

# Water Scarcity in Conakry, Guinea: Challenges and Proposed Strategies for a Way Forward

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## Abstract

The capital of Guinea, Conakry, faces a notable difficulty due to a water shortage, which is worsened by the rapid increase in population and urban development. The Guinean Water Company (SEG) faces challenges in supplying water to the entire city due to its limited area of approximately 420 km<sup>2</sup> and a population of 2 million. Moreover, the population growth rate is anticipated to increase dramatically, exacerbating the difficulty of fulfilling future water requirements. As a result, this study employs data from the Knoema website and the Institute of National Statistics of Guinea (INS) to examine the water production and distribution process by the SEG. The study examines the challenges related to water scarcity in Conakry and suggests strategies to assist the city in managing the present circumstances and planning for the future. The primary objective is to get a long-lasting water supply and uphold water quality to advance public health.

## Keywords

Water Scarcity, Conakry, Population Growth, SDGs, SEG

## 1. Introduction

Freshwater is a renewable resource, but rising population and urbanization have put pressure on the ability of many local supplies to meet water quantity demands while maintaining adequate water quality levels [1] [2]. In recent years, due to urbanization and population growth, the increasing human demand for water has led to a global water shortage problem, hindering the economic, social, and environmental development of developed and developing countries [3] [4] [5]. Water scarcity affects 1.6 billion people worldwide, leading to global eco-

conomic water shortages. With it comes two types of scarcity, which are physical and economic water scarcity. Physical scarcity highlights the demand for water due to limited water in a particular place, while economic scarcity highlights poor management that fails the system. So, the increasing demand for freshwater around the globe shows how much water is in demand, especially for developing countries. Yet, with proper water management in a particular country, cases of water scarcity can be less seen. However, due to poor management and infrastructure, countries face a water shortage [6]. The score range for Africa is quite alarming from these different continents due to water scarcity. Thus, water crisis is a prevalent issue in most African countries due to the lack of infrastructure. However, with the recent advancements in the water treatment sector, there is hope for a brighter future if African countries adopt these modern methods to treat groundwater and surface water. Technologies like reverse osmosis [7], desalination [8] [9], nanotechnology [10], or even the use of evaporation associated with photovoltaic [11] are all means through which other countries are treating water and making it accessible to their population. So, a need for water management [12], modern implementation of advanced treatments [13] [14] of water and a technical assessment of the water resources in the region is needed. The evaluation pinpoints the causes of water scarcity [15] [16] [17] [18] and its sustainability [19].

This research paper addresses the issue of water scarcity in Conakry from 2014 to 2019. It discusses the challenges the Guinean Water Company faces in supplying water to the city. However, the current management of the water supply by SEG makes it almost impossible to achieve the SDG 6 goals without implementing further strategies in the water sector that cater to the growing population of Conakry. Therefore, this paper provides strategies and regulations to help navigate future water crises.

## 2. Methodology

### 2.1. Research Area

Conakry is the capital city of The Republic of Guinea, which is located in West Africa (9°30'33.0012"N and 13°42'43.9992"W). Conakry lies on the Tombo (Tumbo) Island and the Camayenne (Kaloum) Peninsula along the Atlantic Oceans and nearby islands called Iles de Los, covering a total area of approximately 420 km<sup>2</sup>. According to the World Bank Organization, the city of Conakry's latest population is estimated at 2 million, and the Guinean population is 13.53 million (2021). Conakry is home to the primary international seaport for importing and exporting goods. Thanks to its main port, the city contributes to Guinea's economy. The port plays a crucial role in the country's economy as it is a vital channel for exporting bauxite to other nations. However, with the population increase, Conakry has been under enormous imbalance in urban planning in its infrastructures and urban networks, especially in the water network sector of the city. Conakry's administration is divided into more than five communes, but the

main ones are Kaloum, Dixinn, Matam, Ratoma, and Matoto (Figure 1). Since Guinea's population is projected to increase significantly, Conakry's water demand will increase along the way. Thus, this research studies water consumption over these past years and what the future of the water sector in Guinea projects will be like with increasing population growth.

