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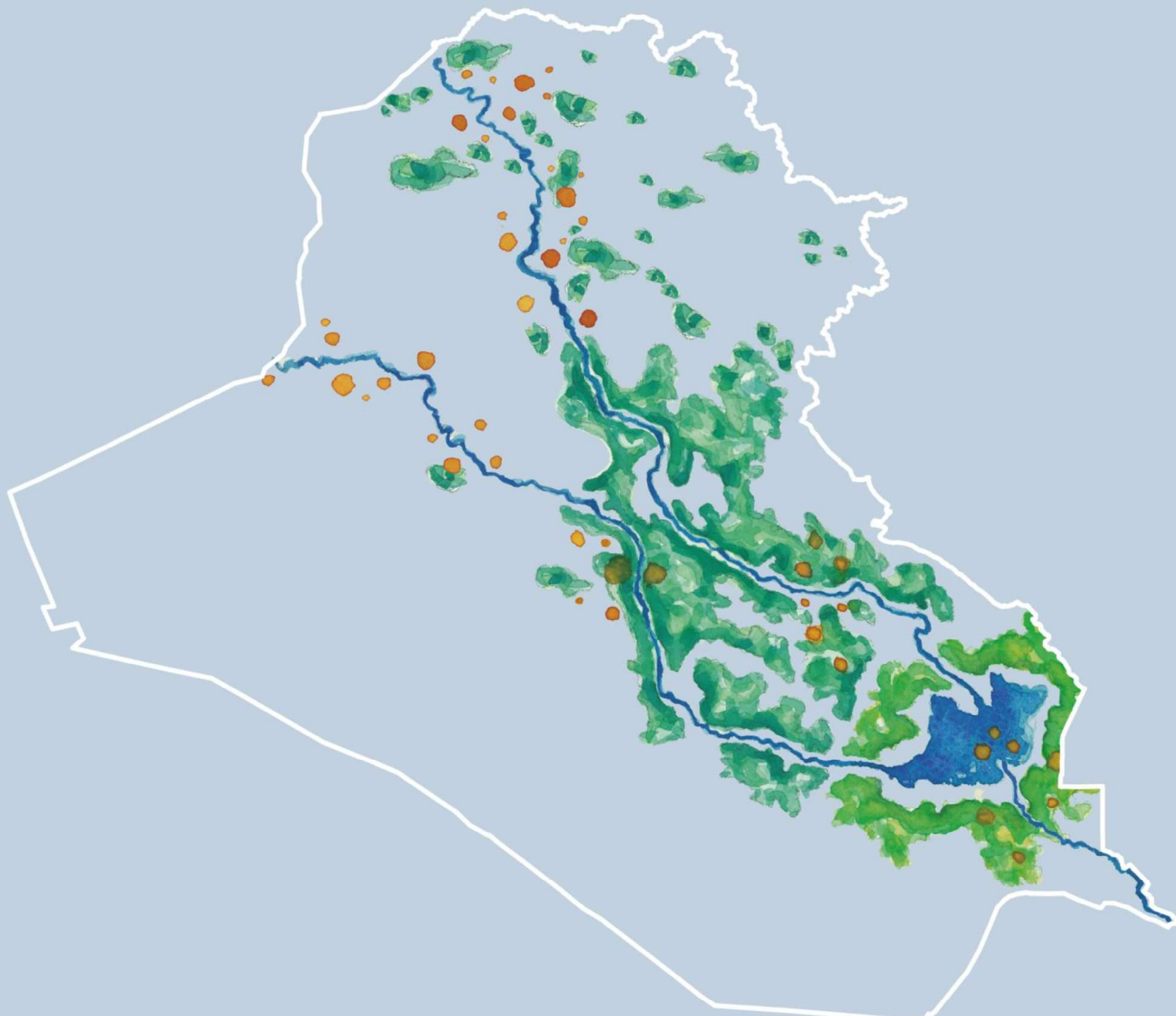
MINI STRY OF WATER RESOURCES

