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Addressing Water Shortages in Sulaimani: Policy Approaches and Recommendations

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Sulaymaniyah, Ashty,
Opposite to Azadi Park

www.visionfoundationiq.org

+964 772 330 0005

Research Department – Vision Foundation for Strategic Studies

Researcher:

Dara Faeq Hamamin
Sarmad Latif
Salahaddin S Ali

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Addressing Water Shortages in Sulaimani: Policy Approaches and Recommendations

Dara Faeq Hamamin[1], Sarmad Latif[2] and Salahaddin S Ali[3]

[1] Professor of hydrogeology, groundwater sustainability, climate adaptation, University of Sulaimani, Iraq
[2] Senior Researcher in Water Security, AI & Machine Learning, Komar University of Science and Technology, Iraq
[3] Professor in Hydrogeology, Komar University of Science and Technology

Summary

Sulaimani city faces water shortage due to decreasing rainfall amount, climate change impacts, population growth, and aged infrastructure. The surface water is low, and groundwater is overused and contaminated, leading to insufficient water supply and results in threatening farming, public health and industry. Therefore, this policy report analyzes the current water shortage situation in the city and recommends three stages for solving it. The recommended plans have been proposed gradually considering the current economic condition of the city's governorate and it consists of short-term, medium-term and long-term solutions which address immediate relief and sustainable water management for the future. The proposed plans could be strong scientific and policy guidelines for the city's governorate for achieving water security and planning for sustainable water resources management.

1. Introduction

Sulaimani city is located in Kurdistan Region of Iraq with a total area of 266 km^2 and population of approximately 847,000 in 2025. The city is experiencing water shortage driven by various purposes including climate change, declining rainfall, population growth and old infrastructure. Currently, supplying water to the city is a challenging process due to reducing surface water availability, over-extraction of groundwater and insufficient distribution systems. These challenges affect public health, agriculture crops production, industrial operations, and social and political stability (EPIC, 2025; Latif, 2025; Latif et al., 2024; World Population Review, 2025).

In recent years, especially 2025, Sulaimani faced an intensive water scarcity and drought situation which led to declining water levels in the dams and reservoirs. One of the main issues was reduction in rainfall compared to previous years which affected the region's natural hydrological cycle. Another issue is aged infrastructure in the city which led to pipeline leakage by 30% until it reached citizens. This issue is mainly because of building these infrastructures decades ago without enough maintenance and expecting population growth.

Furthermore, lack of sensors for detecting leakage locations is another cause. In many areas of the city, the distribution pipeline system is unable to deliver adequate quantities of water of good quality, which worsens the water scarcity situations (EPIC, 2025; Khzr et al., 2022; Latif, 2025; Nareeman et al., 2023; Sarhat, 2022; Tahir and Harun, 2022).

Another issue was reducing river flow from upstream source since Dukan Dam rely on Lower Zab which originates from Iran. The upstream regions, especially Iran has also faced a massive drought this year, therefore, they decreased the Lower Zab flow rate by 70% which resulted in decreasing water level Dukan Dam to less than 25% of its storage capacity. Thes unexpected fundamentals result led to challenges in supplying water to the city. In case if these water issues are left unaddressed, the situation is expected to become worse in the future and will lead to bad consequences for public health, local economy, and social and political stability. Therefore, it is crucial for the policymakers to focus on sustainable plans (Latif, 2025).

Meanwhile, groundwater depletion is another major issue in Sulaimani city. The city's groundwater levels have rapidly decreased due to various causes. One of the causes is digging illegal wells due to lack of law implementation and enforcement. Another cause is unfollowing policy instructions by citizens for the proper distance between wells. In many areas, the distance between two wells should be at least 450 meters, while more than five wells could be found in many places within this limit. In addition, the leakage from underground storage tanks of various petrol stations led to groundwater pollution in the city with toxic petroleum hydrocarbons. Also, the carwash services in the city rely on using groundwater to wash thousands of cars daily. At the same time, 70% of the farmers rely on groundwater for irrigation process (Hamamin et al., 2016, 2018; IRIS, 2024; Latif, 2025). This improper usage of groundwater results in aquifer depletion since overextraction does not let the aquifer layers replenish. Therefore, addressing groundwater issues is crucial for the long-term sustainability of the city.

