International Journal of Biological Engineering and Agriculture
ISSN: 2833-5376
Volume 03 Number 03 (2024)

www.inter-publishing.com

Article

Innovative Pipeline Solution for Water Scarcity in Iraq

Wafaa Fadhil Abbas

Collage of Civil Engineering, AL Mustansiria University, Baghdad, Iraq
Correspondence: wafaaf.abbas@gmail.com

Abstract: This project aims to transport potable water from Mosul Dam Lake to Basra Governorate via a pipeline designed to meet specific engineering requirements. The pipeline intersects reservoirs in central and southern governorates, supporting the Shatt al-Arab using the Tigris and Euphrates Rivers. The route, optimized through spatial data analysis, leverages topographical inclines for efficient water flow. The project addresses a critical need for potable water in central and southern regions, functions as an emergency backup for potential dam failures along the Tigris, and operates to maintain urban water quality amidst river pollution. Additionally, the pipeline's interior routing mitigates risks from terrorism and evaporation. Employing artificial intelligence in project management ensures cost-effective and efficient pipeline administration. This study highlights the innovative approach to water transport, addressing health, environmental, and security challenges, and filling a significant gap in regional water resource management.

Keywords: Euphrates and Tigrisurt , Southern Iraq, Shatt al-Arab.

1. Introduction

Water plays a major role, for all forms of life in general and for humans and their requirements in particular [1]. It represents the most basic foundations and the most urgent life requirements in its system, philosophy, and quality [2]. Water is a vital resource on which food production is based and development processes in all their aspects and forms are based on it [3]. It covers all human and civilizational needs and secures requirements and various human uses, such as water for drinking, water for agriculture, industry, energy, services, etc [4].

Since water is of such importance and the utmost necessity for the perpetuation of all variables of life [5], it therefore constitutes the first factor in the existence of life. Unfortunately, people often ignore the great importance of water through clear negligence towards this resource, ways to deal with it through waste and depletion processes. The challenges it faces and stand in the way of its development ambitions [6].

Generally, a small percentage of fresh water on the face of the Earth is estimated at approximately 0.001% of salty and shallow water [7]. Carefully, seriously about respecting the use of water in more rational ways and with keen awareness. Our Lord has warned us against excessive use [8].

Therefore, water is included in all human uses [9]. Starting with the craft of agriculture [10], which consumes approximately (more than 50%) of the volume of fresh water revenues [11]. To cities and urban settlements, which come in second place on the scale of human water consumption [12]. The city includes the population and all their urban activities and various activities [13], all of which depend on water continuously, increasingly to ensure its permanence and modernity of life [14].

Citation: Wafaa Fadhil Abbas. Innovative Pipeline Solution for Water Scarcity in Iraq. International Journal of Biological Engineering and Agriculture 2024, 3(3), 188-204.

Received: 14th Apr 2024
Revised: 14th May 2024
Accepted: 21th May 2024
Published: 28th May 2024

The nature of the increasing water needs of urban residents [15]. Its technology has become the most important criterion in the process of actual balance between human needs and available water resources [16]. As the World Health Organization estimates that more than (one billion) people are deprived of the availability of healthy water, and more than (5,000) people die (850 thousand) people per day as a result of consuming contaminated water. This number will double if the process of depletion of water resources in the world continues in light of the impact of sudden climate changes [17]. Increasing waves of drought and desertification that cast their shadow on the Earth's climate in general [18].

Human use of water may have multiplied by approximately 35 times during the last three centuries [19]. Increasing the population's consumption process. The amount of water in the last two decades is (4-8%) annually. Most of this increase occurs in developing countries where the culture and technology of water use is less, and Iraq is among the Arab countries whose water resources represented by surface water are exposed to excessive consumption and pollution due to an increase in the volume of water losses [20].

The annual flow of its fresh water towards the sea on the other hand, which will display. Its well-managed wealth leads to destruction and deterioration, which leads us to think and search for quick mechanisms and serious steps, as our water sources are threatened with depletion if we do not take the best means to control water requirements and address the methods of their consumption [21]. Hence, the study problem, its justifications, and hypothesis were chosen as follows.

The nature of urban water uses in Iraq, specifically in the study area, is not consistent with the requirements of the urban population and their economic reality [22]. The dominance of traditional methods in dealing with water consumption, the weak management of water resources followed, contributed to the exacerbation of the water crisis, the increase of its material and moral effects on the population, and the size of their urban requirements.

The Aim of the Project. The project was conceived with the objective of transporting fresh water from the Mosul Dam Lake to Basra Governorate. This would be achieved by extending a pipeline that adheres to specific engineering specifications. The proposed pipeline would intersect tanks located at the administrative borders of central, southern governorates, and including Basra. Additionally, the pipeline would support the flow of water through the Tigris and Euphrates Rivers ultimately benefiting the Shatt al-Arab region [23]. The trajectory of the pipe was selected by the analysis of spatial data, wherein the optimal route was identified to facilitate the unobstructed movement of water along the inherent topographic gradient.

The provision of potable water to the governorates located in the central and southern regions [24]. The system functions as an emergency mechanism, in the case of a malfunction in the Mosul Dam or a breakdown in any of the Turkish dams situated along the Tigris River. The system has the capability to operate in its natural state, facilitating the transportation of potable water to urban areas while preserving the quality and quantity of water in light of pollution discharged into rivers. This aspect encompasses both health and environmental considerations.