NAT I ONAL CENTER FOR WATER RESOURCES MAN AG EMENT

Strategy for Water & Land Resources in Iraq

Strategic Study of Water and Land Resources in Iraq



Final Report

4102

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Abbreviations and acronyms

Description	Description	abbreviation
Agro-climatic zones, agro-	Agro Climatic Zones	ACZ
ecological zones, hierarchical	Agro-Ecological Zoning	AEZ
analysis process	Analytical Hierarchy Process	AHP
Advanced Management	Advanced Management	AM
Reconstruction and development of agriculture in Iraq	Development Program for Iraq Agriculture Reconstruction and	ARDI
Pre-Central Era (BC) billion	Before the Current Era	BCE
cubic meters	Billion cubic meters	BCM
billion cubic meters	Billion cubic meters per year	BCM/Y
per year capital costs	Capital costs	CAPEX
cubic meters per second	Cubic meter per second	CMS
Central Agency for Statistics and Information Technology	Central Organization for Statistics and Information Technology	COSIT
Combined seawater supply facility with	Common Seawater Supply Facility	CSSF
integrated units	Compact Units	CU
data storage system	Data Storage System	DSS
Drainage water	Drainage Water	DW
East Tigris Drain	East Tigris Drain	ETD
Food and Agriculture Organization of the United Nations	Food and Agriculture Organization of the United Nations	FAO
Flood models	Flood Models	FM
Type of agriculture	Farming Type	FT
GDP	Geodatabase	GDB
Geodatabase	Gross domestic product	GDP
Hydrogeological Resources and Assessment Network and Database for Iraq	Hydrogeological Resources Assessment Network and Database for Iraq	GEO-FIA
Geological Survey of	Geographic Information	GEOSURV
Iraq GIS Iraqi	Systems Geological Survey of Iraq	GIS
Government	Government of Iraq	GOI
Iraqi government	Government of Iraq	GoI
Groundwater Unit	Groundwater Module	GW
gigawatt-hour per year	Giga Watt per hour per year	GWh/y
Hydrological Engineering Center (U.S. Army Corps of Engineers)	Hydrologic Engineering Center (of the USACE	HEC
HEC River Analysis System	HEC Reservoir Simulation	HEC-RAS
Simulation model for harvest	Model HEC River Analysis System	HEC-ResSim
index tanks HEC	Harvest Index	HI
The percentage of dependence on imports is the	Import Dependency Ratio	IDR
national integrated energy strategy.	Integrated National Energy Strategy	INES

Description	Description	abbreviation
International Water Resources Management	International Water Resources Management	IWRM
Knowledge base data	Knowledge Base Dataset	KBD
Kurdistan Regional Government	Kurdistan Regional Government	KRG
Paper area index	Leaf Area Index	LAI
Liters per person per day	Liter per day	LPCD
Cubic meters per second	Cubic meters per second	/s3m
meter above sea level	Meters above sea level	masl
million cubic meters	Million Cubic meters	MCM
Minimum dietary energy requirement	Minimum dietary energy requirement	MDER
Mid Engineering Company	MED Ingegneria, srl.	MED
One million cubic meters annually,	Million cubic meters per year	mm3/year
Ministry of Agriculture	Ministry of Agriculture	MoAg
Public drain	Main Outfall Drain	MOD
Ministry of Water Resources	Medium Term Expenditure	MoWR
Iraqi Ministry of Water Resources	Framework Iraqi Ministry of Water	MoWR
Medium-Term Expenditure Framework	Resources Ministry of Water Resources	MTEF
Megawatts	Mega Watt	MW
megawatt per hour per day	Mega Watt per hour per day	MWh/day
National Center for Water Resources Management	National Center for Water Resources Management	NCWRM
National Development Strategy National	National Water Development	NDS
Water Development Strategy Operating	Strategy National Development Strategy	NWDS
Costs	Operation costs	OPEX
Planning template	Planning Model	PM
Prime Minister's Advisory Board	Prime Minister's Advisory Council	PMAC
Maximum Flood Potential	Probable Maximum Flood	PMF
Regional Development Strategy	Regional Development Strategy	RDS
Return on Investment	Return On Investment	ROI
Sodium absorption rate in soil:	Sodium absorption ratio of soil	SAR
strategic evaluation criteria	SGI Studio Galli Ingegneria	SEC
SGI	Strategic Evaluation Criteria	SGI
SGI	Surface water module Studio Galli	SGI
Surface Water Unit	Ingegneria, SpA.	SM
Sandia National Laboratories	Sandia National Laboratories	SNL
Strategic questions	Strategic Questions	SQ
Self-sufficiency rate	Self-sufficiency ratio	SSR
Surface water models	Surface Water Models	SW
Water and Land Resources Strategy in Iraq	Strategy for Water and Land Resources in Iraq	SWLRI
Dissolved solids (representative of salinity concentration)	Total Dissolved Solids (representative of salinity concentration	TDS