Moreover, another problem is rapid growing of population in the city as the city develops and expands. Sulaimani city had a population of 37000 in 1950, while it has been increased to 533000 by 2000. Recent statistics show that the current population is 847000 in 2025 while it was 823000 in 2024 (Macrotrends, 2025). Increasing 24000 in only one year shows rapid growth which highly increases the demand for water, food and energy. Rapid population growth coupled with decreasing rainfall and water flow from upstream, and aging infrastructure will lead to serious challenges in the future. The insufficient water supply to the city will threaten agricultural crops productivity and industrial activity which affect the economic development of the city. The city is also continuously expanding by constructing various residential projects which increase the demand for water. Therefore, without a sustainable plan, it is challenging to meet the demand for water in the coming years. Figure 1 shows the metro area population growth of Sulaimani city from 1950 to 2025.

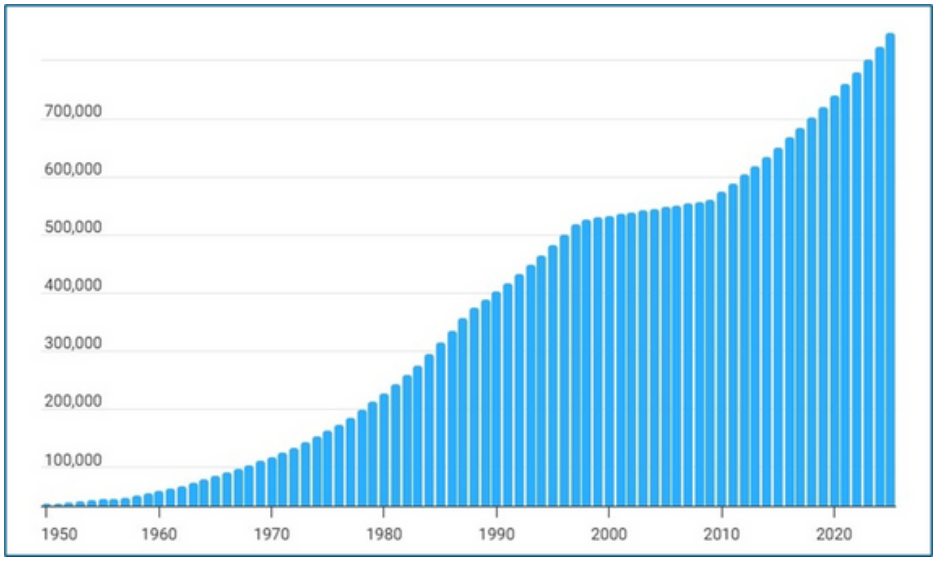

Figure 1. Metro Area Population of Sulaimani from 1950 to 2025 (Macrotrends, 2025).

Social stability is another area at risk since water shortage will lead to conflict at the intrastate level. It may create conflict between various communities such as farmers and industries which lead to social instability. It may also lead to protest against the local authority which worsens the situation and leads to losing trust between society and authority. This report aims to present an assessment of the current water situation in Sulaimani city by considering various factors that cause water scarcity. By exploring these issues, this report presents an actionable plan to mitigate water shortages for both short-term and long-term. The main focus is to address the immediate water shortage issue while a framework is developed for long-term sustainable planning and management. The policy recommendations will focus on improving water conservation efforts, enhancing infrastructure, groundwater improvement, and relying on efficient use of water for various sectors such as domestic, irrigation and industrial usage.

2. Objectives

This policy report seeks to offer viable solutions and guidelines for decision-making on how to handle the water crisis in Sulaimani city. To ensure effective policymaking and implementation strategies, various key objectives have been identified:

1.Assessing the current status of groundwater in Sulaimani and determining the main causes of its depletion

The first objective focuses on studying the current situation of groundwater and its shortage in the city. Groundwater is a significant source especially in the dry period where the city lacks sufficient amount of rainfall. Through evaluating the rate of discharge and water level in the ground, the key factors of groundwater depletion could be identified. Various factors lead to groundwater depletion, including overextraction, lack of enough rainfall to replenish groundwater layers, the changes in land use through urbanization and the agricultural practices by farmers. It is crucial to understand the main factors of groundwater depletion in the city to sustainably address them for long-term planning and management.

