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The Negative Impact of Human Activities on Water Quality in Beijing, China: Population Growth, Urbanization and Development

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17 December 2020

Abstract

A. Current Problem: China is struggling with water pollution and scarcity issues due to rapid population growth, urbanization and development.

B. Population/Area of Focus: Beijing, China.

C. Key Terms: water, population, development

Water is an important component for survival. Many areas of this planet don't have clean water or enough water to drink. The capital city Beijing, which is located in the northern part of China, is known for its water scarcity issues. Chinese society has been steadily afflicted by the same hardship: too much water in southern China and never enough water in northern China. Beijing has become heavily populated. "During the period 1990 to 2018, Beijing's population grew from 10.86 million to over 21.54 million" (Yu et al. 3). The overwhelming rapidity of its urbanization and development process has put more strain on the area's already limited water. The farmland in the suburbs of Beijing has been replaced with urban development due to its growing population. The result of that is devastating to the environment. The water bodies in and around Beijing are depleting due to the growing population and rising demands on the water. The contaminants from urbanization, such as the increased amount of sewage combined with the agricultural and industrial waste is polluting China's water resources.

Carr and Neary's 2008 study found that one of the main actions that leads to extensive water-quality complications is the discarding of human waste. China, India and Iran do not treat human waste before its disposal. The contaminated feces end up as raw sewage in the waterways. The amount of pollution that this action causes is tremendously harmful to the environment and to the water especially (qtd. in Palanappian et al. 52). According to Meena Palanappian et al., the

incomplete or ineffective treatment of human waste occurs even in advanced countries as one of the main causes of water pollution (52).

As a result of this situation, the tap water is not clean, and water is being constantly reused and re-contaminated. All of this heavily polluted surface water ends up leaking into the groundwater. The groundwater resources are being drained. The quality of the groundwater is declining, due to toxins, sewage, agricultural and industrial waste. China in general, and Beijing in particular, are facing huge difficulties that are escalating fast.

Introduction

There is a limited amount of water on the planet, and a growing population which uses water resources faster than they can recover. Zeng's 2012 study found, that an estimated 2.6 billion humans on this planet do not have unrestricted 24/7 access to water (qtd. in Zhang S. et al. 1). Population growth impacts water directly by people consuming the water and polluting it while new housing is developed and toxic household chemicals end up in the water. The runoff-water is a big problem, as it collects the toxic oils and chemicals from the surface, and carries them to the nearest watershed, leaking into groundwater. Clean drinking water is becoming a rarity, and will be even more so if people aren't environmentally conscious about how they treat their water resources. Among many other countries in the world, China is experiencing several environmental issues. In particular, Beijing, a mega city in China, is going through a rapid urbanization process, and is deficient of clean groundwater. The urbanization and development due to population growth in Beijing is harmful to the water resources. Beijing, which I will concentrate on, is surrounded by farmland. All of the irrigation water from agriculture ends up in rivers, and groundwater is getting more contaminated. The population growth and rapid urbanization and development of Beijing has claimed a lot of farmland, which has been replaced by residential land (Ma et al. 329). The suburbs of the city are segmented with housing and farmland. Rapid population growth, urbanization and development, are causing Beijing's water scarcity and pollution of its surface and groundwater. The reused water, due to water scarcity and a declining amount of precipitation, increasing temperature, population growth, urbanization and development, is polluting the groundwater of Beijing.

Background

China is struggling with water pollution and scarcity issues due to rapid population growth, urbanization and development**.** The farmland in suburbs of Beijing has been replaced with urban development due to the growing population, and the result is devastating for the environment. The water bodies in and around Beijing are depleting due to the growing population and rising demands on the water. In fact, China, with its largest resident count in the world, has undergone extremely fast development and urbanization growth lately (Ma et al. 327). According to Yanxin Wang et al., the misuse of groundwater has assisted a secure surge in grain manufacture. All of this information indicates that China's financial expansion and the public's means of support depend significantly on groundwater. Approximately over the span of the past 30 years, the groundwater resources have been taken advantage of and have declined, due to financial growth and the increasing population's needs (1303).

The Ministry and Environment Protection 2011 study found that 33% of northern China's groundwater has been used for agricultural purposes (qtd. in Wang, Y. et al. 1303). The amount of water used for irrigation, is larger than other countries in the world. China's growth has been rising due to the overexploitation of groundwater resources (Wang, Y. et al. 1003).