Description	Description	abbreviation
Dynamic system model of the Tigris and Euphrates	Tigris-Euphrates System Dynamic Model	TE-SDM
Technical questions	Technical Questions	TQ
United Nations	United Nations	UN
United Nations Educational, Scientific and Cultural Organization	United Nations Educational, Scientific and Cultural Organization	UNESCO
U.S. Army Corps of Engineers	United States Army Corps of Engineers	USACE
United States Agency for International Development	United States Agency for International Development	USAID
US dollars	United States Dollars	USD
World Food Programme Water	Water Management System Model	WMSM
Management System Model	World Food Program	WFP
water quality	Water Quality	WQ
Water Quality Index	Water Quality Index	WQI
Water quality indicators	Water Quality Indices	WQIs
water treatment	Water Treatment	WT
water treatment plants	Water Treatment Plants	WTP
Municipal and industrial wastewater treatment	Treat municipal and industrial wastewater	WWT

Thanks and appreciation

The consultant for the strategic study of water and land resources in Iraq extends his sincere thanks and appreciation to the Ministry of Water Resources, the National Center for Water Resources Management - Strategic Studies Department, the study's steering committee, and all relevant parties who cooperated with us over the past three years to prepare the Iraq Water and Land Resources Strategy for the years 2014-2015. We were able to prepare this strategy thanks to their tireless participation and valuable comments.

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Executive Summary

The following pages were written to prove, frame, and plan for one fact illustrated in the graph below: that by the year 2012 Iraq will begin to suffer a progressive decline in its ability to meet its water needs, and that by the year 2041 Iraq will face the reality that it will not have sufficient quantity and quality of fresh water to meet its development needs.[1] However, this dire path can only be avoided through a major overhaul of water use and distribution, and a comprehensive solution. This can only be achieved through an agreement with the upstream riparian states. The Iraq Water and Land Resources Strategy, 2012-2014, provides the building blocks for the required reform and the data and analytical tools necessary for negotiation, adaptation, and planning.