## 2.2. Data Source

Water usage assessment has been a persistent problem worldwide, particularly in developing countries like Africa, where precise data is complex to come by. In this research paper, information related to the water production and distribution carried out by the Guinea Water Company (SEG), the number of subscribers to SEG, and the percentage of people served by SEG were obtained from the Knoema website. Knoema is a comprehensive data repository linked to the Institute of National Statistics of Guinea (L'Institut National de la Statistique (INS)). The data was plotted and analyzed using Excel alongside a population growth forecast from Table 1, as illustrated in Figure 2. Therefore, Table 1 represents the population data of Conakry from 2014-2023, which was used for this study. The year 2019 was considered the primary reference year for predicting future

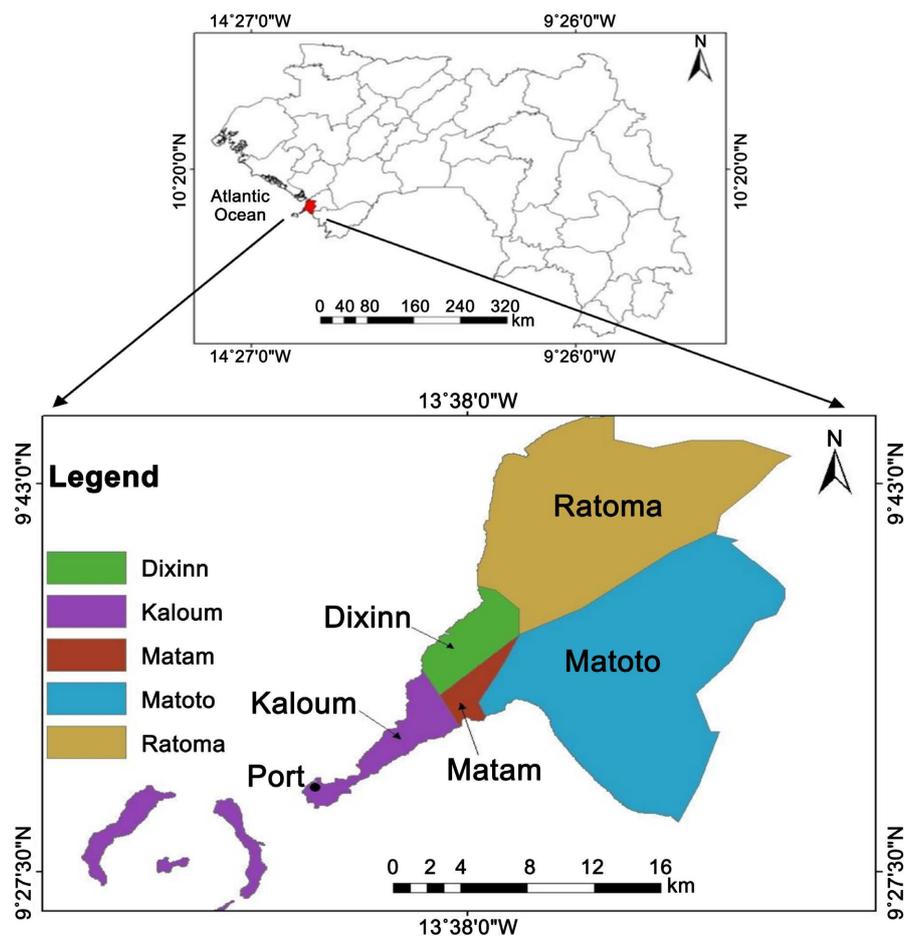
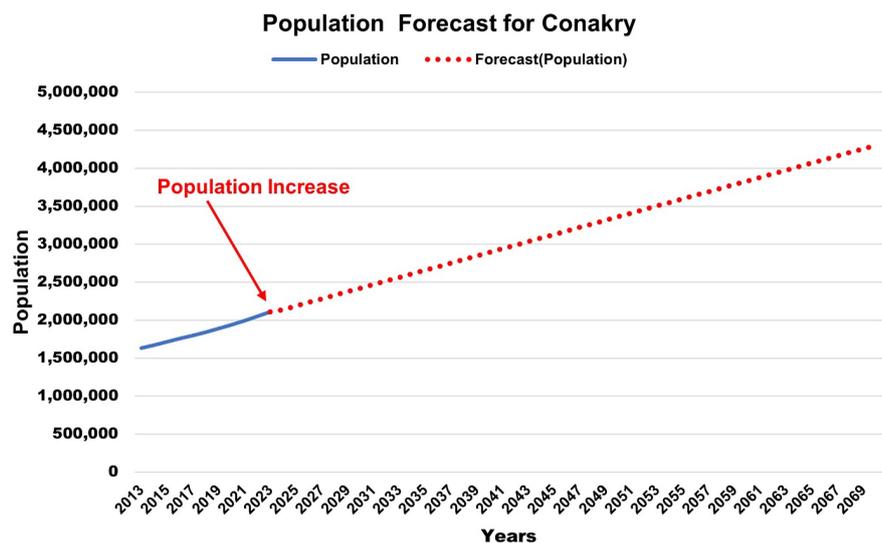


Figure 1. Map of Conakry along its five communes [20].

