funding a reality. Ways I believe could work to make this happen consist of: loans, grants, and crowdfunding. A loan can be defined as a sum of money given by an organization that needs to be repaid at some point. A loan from the World Bank could be the best possible option in terms of loans. The World Bank is an organization that leads in funding countries that need money for development of infrastructure. It is a group that promotes sustainable development for many countries. Vietnam's case fits this and so a loan from the World Bank can happen. Vietnam's economy will improve if they fix a persisting issue and so with an improved economy, Vietnam will be able to pay off the loan in the long run. The next method is the use of grants. Although I believe that this is the least likely method out of the three, it could happen. A grant, which is money given by the government or an organization does not need to be repaid, unlike a loan. The reason this feels the most unrealistic is because of Vietnam's past. Focus on Vietnam's government will come later, but in the past, Vietnam has struggled with corruption, mainly monetary form of corruption. They still are not classified as an uncorrupt country, so that is why I feel like this is not the easiest method. However, the government could come to realize the need and pull through for the sustainable development of their country. The last viable solution is crowdfunding. Crowdfunding is simply usage of the Internet to find potential funding sources. A large number of small individual investments into projects, charities, campaigns online can speed up the installation of the desalination plants. In an age where the world is turning more towards technology, this is bound to work efficiently as it can be easily seen by many. The donors would be normal citizens that feel compelled to help their own country get out of such an issue. Further explanation of the problem could even drive the people to donate more or frequently. I believe that such small donations will not be able to stack up to the amount necessary for these types of developments, so I can advise to combine the methods and use more than one of these ideas to make the process of raising money faster. The three methods chosen are what I believe could make the process of installing an infrastructure more quickly.

The cost of a desalination plant may vary depending on location. As of now, Vietnam can utilize both brackish water desalination plants and seawater desalination plants. Brackish water plants work in locations where the salinity is not quite seawater, but not fresh either. In 2007, the state

of Texas spent \$87 million to build a brackish water plant. The capacity of this plant was 27.5 million gallons per day (MGD). Texas also projected that it would take \$32 million to construct a 2.5 MGD seawater desalination plant. While Vietnam can always change the amount of water to desalinate, it needs to take into consideration that seawater desalination plants are more expensive than brackish water plants. Vietnam's economy is already projected to decline, so if they spend some money now they can potentially solve the issue and lessen the decline or even turn it into growth instead of decay. Finally, awareness needs to be brought to the citizens and other companies. The peoples' lack of knowledge led to the mismanagement of wastewater in households and factories, so just like Israel, spreading awareness of the issue and instructing all age groups on how to conserve water can help Vietnam in the future.

However, one final issue to address is the state of Vietnam's government. There are barriers that the government of Vietnam must overcome in order to work towards improving the nation and that consists of: management of past corruption and possible resistance from the citizens of Vietnam. In terms of past corruption, research shows that in 2011, about 44% percent of Vietnam's population were involved in some sort of monetary bribe (Corruption). According to the website, due to teachers' lower salaries, monetary bribery was also found in higher education sectors. It became common for these things to happen in order to get into educational institutions and pass examinations. There was also bribing in forms of expensive items, such as electronics or fashion apparel/accessories. The site also continued by saying, "corruption hampers economic growth, though they have noted in the same study that corruption is positively correlated to human capital, which is also positively correlated to economic growth...corruption brings about negative effects to the country's economy and is detrimental to the nation's education sector (Corruption)." While this might not include government officials of Vietnam, the fact that the government cannot police its own country leads one to believe that they cannot manage their economy to its potential. Furthermore, according to the Transparency International, Vietnam's 2019 corruption score was at 37/100 (Vietnam). These statistics show improvement as in 2011, the score was 31/100. In the near future, if Vietnam's government can overcome and rein in the population so that corruption rates will drop, the economy will surely improve and funding for the installations for the infrastructure can be done quicker. The other part is that the people, which many take part in these bribes, need to agree with this. Possible reformations can lead to resistance from the population because they do not want to lose out on advantages gained from these bribes. So when the two barriers that oppose the government are overcome, there will be many advantages for the country morally and economically.

Overall, the issues regarding Vietnam's water scarcity crisis are that the economy is negatively affected, residents are unaware of the predicament they are in, and they are exposed to

poisonous and polluted water. Due to physical and economic water scarcity, this city-state has been unable to acquire a reliable water source. This is something that must be fixed right away, as water is a necessity in everyday life, whether it is for agriculture, drinking, or more. The way to fight back against this is by raising money to build desalination and wastewater plants, adding laws to further prevent damage to current water sources, and spread awareness. To top this, the government must be able to efficiently push the citizens away from the practice of bribing and corruption. Achieving this will be able to maximize Vietnam's economy towards higher success. Otherwise, the government can get a loan, a less possible but still viable grant, and/or gain funds through crowdfunding so that they can install the infrastructure for desalination plants as soon as possible. The method above and the correcting of the country will pay off in the future and will make a considerable improvement towards Vietnam's people and economy.

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