2.Assessing the impact of climate change on rainfall patterns and surface water resources in Sulaimani city

Climate change is one of the main causes that affect the availability of water in Sulaimani, and its impact is becoming more within the long-term shift of rainfall patterns. This objective focuses on how climate change affected local water resources. This evaluation will be based on the collected monthly rainfall for 25 years starting from 2000 to 2025. This assessment will focus on rainfall trends, variability and seasonal distribution which have significant impacts on supplies of surface water and groundwater. These changes happen due to climate change and will affect society and economic development. Unpredictable rainfall reductions will have negative consequences on agricultural crops productivity in the city. Agricultural sector highly depends on water supply and has direct relations to food security and livelihood of society. Furthermore, water shortage will lead to dangerous consequences for public health as it limits access to clean water. Through evaluating these climatic situations, this objective will provide a clear image of the impact of climate change on water availability in Sulaimani city, which helps the policymakers to arrange a strategic and sustainable plan for water resources.

3.Developing adaptation and mitigation plan

The final objective aims at developing an actionable and comprehensive plan to mitigate and adapt to the current water shortage of Sulaimani city. This plan will suggest short-term and long-term solutions to achieve water security in the city. The strategy of adaptation plan will be proposed for increasing efficient use of water, improving capacity of water storage, enhancing water infrastructure and solving leakage problems in the pipeline distribution system. The strategy of mitigation plan will focus on reducing the long-term impact of climate change through various techniques, including water conservation, smart agriculture, and using modern technologies for enhancing water availability and quality. The main aim of this objective is to create a balance for meeting the current needs of water while planning for future in a sustainable manner.

3. Methodology

There are two main interconnected components for methodology section, assessment and analysis. This dual framework helps the study achieve not only the collection of real data and diverse perspectives at community level but also interprets those findings into practical and policy-relevant recommendations. Moreover, field observations in a systematic manner have been performed to clearly examine the status of groundwater in the city.

3.1 Assessment

In order to address the current water shortage situation in Sulaimani city, the assessment phase focuses on quantitative data collection for monthly rainfall and various parameters of groundwater data including longitude, latitude, depth, discharge, static water level, dynamic water level, and drawdown. These data have been examined to check the current status of water availability in the city.

Additionally, systematic field observation for groundwater conditions were performed in order to check the affected areas (e.g. Sarchinar Spring) where people heavily rely on groundwater.

3.2 Analysis

The analysis phase builds on the information that has been collected in the assessment phase and focuses on identifying vulnerabilities, including climate change and expansion growth of the city. In addition, it focuses on prioritize issues such as outdated city's distribution water systems, updating water level in selected wells, and pollution.

4. Analytical Findings

4.1 Evaluating Discharge–Drawdown Imbalances in Sulaimani City Wells

The analysis of well performance in the city shows important variability in terms of the rate of discharge and drawdown levels (differences between static and dynamic water level in the ground) among the municipal well networks. Figure 2 represents the wells, petrol stations, pollution sources, centers and flow directions on the hydrogeological map of Sulaimani.