**Table 1.** Conakry's historical population growth.

Year	Population	Growth Rate
2014	1,673,000	2.45%
2015	1,714,000	2.45%
2016	1,756,000	2.45%
2017	1,799,000	2.45%
2018	1,843,000	2.45%
2019*	1,889,000	2.50%
2020	1,938,000	2.59%
2021	1,991,000	2.73%
2022	2,049,000	2.91%
2023	2,111,000	3.03%

**Figure 2.** Guinea's population projection [21].

population growth since there was an increase of 0.05% in population growth rate. Hence, starting in 2019, the rise in population has impacted the water demand, which in turn affects Conakry's water industry.

### 3. Water Resources

#### 3.1. Groundwater

Guinea is relatively well-off in terms of water resources compared to other Sahelian countries. The country mainly relies on groundwater, surface water, and raw water. Most of the rivers in Guinea are perennial and can provide sufficient water for nearby population centers even during the dry season. Although there are springs near some cities, they usually do not yield enough water to meet the needs of the residents. So, people in both urban and rural areas of Guinea obtain fresh drinking water from drilled wells and pumps that extract water stored be-

neath the earth's surface in aquifers. Surface water is sourced from the multiple rivers and lakes in Guinea and is used for hydropower generation and electricity supply to communities. Groundwater, on the other hand, is used for agricultural, domestic, and water supply in areas where access is limited. However, the excessive use of fertilizers in agriculture, a crucial activity in Guinea, pollutes the soil and groundwater. Therefore, monitoring and treating groundwater sources in Guinea is essential to maintain their quality over time and prevent people from getting sick from drinking contaminated water.

The rural population mainly relies on shallow wells and running streams for their water supply. However, these wells often dry up during the dry season, and there has been little groundwater exploration to find alternatives to this problem. In urban centers, piped water is available only in areas occupied by public services such as ministries, hospitals, and schools. The remaining population obtains water from shallow wells, ponds, or running streams, which may be polluted. Even the piped water systems provide poor service and are often offered intermittently for a few hours daily. In addition, the water is rarely chlorinated. The water system network is old and in poor condition, with many standpipes not functioning correctly. In cases where they do function, the surrounding sanitary conditions are so poor that they frequently pose a health hazard. Only Conakry and the mining centers of Kamsar and Fria have sanitary sewage systems. The network of sewers is limited to pre-independence city limits and appears clogged in many points. While connections have been made between the drainage and sewerage systems to help dispose of sewage, these arrangements do not provide satisfactory long-term solutions. Septic tanks and pit latrines are commonly used in urban areas and are often a source of contamination for private wells located nearby [22].

### **3.2. Raw Water**

Conakry is a city that relies heavily on raw water from rivers and lakes. The population is supplied with treated raw water from the Grandes Chutes Dam through pipelines to the Yessoulou Water Treatment Plant, which then supplies the city. However, the infrastructure for a stable water supply is not well-developed, and water shortages are hindering economic growth, especially in urban areas where the population is rapidly increasing. Due to the increasing population, one treatment plant cannot supply enough water for everyone daily. Therefore, several international projects have been carried out in Conakry to supply the city with water. The World Bank carried out the Conakry Water Supply and Sanitation Project I (1978-1985), which developed a complete water supply system from water source development to the connection of water supply pipes. In the subsequent project, the Conakry Water Supply and Sanitation Project II (1989-1997), further water system development was carried out with donors such as the World Bank and Japan.

Guinea has a significant potential for hydroelectric power, thanks to its high

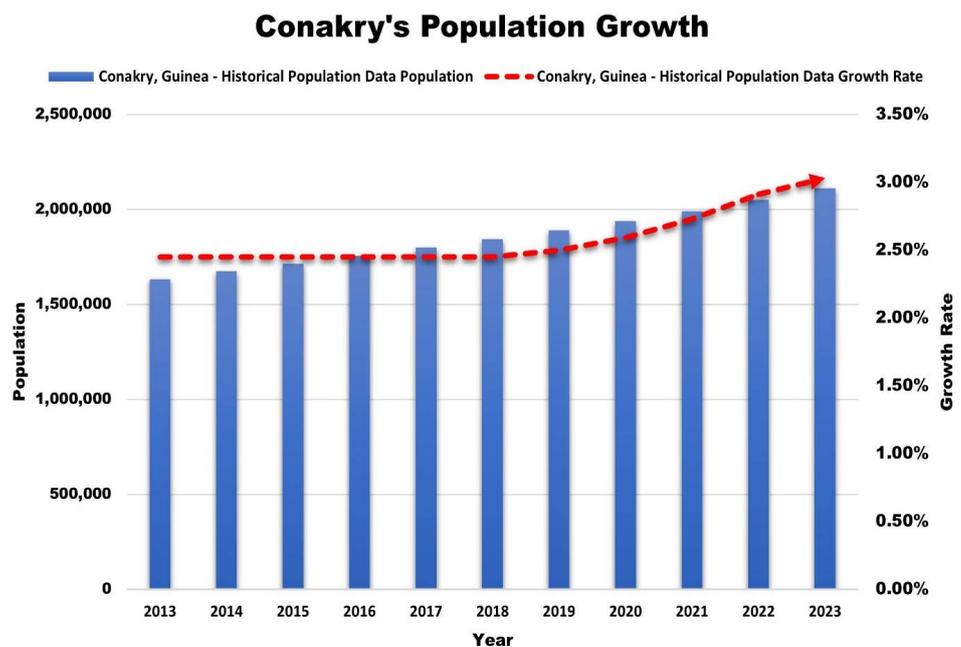
rainfall and deep gorges in the Fouta Djallon region and other cities. However, the country's hydropower is not being fully utilized, mainly used to meet the demands of the alumina sector. Only one dam and hydroelectric power station on the Konkouré River generates almost one-third of the country's electricity. Despite this, the national grid supplies only a small portion of energy, primarily serving electricity in Conakry, Dubréka, and Kindia.