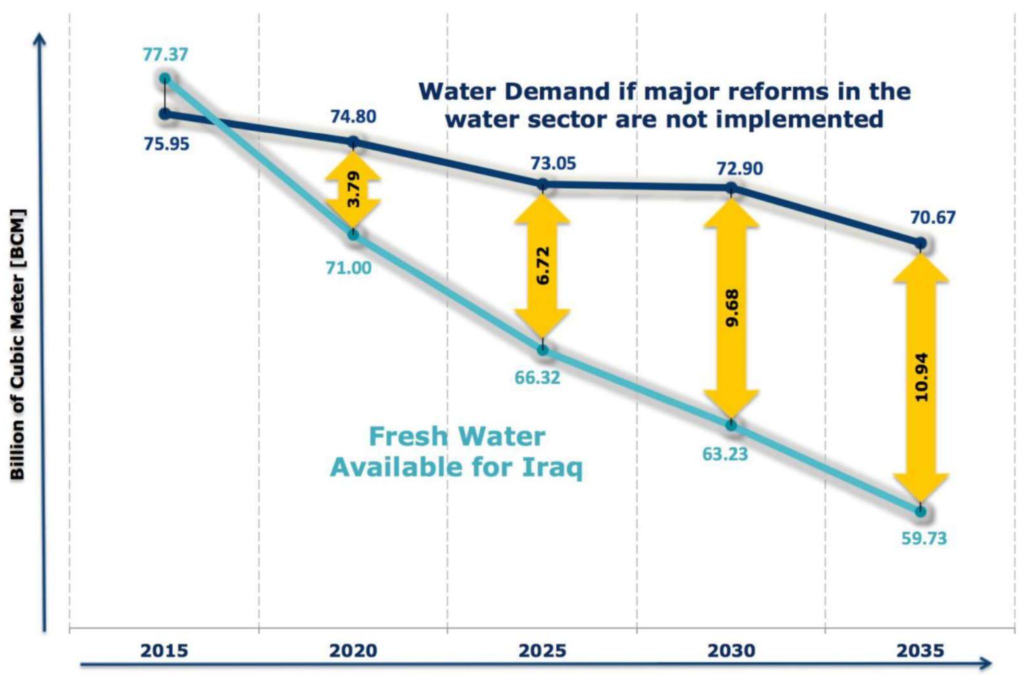

Illustration4-4: Comparison between available freshwater and water demand if major reforms are not implemented in the water sector in Iraq.

[1] This is assuming that no major reform of the water sector has been implemented and based on the current rate of population and industrial growth. The poor-quality water that would result from non-intervention would be expensive to use due to the level of treatment required. In addition, the expected low quantity of water available would hinder some water uses, such as feeding the Mesopotamian marshes or maintaining minimum flow rates for power plants.

Current study

A coalition of technical consultants has been working with the Iraqi Ministry of Water Resources staff since 2010 to prepare a strategy for water and land resources in Iraq (The SWLRI coalition consists of: Study from my companyMED Ingegneria srl and Studio Galli Ingegneria SpA The Italians and the Jordanian Concorde LLC. Some aspects were subcontracted with theIt is a US-based consulting firm with Exponent Center. Hydrological Engineering (U.S. Army Corps of Engineers) and Sandia National Laboratories.

The coalition has workedIntensively over the past three years with key SWLRI staff The Ministry of Water Resources was tasked with developing recommendations for the optimal use of Iraq's water and land resources for the next twenty years. The final outcome of this effort, this strategy, would not have been possible without the hard work and expertise of the Ministry of Water Resources and the Strategic Study Steering Committee. To implement its directives, this project relied on massive data collection, extensive field visits, and state-of-the-art computer modeling technology to better understand the country's hydrological and strategic options. Equally important, the strategy was developed with continuous input not only from the Ministry of Water Resources but also from more than ten other ministries, as part of a dedicated steering committee, in addition to project managers, water control facilities, and other technicians.

The result is therefore a set of recommendations that are not only carefully engineered solutions to water management issues in Iraq but also a reflection of the experiences and interests of the relevant ministries in the Government of Iraq..GoI)

Most important achievements

Some of the project's key achievements:SWLRI includes:

- **Do more with less**Water availability will be 44.2% lower by 2042. However, with this strategy, Iraq will be able to expand its agricultural area by 0.0%.[2]and increased agricultural density by 42%.
- **Investing in the future**There will be an investment of $0.2 billion in the water sector over the next 20 years.

[2]This is the difference between the future cultivated land multiplied by111% targeted agricultural density and currently cultivated land multiplied With the current agricultural density, it is51%

- **Feeding the country**Through gains in the agricultural sector, Iraq will be able to improve food security and reduce dependence on imports, even as the population nearly doubles over the next 41 years.