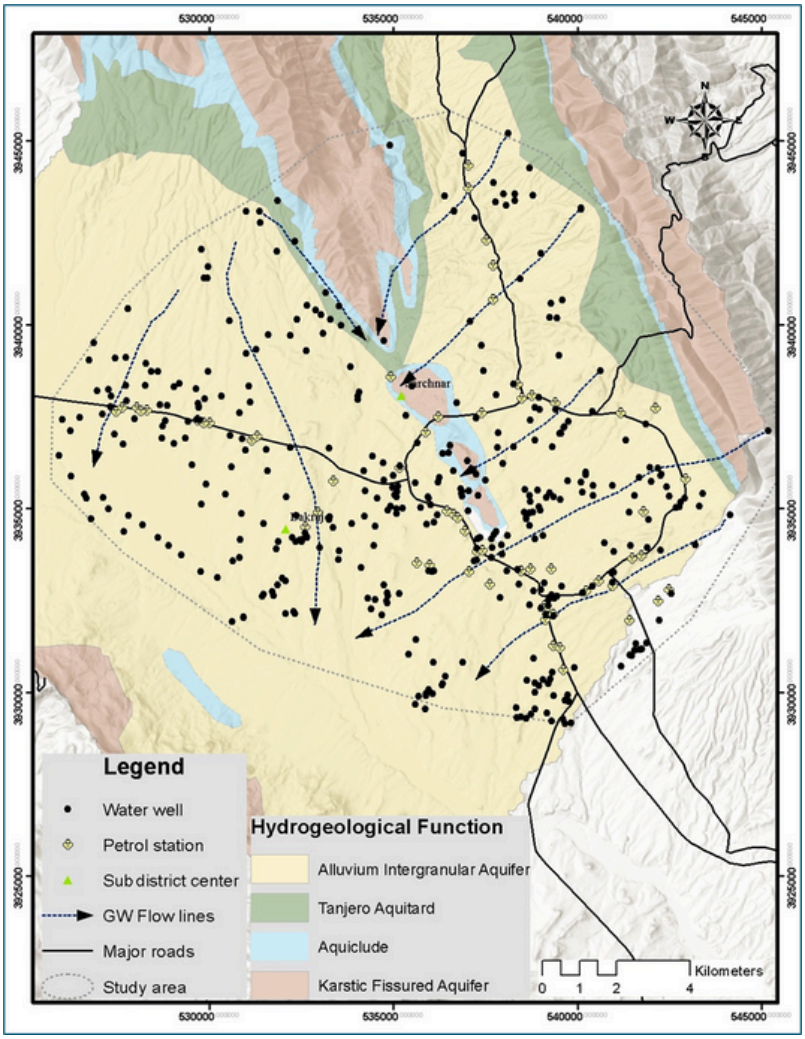

Figure 2. Hydrogeological map of Sulaimani: wells, petrol stations, and flow directions.

The dual chart provided (Figure 3), "Discharge with drawdown" lists key performance metrics for the selected productions wells inside the city, specifically their discharge rate (Q_gpm) and resulting drawdown (DWL in meters). A standard, efficient well produces a high discharge with minimal drawdown. However, the data reveals a critical anomaly in a specific cluster of wells.

Wells such as No. 10, 12, 38, 48, 56, 61, 62,64 and 69 which are distributed in most parts of the city are clear outliers. They exhibit a highly inefficient and unsustainable characteristic: they yield a very low discharge (Q_gpm) but cause a significantly high drawdown (DWL). This inefficient relationship is a strong indicator of severe problems at these specific sites, likely due to:

i. Low-Yielding Aquifer: The hydrogeological units supplying these wells have low hydraulic conductivity and cannot readily yield water.

ii. Well Damage or Clogging: The well screens or the surrounding aquifer are likely clogged by sediment or mineral deposits, severely restricting water flow.

iii. Localized Overdraft: The aquifer in this specific area is likely already over-exploited, and the water table has dropped significantly. Pumping any amount of water causes the level to fall rapidly. Furthermore, it might influence groundwater storage in the surrounding area.

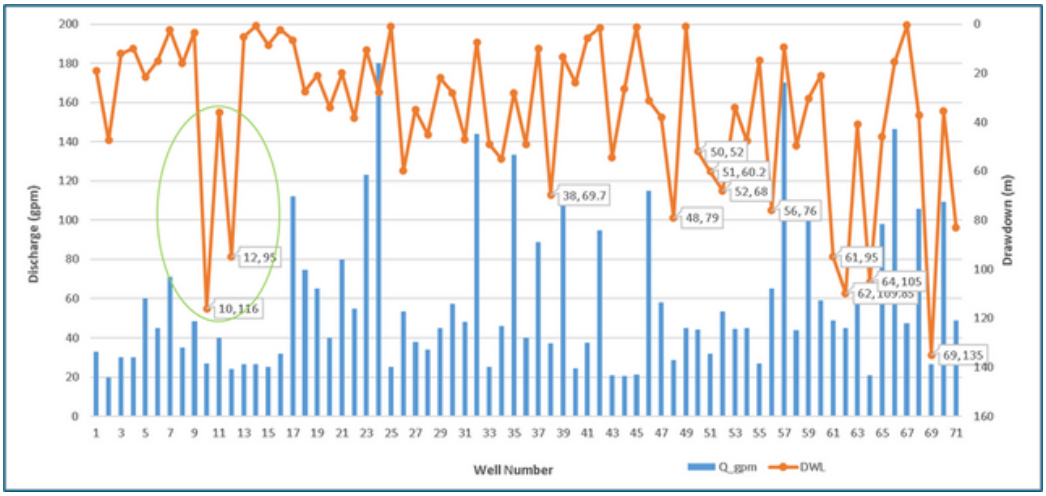

Figure 3. Groundwater discharge (Q_spm) and drawdown (DWL) across various wells in Sulaimani City.

Based on the data represented in Figure 3, it shows that the relationships between drawdown and discharge are irregular. While some wells have been used at a moderate pumping rate, but it still shows extreme drawdown conditions. Also, it should be noted that overextraction of the wells will lead to more compaction of the aquifers which leads to subsidence later. Furthermore, the high-risk wells need pumping reductions immediately in order to avoid any failure. To conclude, immediate actions should be taken to control and monitor the pumping rate, then assessing and managing the coordinated city-wide groundwater is crucial. Figure 4 shows the location of the wells “10, 12, 38, 48, 56, 61, 62, 64, and 69” on a map.