This dam has the potential to supply Conakry with ample amounts of raw water, which could be treated by treatment plants and then serve the population. The same goes for Dubréka as well. Using the raw water from the Soumba River is an alternative to serve not only the people of Dubréka but also the suburbs of Conakry towards KM36. Using these two main rivers will significantly supplement the city's water needs and reduce the burden of solely relying on the Grandes Chutes Dam.

## 4. Challenges in the Water Sector

### 4.1. Population Growth

The population growth in Conakry is expected to increase due to its status as an economic city containing all administrative headquarters in the country. Moreover, Conakry has one of the largest seaports in the sub-region, generating half of its economy by importing and exporting bauxite and raw materials from mining companies nationwide. As a result, more people are moving to Conakry for a better life, increasing water demand and urbanization. So, it is necessary to improve infrastructure planning to meet Conakry's water supply system so that more areas in the city can be connected to the water supply from SEG. **Figure 3** illustrates the population growth in Conakry over the years. From 2013 to 2018,



**Figure 3.** Conakry's population Growth from 2013 to 2019.

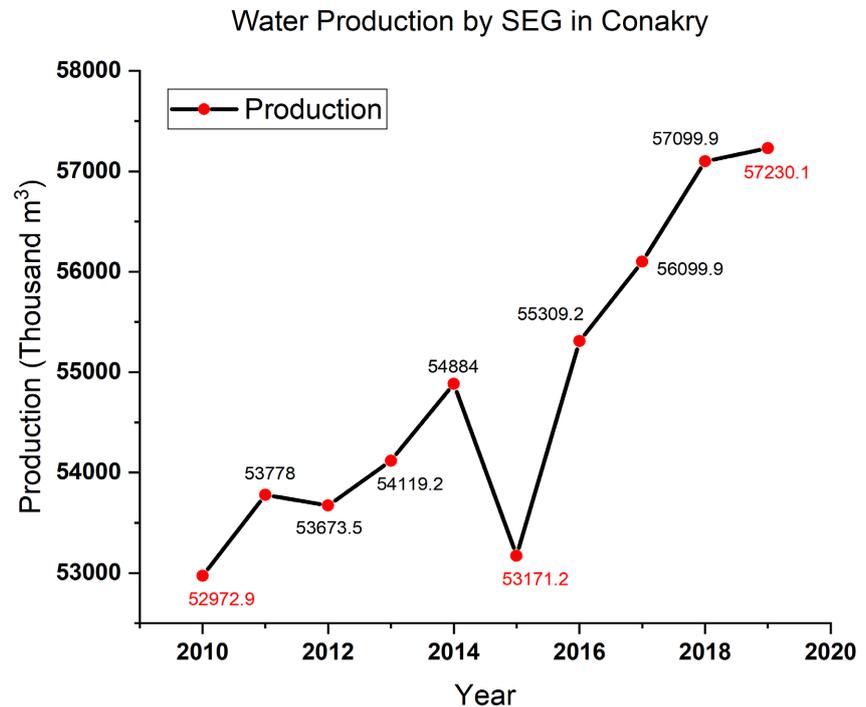
the growth rate was steady at 2.45%. However, the population growth rate increased 2019 by 0.05%, which has continued to grow. This growth rate is expected to continue to rise in the coming years. This projected increase in population, shown in **Figure 2**, will impact Conakry's population significantly and increase the need for water requirements in the city.