Liu Hanqing et al. write that population expands and grows around the world. Due to the needs of modern society's growing standards, water consumption has increased tremendously over the recent decades. That creates a problem of water sufficiency (1).

Haijao Yu et al. explain that the inadequate water assets are also creating socioeconomic issues among the inhabitants. Outstanding irregular longitudinal and sequential supplies of water funds, as well as the fast financial growth and development that has occurred over the past three decades, Beijing, the capital of China, is experiencing severe water shortage (3).

This rapid urbanization is causing a reduction in water bodies, environmental pollution, and bio-habitat loss. Construction and development are paving the land, which was farmland before. Therefore, the pavement does not absorb water, and it's causing floods and pollution from run-offs into the groundwater. Men Baohui and Liu Huenanlong state that surface water is a significant foundation of water and its cleanliness is imperative. Applicable displays consist of the all-inclusive guide of water contamination, the degree of pollution control, the water cleanliness acquiescence rate, and the water purpose zones of water quality criteria (3).

Further, Meena Palanappian et al. write that it is common for surface water to be more polluted than groundwater. Groundwater is located deeper inside of the earth and therefore is somewhat protected from pollution. However, the contaminated surface water does not get removed or detected, and ends up in the groundwater over the years. The result is groundwater contamination (55). UNEP's 1996 study found that the process of purification of the groundwater is costly and problematic, most of all, to proceed and to succeed (qtd. in Palanappian 55).

Beijing's increasing population and urban development has decreased the waterbodies around the area. It has also polluted the surface water with different household and industrial chemicals. The groundwater usage has been excessive and the groundwater condition is alarmingly polluted.

Urbanization and development due to population growth is harmful to water resources and causes water pollution. According to Mia Ma et al. the grasslands in Beijing have been used for urban construction. Approximately three quarters of the pastures around Beijing have been used to house the rising population. The grassland has not decreased as much as the amount of

waterbodies around the area that have suffered a great loss (328). Rapid population growth needed land to accommodate the increasing inhabitants.

Kaize Zhang et al. researched Beijing's increasing population in 2008-2017. Zang and his colleagues found that Beijing struggled to cope with such a rapid resident count. The growing population had inadequate arrangements for its needs and consumed great amounts of water. People needed to earn a living. The industrial process developed and the pressure on water usage grew due to population growth and its needs. People also need to eat. The farming community therefore accelerated and irrigation was increased to accommodate the growing population. The three factors of population growth, developmental process and unindustrialized industry drained the water resources with alarming promptness (13).

Air quality, which is affected due to rapid population growth, impacts water quality. The effects of population growth and industrialization of Beijing have left a constant haze in the atmosphere. The climate in Beijing can be quite humid and windy and distribute the harmful haze everywhere. The air quality is compromised due to haze. Especially after it rains, the haze will end up on the surface of Beijing.

Sun et al.'s 2014 study found that the upsurge in overflow of surface water and its leakage into the depreciated municipal shallow waters, due to the radiative consequence of mist, will increase the contamination of the groundwater (qtd. in Kokkonen et al. 7010).

The migrant workers and growing population are liable for major population growth and housing development in suburb areas of Beijing. The high stresses on accommodation and lack of sanitation are causing the water pollution problems in Beijing's peri-urban areas. According to the World Bank's 2017 study, Beijing's population was 14 million in early 2000 (qtd. in

Neighbour and Qi 358). Yu Cheng et al. explain that Beijing's population has reached and overgrown the 20 million mark. The increase of inhabitants continues, and the scarce water resources keep declining and contaminating (5246).

Beijing's water is experiencing damaging pollution problems. The population growth, migration to Beijing and heavy urbanization is putting high demands on affordable housing developments. Pengjun Zhao states the peri-urbanization and flow of immigrants started different developments in Beijing, regarding the newly added population and their employment. After 2000, the rapid peri-urbanization and employment frequency elevated excessively. Beijing's worker count increased respectively by 3.7 million from 6.1 million to 9.8 million, from 2000 to 2008 (287).

The urban villages that are developing so rapidly are causing environmental problems and water pollution. The deficiency of sanitation and out-houses are an extra strain to polluted ground water. Yu Cheng et al. write that in addition to the toxic waste, groundwater is also causing complications due to the excessive utilization. Particularly in evolving nations like China, the prompt emergent financial prudence necessitates enormous quantity of water assets (5246).