- **Making planning possible**:I have created a coalition.,SWLRI0 databases and 4 geodatabases that provide an unparalleled understanding of the country's water resources through the systemJUMP Online, which provides an interactive tool for organizing and accessing data needed for future planning.

- **Improving health**Iraq will reduce salinity in rivers by 41%, improving the quality of drinking water and helping protect river ecosystems. In addition, funds have been allocated to ensure that sanitation services reach 11% of the population over the implementation timeline.

- **Protecting the marsh ecosystem**There will be 2.842 billion cubic meters of fresh water allocated to the marshes in an average hydrological year. This amount will cover 21% of the marsh area identified by the Iraqi Marshlands Restoration Center.CRIM will help Providing adequate flow to the Shatt al-Arab, in addition to good land management and modern agriculture, will reduce soil degradation and prevent desertification of agricultural lands. As a result, biodiversity will be protected in marshes, rivers, and lands that would otherwise be vulnerable to degradation.

Strategic study procedures

One of the main objectives of the strategic study is:SWLRI is the identification and classification of projects. Which allows for the optimal use of water and land resources. In formulating the project selection process, the Strategic Study Consortium followed an objective procedure that also responded to the comments of relevant stakeholders, which fuels industry and growth, and also relies on responsible distribution among competing uses. In other words, the selection process aimed to be organized, transparent, and balanced. To achieve this, and to identify the most appropriate projects, the process followed the following steps: determining the current quantity and quality of water uses (“facts”); setting future development goals and demands (“needs”); and using the priorities and objectives of the Iraqi government and other stakeholders to identify and prioritize projects.

Development (“Opportunities”).

The facts were collected in order to understand the historical conditions as well as the current uses of water and land resources in Iraq. This quantity has been coordinated

The vast amount of information within the databases is easy to use. Creating the databases is a notable achievement of the strategic study project.Because it represents the most advanced understanding of the SWLRI system. Hydrology in Iraq. Equally important, their ability to be continually updated to adapt to changing realities on the ground provides a highly flexible mechanism through which the Iraqi government can understand and plan for the efficient and sustainable use of water and land resources in the face of anticipated future water scarcity.

Future needs were estimated based on the expected water needs, and the quality of that water is related to that during 01 sector for the year 4142[3]The list of needs was drawn from the development plans of the federal, regional, and provincial governments, as well as from future projections of population and industrial growth. At all times, the identification of needs was constrained by priorities set by the Iraqi government, such as the promotion of certain crops, electricity generation targets, and the conservation of the Mesopotamian marshes.

There was broad participation from relevant stakeholders in gathering facts and highlighting needs.[4]Several committees were established and consulted, based on the technical expertise of fourteen ministries and government agencies. In addition, numerous meetings were held with senior decision-makers on the political and social aspects of the strategy. Finally, the Ministry's technical staff were consulted on a range of issues, including cropping patterns, the cost function of infrastructure development, land management practices, existing and planned irrigation projects, agricultural drainage infrastructure, and drought management strategies. There was also a significant capacity building effort by the Ministry of Water Resources, both at the general level and in terms of on-the-job training. The study consortium was keen to The presence of a staff of no less than SWLRI1 full-time experts in the Ministry for the duration of the project, which is three years, to provide ongoing advice and communication.

After identifying the current uses of water and land resources, the expected needs for the future, and the priorities and objectives of the Iraqi government, the study coalition reachedTo set priorities SWLRI For development opportunities. This selection was then included in a computer model called a planning model. As well as other analytical tools, (PM)[5]...to test different combinations to arrive at the most effective and sustainable project selection. Finally, after this arduous process, a final list of priority projects was selected and distributed on a feasible and equitable timetable across the country, as presented in this Iraq Water and Land Resources Strategy, 2012-2014.

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[3]For a full description of the sectors, see Part III of this document.
[4]For a full description of the process, see Part II of this document.
[5]For the complete list, see Part II of this document.