To mitigate potential risks such as terrorist attacks and breaches [25]. The pipeline is situated within the river [26], safeguarding it from external threats and minimizing losses due to evaporation. One potential approach to project management is the utilization of artificial intelligence (AI) technology [27]. By employing AI, it becomes possible to effectively monitor and regulate expenditure levels, as well as facilitate the efficient opening and closing of project pipelines.

Geography of the Euphrates River and Its Water Revenues. The emergence of the first population centers in Iraq was the result of investing its water resources in irrigation, agricultural operations, urbanization, and the regions of central and southern Iraq. Particular qualified for human settlement from an early time relying on the waters of the

rivers (Tigris and Euphrates) to establish the first agricultural settlements in ancient Iraq. An abundance of water was a major driver in its spread throughout the region and quickly [28]. The waters of the Tigris and Euphrates rivers represent the main surface resources in Iraq. Despite the availability of usable groundwater, the scope of its use is relatively limited [29].

In addition to rainwater rates which vary depending on its natural regions and climate fluctuations. Both the Tigris and Euphrates rivers originate from Turkish territory and enter Iraqi territory after passing through Syrian territory. Here we follow the Euphrates River in particular as it is the only water resource on which the cities of the Middle Euphrates depend. The area of the Euphrates Basin is about (444 thousand km2) and the quality of its water is characterized by its suitability for drinking.

Its uses vary from time to time depending on the number of dissolved salts and the percentage of silt suspended in it. It contains a percentage of salts ranging between (400-200 mg/L) parts per million, which is an acceptable percentage. As for the percentage of plankton, it ranges between (1000 and 4000 mg/L) parts per million, and it increases during flood seasons. The Euphrates River originates in the mountains of Turkey at an altitude of more than (3000 m) above sea level and consists of the confluence of Arfidiyah (Mard-Su) and (Fart-Su) which meet near the Turkish village of (Kiban), where the river is later known as Euphrates.

The river flows through Turkish territory and then enters Syrian territory at the village of Jarabulus, where its tributary (Al-Sajur) flows into it. Then the river continues its flow through barren lands and at the village of Al-Raqqa, where it meets its tributary (Al-Balikh) while its other tributary (Al-Khabur) flows into it at The Syrian village of Al-Busayra, located to the south of the city of Deir ez-Zor. The river enters Iraqi territory at the village of Husayba in Al-Qaim, northwest of Iraq (Map-1).

During its course, it passes through the cities of Anah, Hit, Ramadi, and Fallujah, heading towards the low-lying Iraqi alluvial plain area to reach a dam. After the Hindiyah Dam, the river passes through the cities of Hindiyah in Karbala Governorate and Al-Kifl in Babylon. At a distance of (1) km from the city of Al-Kifl, the Euphrates branches into two branches: (Shatt Al-Kufa) to the west and (Shatt Al-Shamiya) to the east. The first passes through the cities of Kufa and Abu Sakhir.

It reaches the south to Al-Mishkhab and the Al-Qadisiyah district within the Najaf Governorate. The second branch disappears at the Al-Khoms and Al-Nughishiya districts, after which it meets its first branch. The Euphrates continues to flow south towards the Al-Shinafiyah area within the Al-Qadisiyah Governorate, splitting again into two branches: (Al-Daghfiliyah) to the east and (Shatt Al-Atshan) to the west, which meet once again at the borders of the city of Samawah within Al-Muthanna Governorate. After about (8) km from the city of Samawah, (the Al-Suwayr River) branches off on its left side to meet again with the main river course near the city of Al-Khader, a distance of (51) km south of the city of Samawah.

Then the river continues its course until it enters the city of Nasiriyah, southern Iraq to pass through the town of (Souq Al-Shuyoukh), and then branches from it (Shat Al-Safha), which ends with the two streams (Al-Akika and Karma Hassan), which flow into the Al-Himar Marsh within Dhi Qar Governorate. While the main course of the river continues to pass through the area of (Karma Bani Saeed). The river then branches into three branches: (Bani Saeed, Al-Haffar, and Umm Nakhla), all of which end in the Al-Himar Marsh in the south.

The Euphrates River takes two streams within the Al-Himar Marsh. Where its northern course meets the Tigris River at the city of Qurna, north of Basra Governorate. While its southern part meets the Shatt Al-Arab in the area (Karma Ali) 10 km north of Basra. Thus it becomes clear most of Iraq's cities, which are located on the edge of the western plateau are fed by water from the Euphrates River, which is the main water source

for all its needs and life requirements. The water crisis in Iraq began with a significant drop in the levels of the Euphrates River. In 1969, the Euphrates River's maximum discharges reached (7406 m3/s).

Moreover, which exposed the river basin to flooding the level of river discharges decreased to its lowest level of (622 m3/s) in 2006. The highest annual discharge rates of the river in rainy years reached (65 billion/m3) with an average discharge capacity of (1300 m3/s). While its discharges in dry years reached (14 billion/m3) with an average discharge of 450 m3/s which will expose the region and its residents to serious risks with undesirable consequences.

The Euphrates' imports a current amount, according to the last monitoring of the station during the first quarter of 2009, amounted to five billion and 700 million cubic meters. This quantity represents (42%) of the average river's general imports, as the European Water Organization expects the river to completely dry up by the year 2020 if the current water policies on the river continue.