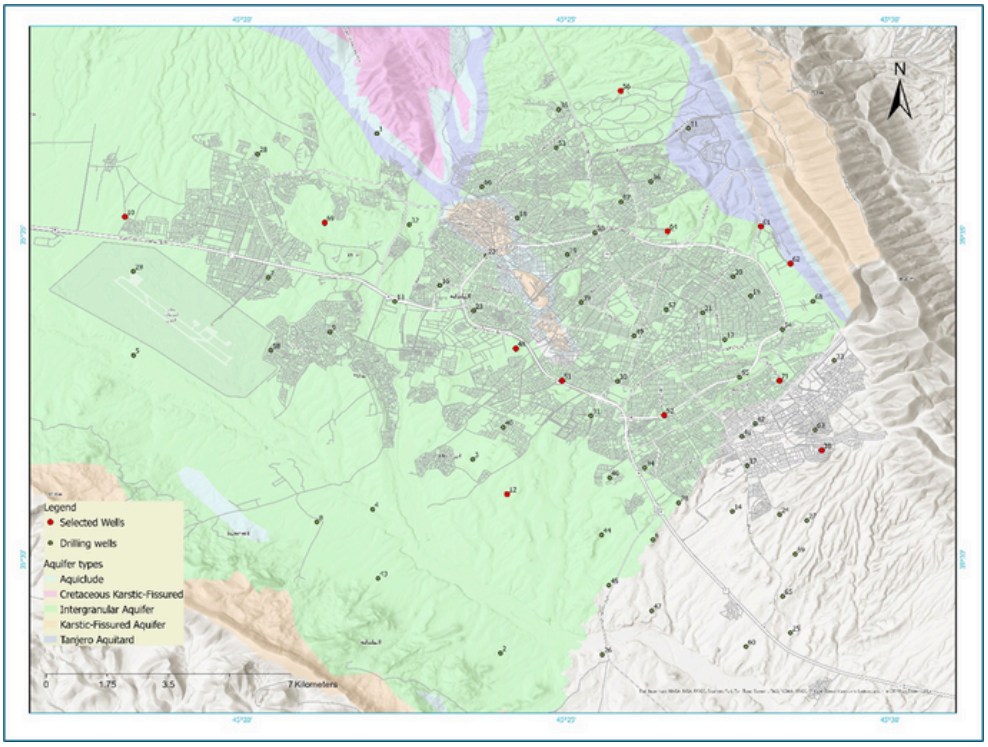

Figure 4. The location of the wells "10, 12, 38, 48, 56, 61, 62, 64, and 69" on map.

4.2 Rainfall Patterns and Climate Change Impacts in Sulaimani City (2000–2025)

Sulaimani City has experienced a massive change in terms of rainfall patterns as shown based on the collected monthly rainfall data from 2000 to 2025. The city has a semi-arid climate condition and has a specialty of wet season compared to many other parts of Iraq, especially from the late autumn to the early spring. The dry season occurs during summer months. Analyzing rainfall patterns and trends for the city is crucial for the policy and management of water resources and adapting the climate conditions. According to the data, the wet season of the city starts in December and ends in March, as these months recorded the highest amount of rainfall. Meanwhile, the summer months starting from June until September recorded the minimal rainfall amount, close to zero millimeters. These shifts in weather show that the farming process, storing water and balancing ecosystems are completely rely on the rainfall in the wet seasons. Therefore, if the rainfall is decreased in any winter season, it will negatively impact water security in the city. Figure 5 shows the monthly rainfall in Sulaimani City from 2000 to 2025.