The relationship between water, food, energy, and environment

It was a big challenge inIdentify projects that maximize not only water and land use SWLRI But it also meets the need for food and energy security and preserves the environment. These sectors—water, food, energy, and the environment—are so closely interconnected that impacts on one inevitably have repercussions on the others. The interconnectedness or relationship between these sectors highlights the need for a delicate balance between competing uses of water, and this strategy seeks to achieve such a balance.

Project identifies:A number of pioneering results in each of the interconnected areas of SWLRI

Key water security outcomes:

- The rehabilitation of Mosul Dam, the expansion of Samarra Dam and Al-Muharrab Canal, and the rehabilitation of the Irrigation Canal (And maintaining the design of the Tigris conveyor in Baghdad,[6]
- The completion of the main drains should be considered the most important and urgent of the civil engineering projects. The Upper Zab River contributes 42% less water than previously thought, meaning that the amount is approximately 4 billion cubic meters less per year than Iraq should consider.
- Iraq does not need new large dams to achieve its 2042 goals. Hydropower is no longer the primary source of water in Iraq. Flood control can be achieved by rehabilitating the Mosul Dam, expanding the capacity of the Samarra Dam, and extending the Tharthar Canal.

  Therefore, due to the decrease in the amount of water entering Iraq, the change in the management of water reservoirs' operations, and the improvement of efficiency in all water sectors, Iraq will not need to build large new dams such as those proposed in Bakhma, Mandawa, or Al-Fathah.
- The lakes of Habbaniyah, Tharthar and Razzaza[7]They no longer provide water storage services to the country. In the future, due to declining available water resources and changes in water resource management, there will be no water to store in these two large natural depressions except during floods.

Key Food Security Findings:

- If Iraq fails to negotiate a water quality agreement with riparian countries and also fails to complete the drainage network proposed in this strategy, this will lead to a deterioration in water quality along the rivers and will cause a decrease of up to 41% in

[6]The flood design of Baghdad is 0122 m^3/Th in case of a flood in the Diyala River also (with flow0222 AD^3/th) and3022 AD^3/s When there is no flood in the Diala River (that is, it carries a flow not exceeding122 m^3/th)

[7]Lake Habbaniyah will not be used in the future for water storage simply because, based on the proposed water management, there will be no Excess water is diverted to this lake except in the event of floods.

Food production will result in the loss of more than 4 million acres of agricultural land over the next twenty years.

- Modernizing agriculture in Iraq, including the introduction of pressurized irrigation methods across the country, would cost two to three times more than previously estimated in various official documents, costing $42.244 billion over the next 20 years. However, failure to modernize would be far more costly. As this strategy explains, failure to improve the agricultural sector would spell the end of agriculture in Iraq, leading to unemployment, rural-urban migration, and food insecurity.

Key findings for energy security:

- Oil projects require 4.0 billion cubic meters of water annually by 2042, 4.1% of which must be drawn from the sea or drains. Desalinating and distributing this water will cost Iraq approximately $41 billion in infrastructure development and more than $21 million annually in electricity.
- Assuming that Baghdad and Erbil develop their hydropower plants separately, hydropower will contribute 4.4% of Iraq's total power generation by 2014.
- Ensuring minimum flows for power plants and domestic water intakes will be a challenge. It is estimated that Iraq will suffer a shortage of approximately 1 billion cubic meters per year (assuming 2 billion cubic meters per year for the marshes and 2 billion cubic meters per year for the Shatt al-Arab and Euphrates Rivers to ensure minimum environmental flows (MEF)) by 2022.