Table 1. Water imports of the Euphrates River for the water year 2005-2006 [30].

Monthly average	T1	T2	K1	K2	February	March	April	May	June	July	August	September	Average yearly	Annual billion m3
Average monthly	630	650	520	800	1250	600	510	520	565	615	660	580	654	6420
Average monthly	532	689	385	834	923	831	618	490	401	438	482	461	622	1962
%	118	94	66	96	135	72	83	106	141	140	137	126	105	105

Municipal use of water. There are many aspects of water use in urban areas, in a way that is related to the lives of residents and their daily requirements. As well as, to the level of the urban areas in which they live, the greater the rates of spatial urbanization. The higher the rate of water consumption to a degree parallel to it and sometimes exceeding it. It is expected those interested in this field have witnessed a significant increase in the amounts of water used to cover the needs of civilian life by a percentage exceeding consumption.

Water for agricultural purposes, the demand for water for industrial purposes in Europe recorded 54% of the total demand for water: This percentage in North America reaches (42%). While domestic uses are not less than (8%) of the total demand. This activity is expected to increase, especially in the Omani countries that are witnessing population growth, which has led to an increase in the size of cities, its suburbs and domestic water consumption is constantly changing from one place to another and from time to time. The total basic purposes for urban water uses are as follows:

1. Household uses such as drinking, washing, cooking and bathing.
2. Different industrial uses.
3. Transportation and communications uses.
4. Water uses for garden irrigation.
5. Water uses for building and construction.
6. Uses of water to maintain public health.

Many recent studies confirm that the rate of increase , water consumption in cities greatly exceeds population growth rates. These uses are distributed among various urban sectors table (2) These standards used to measure the rate of daily water consumption in

cities show that all urban productive and service sectors are moving towards excessive water consumption rates. Which are constantly increasing due to the increasing growth of the population and various economic sectors at the same time.

In Iraq, the volume of exploited surface water is estimated at (41.35). Billion m/year (water used for household purposes (about 580 million/m). for the year 1977, and the rate rose to record about (1.5 billion/m2) for (annually for the period between 1985 and 2000. The Ministry of Planning and Development Cooperation estimates the amount of water produced for urban purposes in Iraq at approximately (8265 million) in the year 2008.

Table 2. Water consumption rate in different urban sectors (Hasan et al.,2023).

Sector diversity	Consumption rate
1 Home consumption (litres)	
For drinking, cooking and cleaning per person/day 20-30	20-30 person/day
For swimming, shower once, 80-40	40-80
Cleaning sanitary facilities	15
garden watering per m	2-1
General consumption (litres)	2
Street washing per m	13
Watering plants	2
School for every child	2
Hospital per bed	650-200
Market per person	5
Circle for each worker	2
Industrial consumption (liters)	3
Coal per ton	205-105
Oil refineries per barrel	70-7
Iron per ton	80-20
Paper per ton	400-600
Dairy per m3 of milk	4-8
Tanning per meter of leather	4-2
Fertilizers per ton	10-12

2. Materials and Methods

Area of study . The project entails the transportation of water from the Mosul Dam Lake to the central and southern governorates via a dual pipeline with a minimum diameter of 2 meters. The transportation capacity of the water system is 1.5 million cubic meters, including a distance of at least 900 km for the Mosul-Tijlah route and 360 km for the Baghdad route. The Euphrates River is pumped in quantities of at least 3-4 pumps until it reaches the reservoirs situated on the administrative boundaries of each governorate in Baghdad.

From there, it continues to flow into the subsequent governorates. The project is widely recognized as one of the most expansive transportation systems globally. It encompasses an estimated 3-4 water pumping stations and 10 steel water tanks. These tanks are distributed evenly across each governorate based on the assigned consumer drainage volume. Each tank is required to have a minimum capacity of 250 thousand m3, with the collective capacity not falling below 2.5 million m3 of potable water per day.

The pipeline traverses' tanks situated at the administrative boundaries of each central and southern governorate. The trajectory of the pipe was selected by the analysis of spatial data, where in the optimal route was identified to facilitate the unobstructed

movement of water along the existing topographical gradient. The per capita proportion of water consumption, encompassing industrial, commercial, municipal, and governmental usage, was determined to range from 250 to 350 liters per day.

A domestic-focused emergency plan was implemented, encompassing essential household activities such as cooking, drinking, bathroom usage, and sanitary facilities. The daily water consumption for these purposes was estimated to range from 75 to 125 liters per day, as indicated in Table (1), which represents the average per capita consumption. During times of emergency. The consumption rate is recorded as 100 liters per day. It is advisable for all governorates to explore alternative approaches, such as desalination of water and investment in groundwater resources. These alternative solutions should also encompass the purification of heavy water within urban areas, its subsequent recycling, and its utilization for agricultural purposes within cities, as well as for street cleaning activities, among others. The following maps describe the locations of the project form the whole aera of Iraq.