This idea is expanded further in Wu's 2002 study and in Zhen et al.'s 2009 study. These studies found that most of the countryside's travelers tend to reside in communities in peri-urban areas, which are also called inner-city townships (cheng zhong cun), as their backgrounds are still subjugated by community accommodation, inadequate metropolitan amenities and a deficient quality of life (qtd. in Zhang 270). The peri-urbanized communities are low cost housing for migrant workers that have low income earnings. The lacking sewage system is contaminating the already bad water resources significantly.

The limited amount of water is becoming an enormous obstacle. Precipitation and the lack of it does not help to refill the water reservoirs. Lin and Yu's 2005 study found that as commercial expansion and inhabitants count progresses, municipal property is increasing and the temperature landmass consequence is becoming more noticeable (qtd. in Pengpeng et al. 600). The precipitation has decreased. Beijing is lacking water.

Danielle Neighbour and Ye Qi state that as the weather continues to transform, Beijing's water shortage will only intensify in the aspect of water famine (362). Yu Cheng et al. affirm that there were waterways flowing from the northwest to the southeast before, however, during the past period of years, almost all watercourses have converted to transitory due to extreme misuse (5246). Haijao Yu et al. state that Beijing's climate was quite humid and prone to monsoons in the past. However, in recent decades, the precipitation has decreased significantly (3).

Beijing is facing the tragedy of exhausting its groundwater resources due to its need for water. The problem is that the water will not be replaced due to lack of precipitation. Jia Pengpeng et al. declare that the lack of precipitation and added farmland overexploitation of water, diminish the already low groundwater resources (602).

Since Beijing is located in the dry northern part of China, its water scarcity has added stress from lack of rain. According to Liu Hanqing et al., ever since 1999, Beijing underwent several rainfall famines unremittingly. Therefore there is not enough surface water to fill the underground natural groundwater reservoirs. Due to groundwater being constantly used and not compensated owing to the drought, which has significantly endangered the safe keeping of the water resource in Beijing (3). The amount of surface water resources has declined sharply, and the groundwater level has declined substantially.

Jia Pengpeng et al. suggest that it would be advisable to bring in outside water resources. The population growth and development have used enormous amounts of water resources in Beijing. The groundwater levels are alarmingly low due to heavy utilization of this precious water resource (599).

Due to water scarcity, Beijing's water has been reused for household and agricultural purposes. Xio et al. 2017 and Chen et al.'s 2013 study found that the recycling of the water may seem like a good solution. Unfortunately, it harms the environment. Reprocessing water for agricultural purposes contaminates the soil with chemicals. The toxic waste is unindustrialized, but harmful for plants and soil. The whole process of reutilizing the water affects groundwater condition and quality (qtd. in Gu et al. "Hydro" 2).

Xiao et al.'s 2017 study found that a study done in the outskirts of Beijing resulted in an alarming discovery. A large pasture area was a subject of the study. Over the period of more than three decades, municipal manure was used for agricultural irrigation purposes. People use the dirty reclaimed water for irrigation, and that irrigated water ends up in the groundwater. The reuse of the water started in 1969 and it was an attempt to come up with a solution for the water scarcity problem. (qtd. in Gu et al. "Hydro" 3). Wu et al. 2014 and Wang et al.'s 2015 study stated that ever since 2003, retrieved water from Gaobeidian, Xiaohongmen, and Huangcun wastewater handling plants has progressively substituted wastewater and became the major water supply for irrigation in the study area (qtd. in Gu et al. "Hydro" 3). The reuse of the water is leaking into and contaminating the groundwater reservoirs of Beijing.

The city of Beijing is divided into areas: urban (construction land), agricultural (where most of the irrigation is done with the reclaimed water), and grass and cultivated lands. Different

areas pollute the water resources differently, but sadly most of the pollution ends up in the ground water of Beijing.

Xiaomin Gu et al. write about a study that determines what type of land pollutes groundwater and to what extent the impact on groundwater is traceable to the different land usages. The outcome of the study confirmed and indicated the human-caused pollution from chemical compost in the facility farming land and manure release in the manufacturing and domestic areas, which affect shallow groundwater quality in Beijing. High levels of sodium, calcium, and sulfate in the groundwater came from grass-, cultivated-, and pasture land. High levels of potassium, chlorine, and nitrate were increased in the groundwater from cultivated-, grass-, construction-, and pasture land ("Natural" 8, 9).