#### 4.2. Water Requirement of Conakry

Generally, Conakry should be one of the cities in West Africa with enough water supply. The Atlantic Ocean borders it, and the country has major river sources. However, due to the lack of water treatment plants, the population turns to groundwater, rivers, lakes, drilling wells, and pumps to satisfy their water demand. With one household in Conakry having an average of four people, the water demand is high, which poses a challenge for the SEG. Additionally, pipeline connections are either broken or under construction, which takes months to repair, leading to a supply shortage in different communities due to broken pipes. The lack of electricity is another significant factor contributing to the water distribution problem. Some communities in the city do not get electricity, and those that do are only served three times a week. This situation has caused people to strike, demanding water and electricity.

The water system in Conakry is primarily sourced from the Grandes Chutes Dam at the foot of Mt. Kakoulima and the groundwater within the city. Raw water from the Grandes Chutes Dam is treated at the Yessoulou Water Treatment Plant before being supplied to the locals. Presently, 15% of the urban area's water supply is sourced from groundwater, drilled wells, lakes, and rivers, leaving the remaining 85% from surface and raw water. Despite this substantial reliance on the surface and raw water, the current supply volume fails to meet the escalating demand due to a population concentration in the capital. Furthermore, water distribution is unevenly distributed among communities due to various factors. Although some areas receive water 24/7, many only receive water for a few hours daily, despite a distribution pipeline.

Although the total water production is approximately 96,000 m<sup>3</sup>/day, only around 36,000 m<sup>3</sup>/day is accounted for and billed. About 26,000 m<sup>3</sup>/day is unaccounted for due to insufficient meters and illegal water connections. In contrast, an additional 34,000 m<sup>3</sup>/day is lost due to leakage, making the rate of unaccounted water very high. **Figure 4** illustrates water production in Conakry by the SEG company, with 2019 being the peak year of production and a decrease in water production in 2010 and 2015, respectively. Specifically, in 2019, the amount of water distributed to the locals was around 48%, a decrease of 26% from the 74% connected to the SEG. Unfortunately, the progress of the water supply in Conakry has been slow, and more effort is needed from the SEG to increase the production of groundwater, surface water, and raw water in the city. This is necessary for Conakry to provide 70 liters of water per person per day by 2030, considering the impact of population growth. Therefore, there is an urgent need to increase water production, which includes developing new water sources.



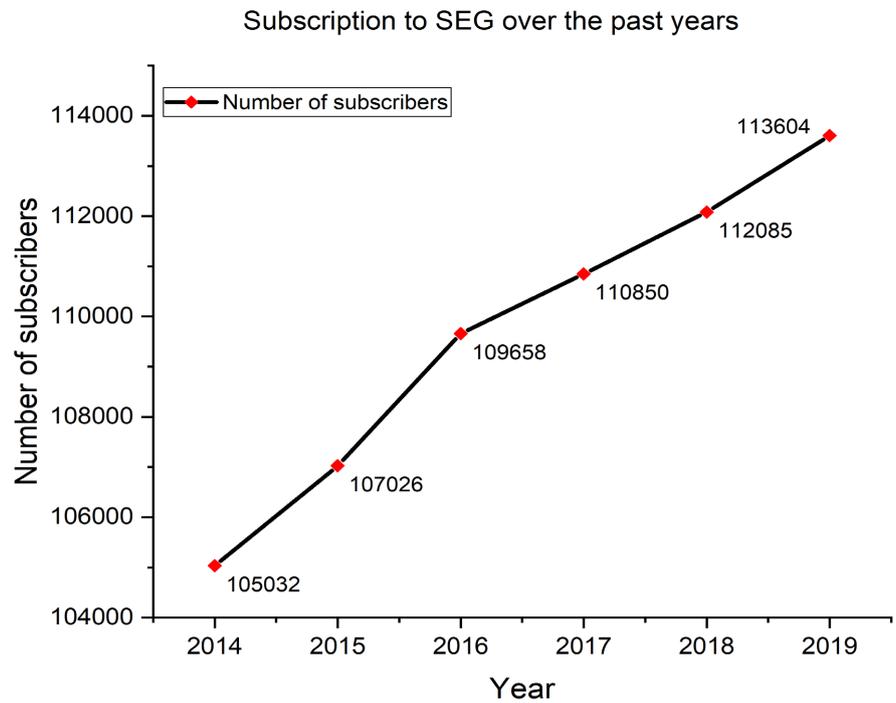
**Figure 4.** Water production by SEG in Conakry.