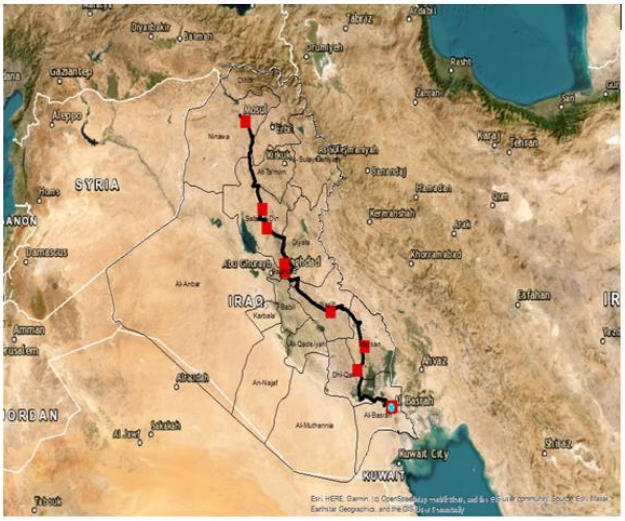

Figure 1. The location of project on Tigris River (the researcher,2024)

Figure 2. The location of project on Euphrates River (the researcher,2024)

Figure 3. The location of the project starts from the Mosul Dam (Google,2023).

3. Results and Discussion

The strategic objectives of this project are the most important:

A. A strategic project, an emergency plan for drinking water, which is needed for water projects , not to provide water for anything else only to the sustainability of the stability of cities with large population centers due to the lack of alternatives. Which is the target group sometimes, a village for which a well may be sufficient to meet the needs in extreme cases. It is considered a project to save Iraq for the next fifty years. Of the system sufficient for the central and southern governorates, each city is allocated strategic basins within the administrative borders as an emergency plan to confront scarcity.

B. The real economic feasibility of this project is to preserve the societal fabric and the stability of the population in the cities and avoid displacement from the city , the occurrence of value chaos here and not material savings. The feeling of insecurity in the period of extreme water scarcity and the panic and fear that accompanies the citizen in that period.

C. Providing fresh water to the central and southern governorates and delivering the sufficient amount of water needed for domestic use only.

D. Maintaining water quality due to pollution that is thrown into the rivers. Where the water quality is bad in Baghdad Governorate according to statistics, polluted and very bad and to a large extent in Basra Governorate (meaning a health and environmental aspect).

E. It can be used in normal cases on summer days during moderate scarcity.

F. The project provides continuous support , survival for the country and gives us the ability to confirm solutions to other problems. Such as, exploiting the water in the river for agriculture, industry, etc.

G. The system works as an emergency system when a defect occurs in the Mosul Dam or a failure occurs in one of the Turkish dams on the Tigris River. Instead of the Mosul Dam being damaged as a result of water releases coming from the Turkish side, instead of opening the dam gates , losing this water, and reduce of pressure on the dam body. This water can be diverted, water will flow into this system, thus it was act as an artificial reservoir and an alternative protective system. As well as , reducing the tremors induced in the dam body that cause widening of the cracks at the bottom of the lake due to hydrostatic pressure.

H. This project can be expanded as an additional proposal in the future in the event that a specific agreement is reached with Turkey. In the event of a real water crisis, it is possible to extend the pipeline.

I. The project consists of several stages that will complement the project in the future, including:1) The storage of Lake Tharthar was used after treating the lake from salinity.2) the project was used to support modern agricultural irrigation projects. 3) In the future, the pipeline would be extended to Turkey and the water would be purchased from it in case Turkey refused to give Iraq its water shares permanently.

J. The pipeline is intended for emergencies and is not an alternative to the current stream at all. Rather. The idea is to connect it with Turkey in the event of extreme scarcity and a global drought, as we can buy water from the Turkish side if it refuses to give the sufficient quantity to confront this global scarcity. Finality, confront the crisis , prevent mass displacement and migration from the people. The center the south causing huge financial losses, that exceed the price of purchasing water from Turkey until the crisis ends and the cities stabilize.

K. The pipe extends from the interior of the river in order to ensure that it is not exposed to terrorist attacks and encroachments. To ensure that losses do not occur from evaporation and encroachments. That the quantity reaches the home's income with uncontaminated drinking water, and also to avoid the state's exorbitant cost of purchasing land if it is extended outside the river by the state.

L. There must be a real direction for this project, by setting up meters for subscribers and pricing water in a real way. So that the citizen works to invest in water, rationalize it, and not waste it. The Ministry of Municipalities and Works, the departments of liquefaction , irrigation, and local governments must now work towards this. Its real direction is to set water standards and prices. Educating the citizen to invest in water in a real way. Especially since the culture of wastefulness is widespread in Iraqi society and the correct use of techniques that help in optimal use of water.

M. Using artificial intelligence technologies for project management governorates. Can improve the management of water pipeline projects , ensure their sustainability and effectiveness :
   a) Effective monitoring and maintenance: Remote sensing ,intelligent monitoring systems can be used to monitor the condition of the pipe and detect any potential problems early. Maintenance operations can also be organized based on predictive analytics.
   b) Optimize resource use: Artificial intelligence can help management optimize the use of resources such as water , energy through forecasting needs and effective planning.
   c) Risk management: Artificial intelligence models can be used to analyze potential risks and develop coping strategies. With it which contributes to reducing negative impacts. 4) Improving safety: Artificial intelligence systems can be used to monitor, analyze safety and maintain the integrity of the pipe and the surrounding environment. As well as, managing dams through artificial intelligence.