According to Xiaomin Gu et al., the study area was the largest study area in Beijing. The area was chosen due to water scarcity issues and due to the solution of utilizing reprocessed water for agricultural irrigation purposes. ("Natural" 2).

Household chemicals and the toxins that end up in water cause the surface water to be polluted. Runoff water with all the toxins, chemicals, and agricultural and human feces is polluting the groundwater. Clean drinking water scarcity is causing a problem for the general public, who cannot drink tap water. Meena Palanappian et al. write that frequent features of the constructed environs distress water magnitude and water quality. For instance, invulnerable exteriors decrease the amount of water that gains access to the groundwater. Due to the surface that does not absorb water, such as pavement instead of grass, more chemical toxins end up in the groundwater (60).

Due to the population growth and development, a lot of farmland, that is also grassland, was used for developmental purposes and pavement covers the large areas, where the grass used

to grow. The surface of Beijing has changed tremendously and the groundwater quality is suffering as a result of that.

Groundwater pollution in Beijing is becoming evident and is creating impediments for the general public and future generations of Beijing. The amount of groundwater in Beijing is limited, and the population uses it faster than they are able to replenish it. The cleanliness of groundwater is becoming a problem, since people use the reclaimed water that is not clean for irrigation, and that irrigated water ends up in the groundwater.

Liu Hanqing et al. state that consequently, Beijing has had to take alternative procedures such as interregional water allocation, over-utilization of groundwater, and the use of reprocessed water to maintenance urban water request over the past twenty years (3). According to Junjie Wang et al., the groundwater impurity is an extensive issue in the practice of expansion and growth (216). Junjie Wang et al. add that ground examination and specimen indicated that in some areas of Beijing Plain, groundwater pollution has changed the original groundwater biochemical nature and augmented the concentration of some toxins, such as nitrate and ammonium (220).

According to Xiaomin Gu et al., during the past twenty plus years, Beijing's resident count multiplied with a rapid speed, and the development of its housing has increased extensively ("Natural" 2). Junjie Wang et al. affirm that successful averting or decline of groundwater pollution is an imperative element in groundwater supervision (216).

Irrigation from agricultural farmland is big problem and a cause of river, surface and groundwater pollution. Zhai et al.2012 study found that Beijing is accustomed to suffer water scarcity and its dependence on ground water resources is overwhelming. Over 60% of yearly overall water source volume is groundwater that gets utilized in different areas (qtd. in Gu, et al.

"Hydro" 2). Zhou et al. 2016 study expanded that due to long-term excess utilization, groundwater level has deteriorated and diminished severely during the past twenty years (qtd. in Gu, et al. "Hydro" 2). Xiao et al. 2017 study extended that in order to improve the water deficiency, manure water and reprocessed water have been exploited for unindustrialized irrigation in Beijing Plain since the 1950s (qtd. in Gu, et al. "Hydro" 2).

Xuming Wang et al. write that nitrate contamination of groundwater and surface water is produced mostly by the exhaustive use of nitrogen based fertilizers in crop growing and irrigation with ammonia-rich runoffs settled by wastewater handling plants (2236).

The surface water turns into run-off water after the rainfall and pollutes the groundwater of Beijing. Chen et al., 2005 and Xia et al.'s 2011 study found that Beijing metropolitan surface soil is deeply contaminated in parks, on shoulders, and in domestic areas (qtd. in Kokkonen et al. 7010). Sun et al. 2014 study elaborated that two-thirds of Beijing's water source is from groundwater, which is often polluted by surface contamination causes (qtd. in Kokkonen et al. 7010). Yufen et al.'s 2008 study expanded that the flat of chemicals from polluted surfaces to municipal water bodies as surface runoff from stagnated and watertight surfaces in Beijing has been shown to contain suggestively more contaminants than precipitation water (qtd. in Kokkonen et al. 7010).

Conclusion

Water is an important part of life. United States residents are used to having access to water 24/7. That is not the privilege of so many people around the world, who have little to no running water. There is so much unconscious harm that we do that affects water and the quality of it. There are limited sources of water and growing populations that affect the water and its quality and quantity. The urbanization process and rapid development due to population growth

is the cause of surface and groundwater pollution, lack of clean drinking water, and the water insufficiency in Beijing, China. The reality is that the quality of groundwater determines the quality of drinking water for the general public. Clean drinking water, unpolluted surface and groundwater is becoming a rarity, and will be even more so if we aren't environmentally conscious about how we treat our water resources.