### Freshwater Management in Guinea

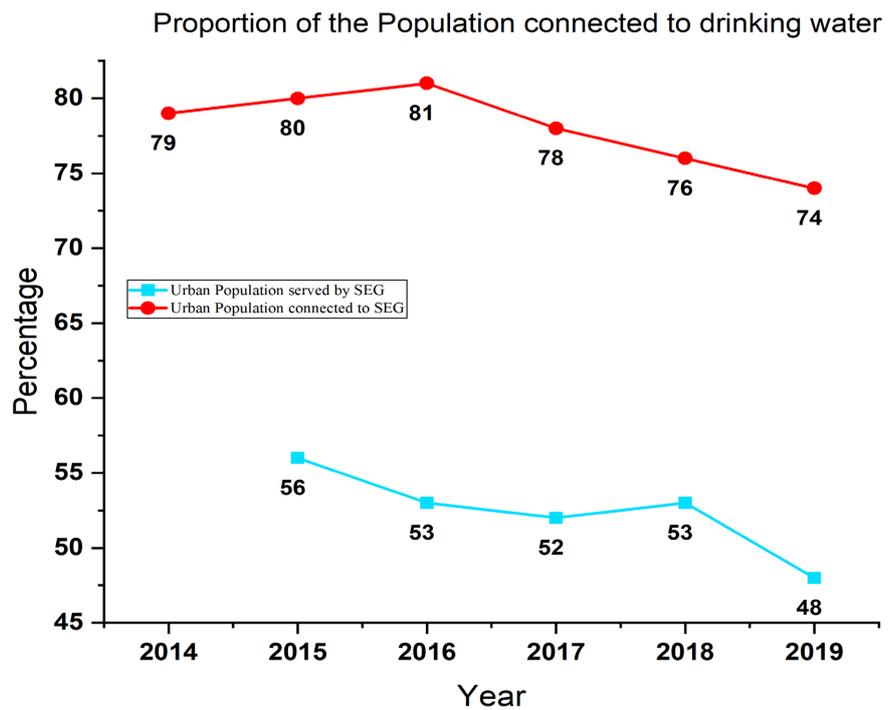
Freshwater management plays a crucial role in the economic development of Guinea. Here's how it influences the economic development in Guinea:

#### 4.3. Low Water Connection Rate

Despite the abundance of water in Conakry, the city's coverage has been low. The low coverage can be attributed to the mismanagement of the SEG in distributing water, where unbilled connections are found for ministers, deputies, and senior civil service employees. Most private connections in Conakry are single taps inside the compounds of workers or wealthy minority groups with running water inside their houses, usually serving nearby households. Field interviews show that access to water pipelines depends mainly on personal links (such as tribal and family), making it easier for some households to connect, while others have to wait several months before establishing their water connection. As a result, a household's capacity to provide water to their neighbors is becoming a significant part of the water supply to people. Although it is difficult to estimate the exact number, many residents in Conakry have illegal connections to the SEG water system, leading to a decline in the connection rate, as seen in **Figure 5** over the years. As shown in **Figure 5**, the number of water company subscribers has increased slightly over the years. However, as per **Figure 6**, there has been a decline in the number of people served in Conakry from 2016 to 2019. This decline in **Figure 6** is also reflected in a decrease in the number of people served by SEG. Showing how illegal meter connection rates lead to a reduction in SEG meter adoption.



**Figure 5.** Number of people subscribed to the water company SEG.



**Figure 6.** The proportion of the population connected to SEG and the proportion of the urban population served by SEG.

The low connection rate is also due to rapid urban growth, which exacerbates the problems related to fast growth due to poor urban planning and regulation in the water supply sector. Service delivery and system expansion are costly be-

cause the poor road network makes it difficult to lay pipes, and a relatively small number of potential customers are subscribed to SEG. Therefore, even if maintenance had been adequate to improve the pipeline system, Conakry's infrastructure would be strained beyond its capacity, and executing such a project would take months or even years to finish.