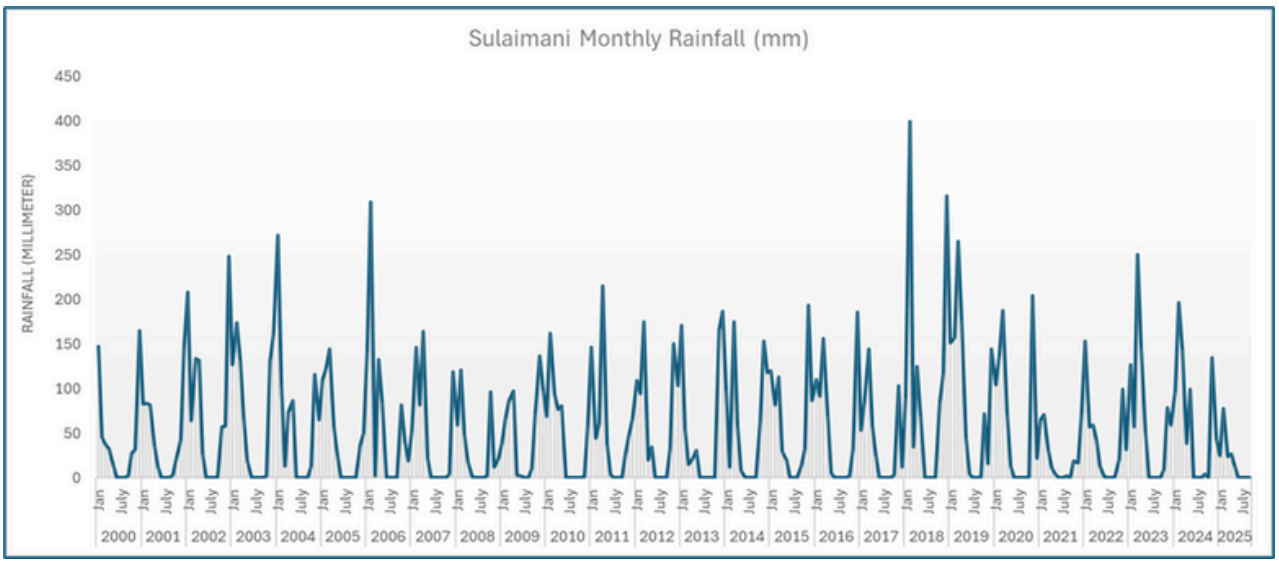

Figure 5. Monthly Rainfall in Sulaimani city from 2000-2025.

To analyze the overall situation of rainfall trends in the city, the description of statistics has been performed in terms of various measures such as the mean, standard error, median, mode, standard deviation, sample variance, kurtosis, skewness, range, minimum, maximum, sum, and count (Table 1).

Descriptive Statistics	
Mean	54.85096774
Standard Error	3.846919575
Median	26.9
Mode	0
Standard Deviation	67.73200844
Sample Variance	4587.624967
Kurtosis	2.964740117
Skewness	1.566249765
Range	400
Minimum	0
Maximum	400
Sum	17003.8
Count	310

Table 1. Descriptive statistics of monthly rainfall in Sulaimani City from 2000-2025.

The analysis of monthly rainfall in Sulaimani for the duration of 25 years shows important trends that are crucial for water resources management and planning in terms of policy. The datasets collected consists of 310 months show the average rainfall value of 54.85 millimeters, while the standard error of the data was ranged at 3.85 which indicates that the average rainfall value may vary by ±3.85 because of natural variability. Meanwhile, the median value was 26.9, which means that half of the months for the collected period were less than 26.9 millimeters and half of the remaining months receive more than this range.

Moreover, the mode was zero, which indicates that most months of the datasets were zero millimeters since rain mostly occurs in wet season. In addition, standard deviation was 67.73, indicating huge change in monthly rainfall from average rainfall amount. For instance, the average rainfall was 54.85, it could be usually ±67.73 since some months are very dry with almost zero rainfall while some months are rich in rain. Additionally, Kurtosis' value was 2.96, which shows that most months in the data have remained same with rare extreme events. The Skewness value is 1.56 which indicates that most months have low rain while few months have high rainfall amount. The range of 400 shows that the differences between driest and wettest months of the dataset was 400 millimeters as the minimum rainfall value is zero and maximum is 400.

To have a better outcome, the yearly rainfall from 2000 to 2025 has been presented in Figure 6 which shows fluctuations clearly. It could be seen that the annual rainfall amount ranges between approximately 200 millimeters and 1200 millimeters, this indicates that some yearly consider as dry year with very low rainfall amount while some years could be considered as wet year. For instance, the years 2018 and 2019 recorded the highest amount of rain which exceeded 1000 millimeters while 2025 shows the least rain. However, it should be noted that the collected data for 2025 was from January to September, excluding October, November and December.