N. Make decisions: Artificial intelligence can analyze huge data, provide accurate recommendations to engineers and supervisors about when the gates. Must be opened or closed and how to manage water flow based on the current conditions of water scarcity in the event of an emergency. Artificial intelligence can even be used to monitor the condition of the dam's infrastructure and early detection of any Problems or damage before serious damage occurs. The details regarding the following project is described as the following table (3). It shows that Emergency

pipeline route (Baghdad-Euphrates)- Governorates located on the Euphrates River.

Table 3. Emergency pipeline route (Baghdad-Euphrates)-Governorates located on the Euphrates River [30]

The amount of consumer spending allocated for emergencies The average household consumption per capita is 100 liters/day For the year 2040	The amount of consumer spending allocated for emergencies The average household consumption per capita is 100 liters/day For the year 2035	The amount of consumer spending allocated for emergencies The average household consumption per capita is 100 liters/day For the year 2030	The amount of consumer spending allocated for emergencies The average household consumption per capita is 100 liters/day For the year 2025	population The next 50 years	The amount of increase annually 2.5%	Population is one million 2020 According to statistics from the Ministry of Planning	Governorate	Emergency pipeline route (Baghdad-Euphrates) Governorate
119 million m³	109 million m³	99 million m³	89 million m³3	4.882.500	54.250	2.17million	Babylon	Baghdad-Euphrates
84 million m³	77 million m³	70 million m³	63 million m³	3.465.000	38.500	1.54million	Najaf	Baghdad-Euphrates
74 million m³	68 million m³	62 million m³	56 million m³	3.037.500	33.750	1.35 million	Diwaniyah	Baghdad-Euphrates
47 million m³	43 million m³	39 million m³	36 million m³	1.929.702	21.441	857.652 thousands.	Al-Muthanna	Baghdad-Euphrates
121 million m³	111 million m³	101 million m³	91 million m³	4.950.000	55.000	2.20 million	Dhi Qar	Baghdad-Euphrates
70 million m³	64 million m³	58 million m³	53 million m³	2.880.000	32.000	1.28million	Karbala	Baghdad-Euphrates
	Total =472 million m³							
The amount of consumer spending allocated for emergencies The average household consumption per capita is 100 liters/day For the year 2060	The amount of consumer spending allocated for emergencies The average household consumption per capita is 100 liters/day For the year 2055	The amount of consumer spending allocated for emergencies The average household consumption per capita is 100 liters/day For the year 2050	The amount of consumer spending allocated for emergencies The average household consumption per capita is 100 liters/day For the year 2045	Opulation The next 50 years	The amount of increase annually 2.5%	Population is one million 2020 According to statistics from the Ministry of Planning	Governorate	Emergency pipeline route (Baghdad-Euphrates) Governorate
159 million m³	149 million m³	139 million m³	129 million m³	4.882.500	54.250	2.17million	Babylon	Baghdad-Euphrates
133 million m³	123 million m³	113 million m³	103 million m³	3.465.000	38.500	1.54million	Najaf	Baghdad-Euphrates
112 million m³	105 million m³	98 million m³	91 million m³	3.037.500	33.750	1.35 million	Diwaniyah	Baghdad-Euphrates
63 million m³	58 million m³	55 million m³	51 million m³	1.929.702	21.441	857.652 thousands	Al-Muthanna	Baghdad-Euphrates
161 million m³	151 million m³	141 million m³	131 million m³	4.950.000	55.000	2.20 million	Dhi Qar	Baghdad-Euphrates
94 million m³	88 million m³	82 million m³	76 million m³	2.880.000	32.000	1.28	Karbala	Baghdad-Euphrates

A comparison between the amount of consumer discharge according to the strategic study for the year 2035, about 7.5 billion m3. The amount of consumer discharge, according to the emergency plan for the year 2035, is about 1.5 billion cubic meters.

Table 4. The details of the comparison between the amount of consumer discharge according to the strategic study for the year 2035[30]

The amount of consumer spending allocated for emergencies The average household consumption per capita is 300 liters/day For the year 2035	The amount of increase annually 2.5%	Population is one million 2020 According to statistics from the Ministry of Planning	City	Track Emergency pipeline route (Mosul -Tigris)
590million m^3	98000 thousand	3.92	Mosul	Mosul- Tigris
253 million m^3	42000 thousand	1.68	Tikrit	Mosul- Tigris
937 million m^3	213.750 thousand	8.55	Bagdad	Mosul- Tigris
159 million m^3	36.250 thousand	1.45	Wasit	Mosul- Tigris
129 million m^3	29.250 thousand	1.17	Amara	Mosul- Tigris
335 million m^3	76.500 thousand	3.06	Basra	Mosul- Tigris
259 million m^3	43000	1.72	Diyala	Mosul- Tigris

Note 0: The per capita consumption rate according to the population equivalent of the Ministry of Planning for the year 2020 is 300 liters/day. The total drainage of the governorates in the normal state = 4 billion m3. Total discharge to the governorates in a state of emergency = 1.5 billion m3.