The magnitude of the problem was emphasized by Haijao Yu et al.'s study in which, an amalgamation of the uninviting circumstances evidently specifies that there is an imperative necessity to portion and preserve the sustainability of water reserve structures in Beijing (1). Long and Pijanowski's 2017 study stated that China is one of the most water anxious nations on the planet (qtd. in Yu et al. 1). Jia et al. 2017 and Van Dijk et al.'s 2019 study explores the inequality between the source and request of water resources, which has endangered the maintainable expansion of many metropolises in Northern China, particularly Beijing (qtd. in Yu et al. 1).

China's population has grown. The agricultural land has been replaced by urbanized and developed land. The water scarcity in Beijing that was a problem in dry northern China has intensified. The agricultural land that reused its water for irrigation has added pollution from the overwhelming amount of sewage and industrial toxins. "Made in China" comes with its price, and the price is the declining and toxified waterbodies and polluted groundwater.

Possible Future Solutions

Like any other megacity, Beijing is trying to come up with sustainable solutions, both to clean the water, as well as to increase the amount of it. According to Men Baohui and Liu Hunanlong, the city is the very habitation that human beings are ingrained in, and municipal

water intake subjugates a substantial part of the flora and fauna's water consumption in this planet for future generations (4).

China is piloting a sustainable and innovative approach to clean the groundwater with the corncobs. Li et al.'s 2012 study found that "corncob contains the highest content of xylan among all of the agricultural by-products, which provides nutrition for denitrifying microorganisms" (qtd. in Wang, X et al. 2237). The groundwater cleaning from nitrates is a step to a cleaner water. Xuming Wang et al. affirm that "therefore, corncob, a kind of agricultural by-product produced largely in many areas in the world, would have a potential application on the removal of nitrate and organic pollutants from groundwater due to its relatively low price" (2241).

Men Baohui and Liu Hunanlong write that individuals are the foremost valuable apparatuses of a civilization. The maintainable usage of water funds also promises an improved world for future generations (4).

Additionally, according to Shuhan Zhang et al., Beijing is planning to construct Sponge City: a city that controls floods and utilizes all its resources effectively. The construction is very complicated, and it's estimated to be worked on in the upcoming decades. The Sponge City will manage the urban storm water and future floods in Beijing in a most effective way. The utilization of urban storm water will ease the water scarcity that is problematic due to growing population (1).

Shuhan Zang et al. expands this idea, by writing that Beijing needs more sufficient drainage systems for the surface water to collect. The uplifting aspect about the water bodies is that they can handle and are in the capacity to collect the storm water. There is a downside about Beijing down-down area. It used to have much more municipal waterbodies and the water had no problem draining. However, with the population growth and development, the landscape has

changed unenviably. This constructional alteration in megacity Beijing, submerged rivers and lakes in an area of estimated 71.84 km2 so far (7).

The innovative technology that is required for reconstructing Sponge City will help Beijing with its water scarcity and will help keep pollution away from the groundwater. Hopefully, the example of Sponge City will be something that countries can use to improve flooding and the control and regulation of it.

In addition, to eliminate the water scarcity problem in dry northern China, where Beijing is located, canals and waterways are going to carry the water from southern China to Northern China. Wang et al. found that, South North Water Transfer Project (SNWTP) was an innovative use of the water resources to bring water from southern China into northern China's dry areas, where Beijing is located. Southern China does not experience water scarcity. The SNWTP started to operate in 2014, however, the capacity has been limited. The SNWTP is projected to begin to operate close to full capacity in 2020. It will take approximately twenty decades for the water to reach the level that were measured in 1998 (qtd. in Neighbour and Qi 362).

China, and Beijing in particular, are in a difficult situation. Beijing deals with a colossal amount of population and development to accommodate its modern world needs. The megacity is struggling with the damage from different sources that increase rudiments that pollute the groundwater of Beijing. The water scarcity is an enormous problem to be faced. Beijing, and China in general, are trying to better the water deficiency issue and find ways to clean the groundwater. It is going to be a long road ahead, but I do hope that with the help of SNWTP and the other proposed solutions the water scarcity will ease.

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