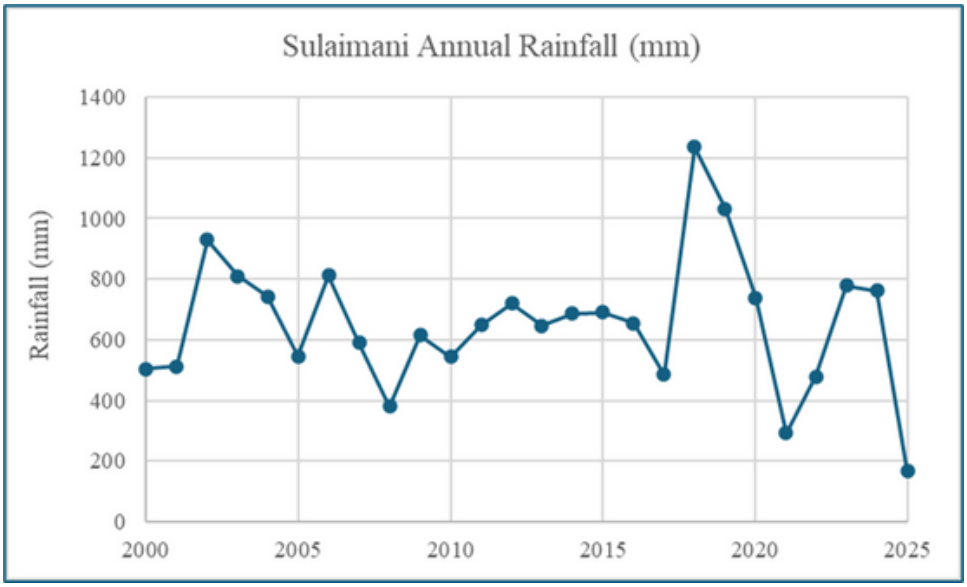

Figure 6. Annual rainfall in Sulaimani from 2000-2025.

Overall, understanding these ranges provides a clear image of rainfall availability which helps to plan for irrigation, dam reservoir storage, and groundwater recharge. It can help policymakers to plan for water resources management in a sustainable manner.

5. Proposed Solutions

The water shortage in Sulaimani city needs a comprehensive plan consisting of short-term, medium-term and long-term solutions. The proposed solutions focus on enhancing infrastructure, governance and policy reform, and water conservation through public awareness campaigns to ensure achieving sustainability and adaptability to the current climatic shift.

i. Short-term solution: This duration for this term would be up to six months, where the plan provides immediate solutions to help affected areas get access to clean water. It also focuses on fixing the leakage in the pipeline distribution system and avoiding wasting it. At the same time, there should be various campaigns through media and workshops at different levels for raising environmental awareness to learn how to use water wisely and how to keep it clean. Finally, polluting Sarchinar Spring through specific petrol stations should be immediately stopped and protect groundwater from contamination.

ii. Medium-term solutions: The duration for this term would be between 6-18 months. The first stage would be installing wastewater treatment plants for industrial factories and residential cities by the project owner through policy enforcements. Then the next focus would be rainwater harvesting system to collect runoff and use it for various purposes including irrigations and industrial usage after simple treatments. Local water governance should also be strengthened through monitoring processes and research activities. Finally, there should be sensor installation for the pipeline distribution system to detect any leakage point in the future automatically for the city generally, and for Dukan Line-1 and Line-2 pipeline networks specially.

iii. Long-term solutions: The duration for this term would be approximately 2-3 years. The long-term plan is designed to achieve water security in a sustainable manner. For instance, the wastewater treatment plant should be constructed for the city whether centralized or decentralized. Within this concept, all or most of the daily wastewater from the city would be treated back and reused for irrigation and other purposes, excluding drinking. This technique is not only to conserve water and solve water shortage issues, but it solves water pollution as well since it avoids wastewater to turn back to the environment without treatment process. Another plan is to construct Dukan Line-3 to ensure sufficient supply to the city. Finally, constructing the suggested dams would be crucial for saving water and increasing water storage capacity in the city. For instance, if Goma Qazan Dam is constructed, it can save up to 400 million m^3 of water. Meanwhile, if Basara and Zalan dams are constructed, they can save up to 35 and 25 million m^3 respectively. Therefore, the proposed long-term plan would completely result in achieving sustainable water resources management for Sulaimani City.

Figure 7 represents the Gantt chart for the proposed solutions of the current study.