Table 5. A comparison between the amount of consumer discharge according to the strategic study for the year 2035 [30]

The amount of consumer spending allocated for emergencies **The average household consumption per capita is 300 liters/day** **For the year 2035**	**The amount of increase annually** **2.5%**	**Population is one million** **2020** **According to statistics from the Ministry of Planning**	**City**	**Track** **Emergency pipeline route (Mosul-Tigris)**
238 million m^3	54.250	2.17million	Babylon	Baghdad-Euphrates
169 million m^3	38.500	1.54 million	Najaf	Baghdad-Euphrates
148 million m^3	33.750	1.35million	Diwaniyah	Baghdad-Euphrates
130 million m^3	21.441	857.652 thousands	Al-Muthanna	Baghdad-Euphrates
332 million m^3	55.000	2.20 million	Dhi Qar	Baghdad-Euphrates
193 million m^3	32000	1.28	Karbala	Baghdad-Euphrates

The job description. Then it was proposed to construct a double pipe with a diameter (4 meters) to transport water from the Tigris and Euphrates rivers. The first takes the water of the Tigris after it enters Iraqi territory and extends from Mosul to the city of Basra, with an estimated length of up to 900 km. The second takes the water of the Euphrates River from an area near Baghdad to the city of Nasiriyah. With an estimated length of up to 380 km. Study required. Pre-project work includes the following:

1) First: Soil tests, including geotechnical and pore holes with a depth of not less than 15 meters in four areas of the river, and topographic examinations of the area

with satellite images, determining the path taken by the pipe in the Tigris and Euphrates rivers.

2) Secondly: Knowing the type of soil through which the pipe will pass
3) Third: Knowing the concentrations of sulfates and chlorides present in soil and groundwater
4) Fourth: Knowing the quality of groundwater and when its level changes during the year
5) Fifth: Determine a suitable method to protect iron pipes from corrosion, such as coating the inside and outside, and appropriate materials compared to the site conditions. Sixth (Any other studies necessary to be mentioned in this report) Speculative detection. To create a pipe in the open state, Estimation table for calculating priced quantities is described in the following tables and the total estimated cost = $13.500 billion.

Table 6. The details regarding the earth works for the pipeline (the researcher,2024)

Notes	Total cost USD	Unit Price USD	QTY	Unit	Description	No.
The foundation layer was assumed to be at a depth of 1.5 m	250 million dollar		19.200million/m3	Meter cubic	Excavation in soil in any type of soil (soft, rock, and semi-rock). The item includes shoring and shuttering. The items include disposal of surplus earth to outside to any unobjectionable place to be identified by contractor at his own cost under the instructions of the civil engineer	1-1
	100 million dollar	Partly	19.200million dollar	Meter cubic	Supply and lay filling material from approved cut soil or imported material around foundations & any other places up to ground slab level in layers not more than 20 cm thick for each layer with compaction. The works including compacting the design soil surfaces, the work includes all tests as per specifications & Engineer Instructions	1-2

Table 7. The details of the pipeline regarding the concrete work (the researcher,2024)

Total cost USD	Unit Price USD	QTY	Unit	Description	No.
256million dollar	100 dollar for meter cubic	Million meter cubic 2.560.000	Meter cubic	Supply and cast ready mix plain concrete Fcu = 30 Mpa for Blinding beds. including polythene sheets. the work includes all tests as per specifications & Engineer Instructions	2-1
3.200 Billion dollar	500 dollar for meter cubic	6.400.000million meter cubic	Meter cubic	Supply and cast ready mix plain concrete Fcu = 20 Mpa for the ground slab 50cm thick including polythene sheets below concrete slab and compacting the soil beneath the slab to 98% of MDD.	2-2

Table 8. The details regarding the steel tanks works Project implementation period 2 years (the researcher,2024)

The continued table					
8.400.000	totally	40000 thousands tubes	M4	Preparing, implementing and connecting iron pipes that are sealed from the inside with food grade epoxy or any other suitable material that does not cause a change in the thickness of the water transported in the pipe, and also sealed from the outside with layers of polyethylene or any other material resistant to rust and corrosion, while adjusting the joints between the diameter of the pipes and ensuring that they are impermeable. Note that the length of each single piece of pipe is (7 meters) and its diameter is (4 metres). It will be a double pipe and fixed on foundations or any other foundations, according to what is stated in the soil investigation report that will work along the proposed route. Note that the double pipe for the Tigris River is 900 kilometers long. Meters and 1,300 pieces, and the double pipe of the Euphrates River, 300 kilometers long and 55,000 pieces.	
7500000000	Totally			Reserve amounts to cover price changes, pipeline route changes, or any other emergency matters	
1.750billion dollars	Totally	140tank		Steel tanks equal (10) tank dimensions (according to the study and specifications of the American code). Steel tanks using high-quality stainless steel certified by AISI 304 or AISI 316, with the latest TIG robot welding system. The size of the tanks ranges from 500 to 250 thousand litres. The prices of storage tanks made of stainless steel depend on the size, type, quality and distribution of the tank in each governorate, and according to the amount of drainage allocated to it, where the carrying capacity of each tank is 250 thousand m3 and the carrying capacity is not less than 2.5 million m3.	
10 million dollar	Partly	24 Pumping unit		Pumping units at distances calculated during the final design, which do not exceed approximately three or four units.	
One million dollar	Partly			The control building (control room) contains integrated furniture for management and maintenance engineers and working staff, with all remote sensors and an artificial intelligence system to control the closing and opening of pumps, tanks and pipes.	