#### **4.4. Governmental Regulations**

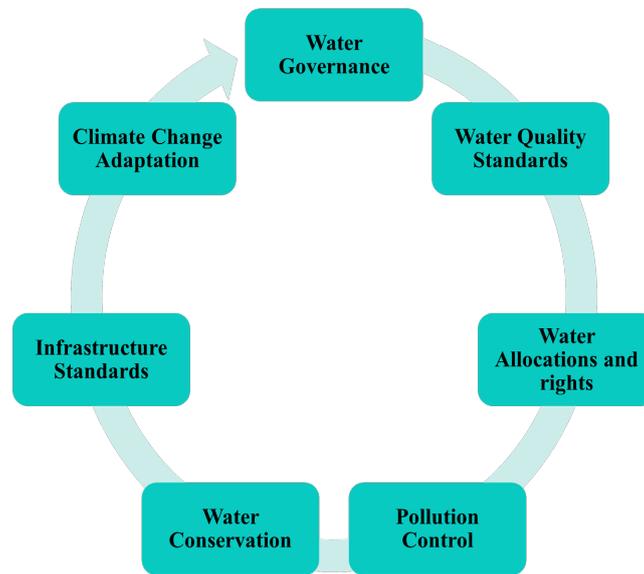
The water system in Conakry is in a dire situation due to a weak institutional framework. The government's implementation and follow-up are not concrete, particularly in the politically sensitive sector where complete denationalization is rare. To address the challenges of water scarcity in Conakry, the government needs to implement several regulations. These regulations should include water governance that outlines a framework for different water management involving governmental agencies, local communities, and private institutions working together to ensure effective integrated water resource management. The government should establish regulations for water rights and allocation. Individuals or companies must obtain permits and licenses before packaging water for private sales. In Conakry, there has been a worrying increase in private water companies selling their underground water brand. These companies must comply with specific regulations and obtain licenses before selling personalized branded water packages.

Moreover, water quality standards must be set to protect public health and the environment. These standards should specify various contaminants and parameters of drinking water sources and a drafted guideline for wastewater and seawater treatment. Above all, the government can reform the water sector in many different ways, but its practical options are constrained due to the need for additional funds. However, if the government outlines the regulations for the benefit of its people by following the illustration in **Figure 7**, the sector's performance could be improved. At the same time, it will lead toward a less water-less Conakry.

### **5. Proposed Strategies: Path Forward**

#### **5.1. Improvement in the Water Management**

Water management [12] is a complex and interdisciplinary field that aims to ensure the sustainable use, conservation, and protection of our precious water resources [23] [24]. This involves a range of diverse techniques that are tailored to specific regional and local contexts [25]. Effective water management strategies include promoting water conservation through public awareness campaigns, irrigation improvements, and leak detection programs. Developing and maintaining water supply infrastructure, such as dams, reservoirs, treatment plants, and distribution networks, is crucial for capturing, treating, and distributing water to meet community needs. One effective way to manage water in Guinea (Conakry) is to implement rainwater harvesting techniques like rain barrels,



**Figure 7.** Governmental regulation adaptation plan for Conakry.

cisterns, and rooftop collection systems. These techniques allow for the capture and storage of rainwater for various purposes. Water reuse [26] and recycling involve treating water to make it suitable for industrial processes, irrigation, and groundwater recharge. However, watershed management focuses on protecting and managing entire watersheds, including rivers, lakes, and adjacent areas just like how China has a lot of research projects concerning different rivers such as the Yangtze River [27] [28], Haihe River [29] [30], Tai Lake [31], Dongji Lake [32], etc. This involves land-use planning, erosion control, afforestation, and wet-land restoration.

Effective water management also involves the implementation of water pricing mechanisms and economic incentives to promote efficient water usage. The establishment of clear water rights [33] [34] and an effective governance framework is crucial to regulating water allocation, usage, and distribution. Climate change adaptation strategies [35] play a significant role in addressing challenges such as changing precipitation patterns and increased water scarcity research, monitoring [36] [37], and data collection provide valuable insights for improved decision-making and planning in water management, including hydrological assessments [38], water quality monitoring [39], and predictive modeling [40] [41]. Similarly, both rural and urban areas in Guinea face drought and water scarcity. However, the management of water supply differs between the two regions. In rural areas, construction of public pumps with groundwater sources is a viable option, yet in urban cities such as Conakry, this may not always be feasible. By combining these methods, we can ensure the sustainable and equitable use of our water resources.

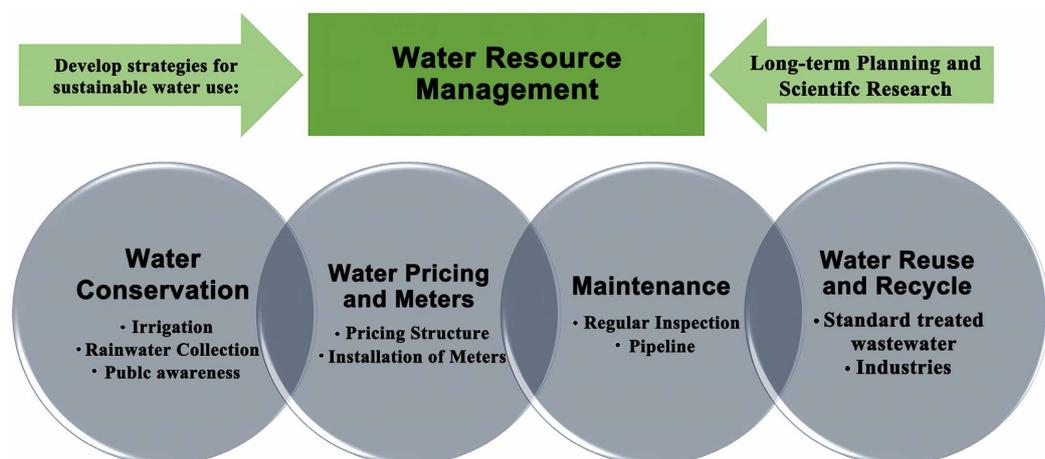
## 5.2. Path Forward for Conakry in Water Management

To accomplish this task, the private sector and citizens must also be involved.