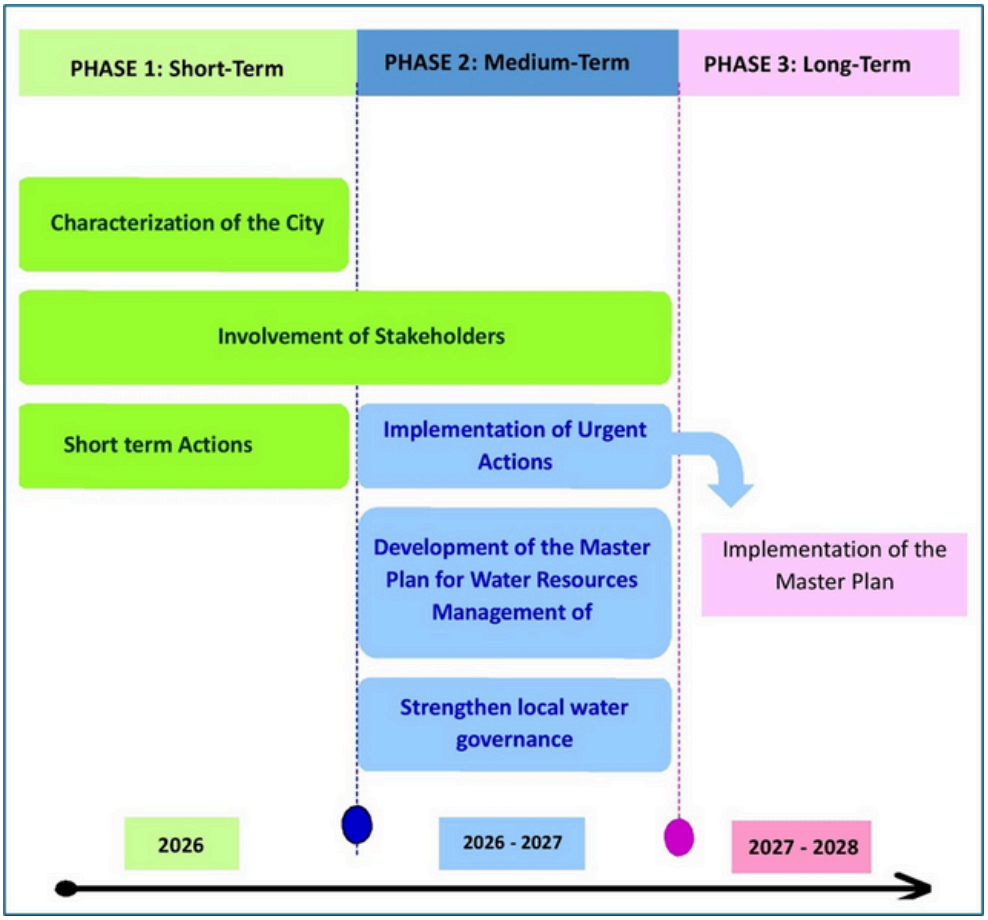

Figure 7. The Gantt chart of the proposed solutions.

6. Expected Costs

The cost for the short-term solution plan would be from low to modest as it includes fixing the leakage in the pipeline distribution system and raising environmental awareness campaigns. Regarding the medium-term solutions, it would require moderate budget as it focuses on building small wastewater treatment systems for the industries factories and residential buildings based on their own cost within policy implementation and enforcement. Moreover, the storage tank and basic filtration units would be needed for rainwater harvesting systems. Additionally, automated sensors for detecting leakage in the pipeline distribution system would also add a cost for the medium-term solution plan. Finally, the cost of long-term solution plan is estimated to be high as it includes constructing various projects, including wastewater treatment system for the whole city, Dokan Line-3 and recommended dams to save water up to 460 million m^3. The cost for the long-term solution plan is high, but it will secure water, food, and national security and establish a sustainable plan for future demands.

7. Conclusion

Water shortage in Sulaimani city would be worsened due to climate change, weak governance and population growth. Based on this study, groundwater has a huge depletion due to various purposes such as digging illegal wells, insufficient pumping rate, contamination, and overextraction. The water level in the main dams, especially Dukan Dam, is decreasing and has less than 25% of the storage capacity. This storage depletion of the main dam shows the need of immediate action to store more water in other places and manage waste usage sufficiently. The proposed solutions focus on various areas, including pipeline leakage repairing, public awareness campaigns, recycling wastewater, sensor detection installation for the pipeline systems, centralized or decentralized wastewater treatment plant, Dokan Line-3 construction, and constructing recommended dams by Sulaimani governorate. The recommended plans would save the city from water shortage and lead to achieving water, food, economy, and national security.

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Vision Foundation
for Strategic Studies

info@vfssiq.org
+964 772 330 0005
www.visionfoundationiq.org
Sulaymaniyah, Ashty, Opposite to Azadi Park

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