The role of the culture of rationalization and government control :

a. Water rationalization methods are an urgent necessity imposed by the conditions of our world today, especially in hot, dry and highly developed regions.
b. Due to the rapid population growth, humans and all aspects of their lives are linked to the presence of water, so preserving it and rationalizing its use are priorities. Countries, , media , community education contribute to the necessity of raising awareness of society at its various classes and levels on various relevant aspects

c. The direct connection to the economic use of water and protecting it from pollution , depletion and even if the individual knows that the water he consumes is for use. Sanitary facilities exceed more than (60) liters per day per person, using a laundry machine once a day requires more than from (40) liters, taking a shower for ten minutes requires (190) liters. leaving the water tap open consumes (190) liters, (15) liters and washing the car once requires more than (200) liters. knowing the extent of misuse of water in light of the fresh water crisis.
d. Globally, on the one hand, the amount of demand for water is constantly increasing, on the other hand, it is the responsibility of the state. Institutions governmental, non-governmental organizations, specifically media institutions and universities. Great national responsibility in conveying the message and culture of rationalization.
e. The full picture becomes clear to the citizen regarding the future of water scarcity. Increased demand for it, as well for citizens to reduce the level of water waste.
f. The education process requires preserving, respecting the quality of fresh water and reducing the sources of its pollution. Specifically, by industrial sectors and sanitation projects. Judicial institutions also have the responsibility of enacting, legislating and holding water conservation laws. Those who are negligent and apply scientific methods represented by water technology and methods of subjecting them to penalties. It also requires the state to approach. Its use, processing, recycling, and various sources of obtaining it.

4. Conclusion

The study can make some recommendations that it deems appropriate, falling into the following axes. Establishing a scientific center specialized in water studies in the region that includes expertise, this field from academics and technicians concerned with collecting data. Conducting field surveys of water, methods of urban use, providing reports and publications. To raise awareness among the population regarding the possibility of using water and ways to rationalize it scientifically.

Work to improve the quality of water reaching the consumer and reduce the levels of pollution in it to prevent residents from resorting to using water desalination techniques that cause the depletion of large quantities of water. The need for the state to move towards providing alternative water sources to surface water and investing in them, such as groundwater, which is widely available with the possibility of using it in urban areas. The entire region, as many geological studies indicate.

Reconsidering the approved urban water pricing in Iraq and the state's actual approach to standardizing the per capita share of water by installing standards in homes, shops, and government institutions to control the amount of water consumed by the population. In order to reduce water losses throughout the study area.

Establishing artificial dams and reservoirs on the Euphrates River in particular. Especially, in the southern region of its mouth to prevent the possibility of maximum use of water from reaching the Arabian Gulf quickly and easily. Accelerating the conclusion of water agreements between Iraq , its neighbors that share with it the waters of the Tigris and Euphrates rivers and their tributaries (Syria, Turkey, Iran). Internationalizing the water issue under the umbrella of the United Nations, striving to preserve the water rights of Iraq. which have been greatly affected by the size of large water projects. In both Turkey and Syria.

The economic feasibility of establishing a strategic project that provides a plan in its natural state and emergency situation to provide potable water at the time of peak water scarcity is as follows. Achieving critical water security and community stability within cities during the period of water crisis. Confronting the threat of displacement , mass

migration from cities , population centers, which, if it occurs and must cause billions in losses to the state. It represents an alternative emergency plan to provide fresh, raw water for filtration projects in the event that riverbeds are exposed to drought.

According to the statistics of the Ministry of Planning and according to the sources, an illustrative table shows the results. As the volume of the amount of consumer drainage allocated to emergencies/the average household consumption per capita is equal to 100 liters/day. As the rates, of increase in the amount of drainage increase annually compared to the increase in the population between the end and the beginning of the year 2020-2070. For the governorates located on the Tigris River.

REFERENCES

[1] D. Sanjuan-Delmás, et al., "Environmental Assessment of Different Pipelines for Drinking Water Transport and Distribution Network in Small to Medium Cities: A Case from Betanzos, Spain," *Journal of Cleaner Production*, vol. 66, pp. 588-598, 2014.

[2] H. Xu, and S. K. Sinha, "Fuzzy Logic Applications for Water Pipeline Performance Analysis," in *Fuzzy Systems Modeling in Environmental and Health Risk Assessment*, pp. 235-258, 2023.

[3] Y. Chen, et al., "Review of Oil–Water Flow Characteristics of Emptying by Water Displacing Oil in Mobile Pipelines," *Energies*, vol. 16, p. 2174, 2023.

[4] J. S. Gan, and Y. M. Hung, "Remarkable Thermal Performance Enhancement of Micro Heat Pipes with Graphene-Nanoplatelet Nano-Wicks," *Nanomaterials*, vol. 13, p. 232, 2023.

[5] O. Giustolisi, F. G. Ciliberti, L. Berardi, and D. B. Laucelli, "Leakage Management Influence on Water Age of Water Distribution Networks," *Water Resources Research*, vol. 59, p. e2021WR031919, 2023.

[6] M. Abd-El-Mooty, R. Kansoh, and A. Abdulhadi, "Challenges of Water Resources in Iraq," *Hydrology Current Research*, vol. 7, pp. 1-8, 2016.

[7] S. H. Ewaid, S. A. Abed, and S. A. Kadhum, "Predicting the Tigris River Water Quality within Baghdad, Iraq by Using Water Quality Index and Regression Analysis," *Environmental Technology & Innovation*, vol. 11, pp. 390-398, 2018.

[8] M. Al-Mukhtar, and F. Al-Yaseen, "Modeling Water Quality Parameters Using Data-Driven Models: A Case Study of Abu-Ziriq Marsh in South of Iraq," *Hydrology*, vol. 6, p. 24, 2019.