The biggest challenge is the growing population, which will inevitably increase the demand for water in the coming decade. The increase in population also demands a larger infrastructure for the distribution of water and requires efficient management. Despite Guinea being known as the “Water Tower of Africa”, water shortage has become a major issue in Conakry. Therefore, to cope strategically in supplying water to residents, six measures need to be implemented: 1) Implementation of Water Conservation, 2) Water Billing and Metering, 3) Water reuse and Recycling (WRR), 4) Maintenance (Leaks and Repairs), 5) Water Management, and 6) Construction of Infrastructure. **Figure 8** provides some strategies to help ensure water is distributed throughout Conakry to meet future demand.

The government has a responsibility to promote and enforce water conservation practices such as efficient irrigation systems, rainwater harvesting, and educating the public on water-saving techniques. These measures can lead to significant changes in water usage and preservation. Additionally, standard pricing structures should be established for water usage across the entire city, where households are charged based on their usage regardless of financial status. Improving pipeline systems in the city is also crucial to encourage households to connect to the water distribution system.

It may take some time to implement a wastewater reuse and recycling (WRR) system due to the poor collection system in the city, but with the latest advancements in technology, the government can afford to implement the latest technologies to standardize wastewater treatment for reuse in households, agriculture, and industries. To do this, investment in constructing additional treatment plants in the city is necessary to reduce stress on freshwater resources, and regular inspection of the water supply infrastructure is necessary to detect and repair any leaks in the pipe system early, thereby preventing loss and maintaining uninterrupted distribution. One practical idea is to construct seawater and desalination treatment [9] [42] [43] facilities to further alleviate this issue, as is the case in developed countries like USA, China, and Europe.



**Figure 8.** Pathway for a sustainable supply of water in Conakry, implementation pathway.

The water resource management in Conakry is inadequate, and it is highly recommended that a change in the management system be implemented. Technology can play a crucial role in facilitating this change. The first step is upgrading the data system that records the water distributed in different branches throughout Conakry. This upgrade will make monitoring and repairs easier promptly, ensuring the water company manages and monitors water distribution throughout the city efficiently. An example of such water system management can be seen in China [44] [45] [46] and Serbia [47] yet Guinea lacks such managerial ideas for water. Meanwhile, if implemented it could improve freshwater management in Guinea and have a positive impact on economic development, particularly in sectors such as agriculture, hydropower generation, tourism and recreation, and water-related industries. These sectors are crucial to Guinea's economy.

To successfully manage and distribute water in Conakry, it is essential to follow the regulations outlined in **Figure 6** alongside the implementation of these strategies in **Figure 7**. These strategies provide a way forward for Conakry to combat water scarcity and meet the growing population's daily demand for clean water.

## 6. Conclusions

Water scarcity is a significant issue in Conakry, primarily due to the lack of treatment plants and a proper distribution system. Various factors have contributed to this problem, including insufficient funds for building more treatment plants and inadequate water management, monitoring, and planning. Despite being a coastal city with numerous lakes and rivers nearby, Conakry still struggles with water scarcity due to the absence of proper infrastructure.

To address this problem, building more desalination and seawater treatment plants is imperative. A treatment plant should be constructed in each commune, as shown in **Figure 1**. This will ensure each commune has its own treatment plant and distribution center, making the workload more accessible for one central monitoring station. It will also allow each commune to report monthly on their water production and distribution, enhancing water management in Conakry and providing better service to the people.

As the world progresses rapidly, Guinea must keep pace by renewing and building modern infrastructure, desalinating and seawater treatment plants, reusing and recycling wastewater and water storage, and adopting the latest monitoring means. Although work has started on specific aspects of these innovations, it tends to be delayed due to a changing regime in Guinea. To avoid this, the government should put regulations into law with a plan that leads to 2030 or 2045. By doing so, the city can work towards achieving Sustainable Development Goal 6, which aims to provide access to clean water for all. To solve the water scarcity problem of Conakry, modern technologies for the treatment of seawater, groundwater, and surface water should be adopted while following water quality stan-

dards for the public good of the people and the environment.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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