[9] N. Al-Ansari, "Management of Water Resources in Iraq: Perspectives and Prognoses," *Engineering*, vol. 5, pp. 667-684, 2013.

[10] S. H. Ewaid, S. A. Abed, N. Al-Ansari, and R. M. Salih, "Development and Evaluation of a Water Quality Index for the Iraqi Rivers," *Hydrology*, vol. 7, p. 67, 2020.

[11] A. Othman, A. Abdelrady, and A. Mohamed, "Monitoring Mass Variations in Iraq Using Time-Variable Gravity Data," *Remote Sensing*, vol. 14, p. 3346, 2022.

[12] N. Al-Ansari, S. Saleh, T. Abdullah, and S. A. Abed, "Quality of Surface Water and Groundwater in Iraq," *Earth Sciences and Geotechnical Engineering*, vol. 11, pp. 161-199, 2021.

[13] R. H. Al-Suhili, and N. J. Al-Mansori, "Forecasting Models for Some Water Quality Parameters of Shatt Al-Hilla River, Iraq," *Journal of University of Babylon*, vol. 25, pp. 1384-1391, 2017.

[14] S. A. M. Alhashimi, and A. S. Mustafa, "Prediction of Water Quality Index for Euphrates River, Iraq," *International Journal of the Environment and Water*, vol. 1, pp. 114-128, 2012.

[15] A. A. M. Al-Hussein, Y. Hamed, A. Z. A. Al-Ozeer, M. Gentilucci, and S. Bouri, "Impact of Climatic Changes on Surface Water in Middle East, Northern Iraq," *Environmental Earth Sciences*, vol. 83, p. 48, 2024.

[16] A. M. Rabee, B. M. Abdul-Kareem, and A. S. Al-Dhamin, "Seasonal Variations of Some Ecological Parameters in Tigris River Water at Baghdad Region, Iraq," *Journal of Water Resource and Protection*, vol. 3, p. 262, 2011.

[17] M. Jawad, A. Abdul Hameed, S. Haider, and K. Bahram, "Application of Water Quality Index for Assessment of Dokan Lake Ecosystem, Kurdistan Region, Iraq," *Journal of Water Resource and Protection*, vol. 2, pp. 792-798, 2010.

[18] S. L. Kareem, et al., "Water Quality Assessment and Phosphorus Effect Using Water Quality Indices: Euphrates River-Iraq as a Case Study," *Groundwater for Sustainable Development*, vol. 14, p. 100630, 2021.

[19] A. H. Ismail, A. H. Muntasir, and R. J. Channo, "Groundwater Quality Assessment in Urban Area of Baghdad, Iraq, Using Multivariate Statistical Techniques," *Engineering and Technology Journal*, vol. 33, pp. 1-15, 2015.

[20] D. R. T. H. Salam ALShamy, "Water Crisis in Iraq: Statistical Analysis for the Years 2019-2022 and Its Prospects Until 2030," *Journal of Positive School Psychology*, pp. 7366-7388, 2022.

[21] F. M. Hasan, and M. Q. A. Ghafoor, "Applying Water Sensitive Urban Design Strategies in the Historical City Center of Baghdad, Iraq," *ISVS e-journal*, vol. 10, pp. 245-265, 2023.

[22] P. Rizzo, "Water and Wastewater Pipe Nondestructive Evaluation and Health Monitoring: A Review," *Advances in Civil Engineering*, vol. 2010, p. 926369, 2010.

[23] H. J. Jun, J. K. Park, and C. H. Bae, "Factors Affecting Steel Water-Transmission Pipe Failure and Pipe-Failure Mechanisms," *Journal of Environmental Engineering*, vol. 146, p. 04020034, 2020.

[24] S. Hassi, et al., "Performance of Prestressed Concrete Cylinder Pipe in North Africa: Case Study of the Water Transmission Systems in the Tafilalet Region of Morocco," *Journal of Pipeline Systems Engineering and Practice*, vol. 12, p. 05021002, 2021.

[25] G. Alawadhi, M. Almehiri, A. Sakhrieh, A. Alshwawra, and J. Al Asfar, "Cost Analysis of Implementing In-Pipe Hydro Turbine in the United Arab Emirates Water Network," *Sustainability*, vol. 15, p. 651, 2022.

[26] T. C. Pierson, "Soil Pipes and Slope Stability," *Quarterly Journal of Engineering Geology and Hydrogeology*, vol. 16, pp. 1-11, 1983.

[27] S. Park, R. Vega, Z. Choto, and M. Grewe, "Risk-Based Asset Prioritization of Water Transmission/Distribution Pipes for the City of Tampa," *Florida Water Resources Journal*, pp. 22-28, 2010.

[28] D. B. Callaway, F. G. Tyzzer, and H. C. Hardy, "Resonant Vibrations in a Water-Filled Piping System," *Journal of the Acoustical Society of America*, vol. 23, pp. 550-553, 1951.

[29] A. O. Al-Jasser, "Pipe Service Age Effect on Chlorine Decay in Drinking-Water Transmission and Distribution Systems," *Clean - Soil, Air, Water*, vol. 39, pp. 827-832, 2011.

[30] F. M. Hasan, "Water Imports of the Euphrates River for the Water Year 2005-2006," unpublished.