Key results for environmental protection:

- Even if Iraq were able to meet all the objectives of this strategy, given the magnitude of the water supply shortage, if no agreement is reached with the riparian states, significant services will not be provided in 2022, and the environment will suffer the greatest losses. Minimum Environmental Flows (MEF) cannot be guaranteed throughout the country. In an average hydrological year, the marshlands in southern Iraq will only partially recover.
- This strategy found that 2.412 billion m4/year[8]A minimum of fresh water must be allocated to the marshes to prevent social and economic losses across the country. If an inflow of at least 21
- m4/Th along the entire length of the Shatt al-Arab River, the leakage of salts from the sea can be avoided, and therefore building a dam on the Shatt al-Arab becomes

[8]This minimum is based on a wide-ranging assessment conducted under the recently completed "New Aden Plan for the Restoration of the Iraqi Marshes."

It is also not necessary. This strategy assumes that freshwater and drainage water can contribute to achieving this goal, and that the Tigris River can supply this minimum amount of water.

Water and Land Resources Strategy:

The following is a summary of the water, food, energy, and environment strategies. It should be noted that this is a brief summary of the complex and highly detailed information. A more comprehensive description is provided in subsequent chapters and appendices.

Water Strategy

Development in the Upper River countries: The strategy for dealing with future development in the high-altitude countries The two rivers are two-pronged. First, facing an uncertain future, this strategy assumes that 110% of the upstream projects in Türkiye, Syria, and Iran will be developed by 2042.[9].

Water allocation and planning in all sectors are carried out within the limits of this assumption and within the amount of fresh water reaching Iraq that is achieved by this scenario.

The second part of the strategy for dealing with the development of the upper reaches of the two rivers is that, although Iraq will plan for the worst, it will continue to seek an agreement with neighboring riparian states to obtain the highest possible quantity and quality of water it receives at the international border.

[9]In the context of the strategy, the concept of developing the upper rivers by 122% means that all planned irrigation projects and infrastructure projects The known water control infrastructure along the Tigris River basin in Iran and Turkey will be fully implemented by 2020.0231, and Iraq will at least guarantee54101 billion cubic meters annually from the Euphrates River (i.e. the existing agreements between Türkiye and Syria and between Syria Iraq will remain as it is) and all projects located along the Tigris River in Türkiye will be fully developed. More details are available in the attachment..C

table1-4: Water budget in Iraq for the years 2135-2145, assuming the development of 411% of projects in the upstream countries: Türkiye, Syria, and Iran

[10]AVAILABLE WATER [BCM/Year]

2035	2030	2025	2020	2015	
28,487	**31,870**	**34,592**	**38,482**	**43,696**	Fresh Water from Riparian Countries
9.999	12,383	14,137	16,683	18,396	Euphrates
9.822	10,703	11,588	12,905	15,919	Tigris
3.294	3,316	3.375	3,377	3,378	Greater Zab
2,182	2.203	2,219	2.236	2.292	Lesser Zab
3,189	3.266	3.273	3,281	3,710	Diyala
21,919	**21,919**	**21,919**	**21,919**	**21,919**	Fresh Water Generated Inside Iraq
1.123	1.123	1.123	1.123	1.123	Euphrates Hadith Dam - Qur'an
5,073	5,073	5,073	5,073	5,073	Tigris
7,462	7,462	7,462	7,462	7,462	Greater Zab
4,551	4,551	4,551	4,551	4,551	Lesser Zab
0.956	0.956	0.956	0.956	0.956	Adhaim
1.788	1.788	1.788	1.788	1.788	Diyala
0.967	0.967	0.967	0.967	0.967	[11]Tharthar
4,076	**4,193**	**4,568**	**5,359**	**6,507**	Return flow to the Rivers
54,482	**57,983**	**61,080**	**65,761**	**72,122**	**Total Surface Water**
5.243	5.243	5.243	5.2431	5.243	Sustainable Groundwater Withdrawals
4,556	4.667	4,817	4.423	3,781	Drainage Water
64,281	**67,893**	**71,140**	**75,426**	**81,146**	**Total Available Water (FW + GW + DW)**

FRESH SURFACE WATER CONSUMPTION [BCM/Year]

2035	2030	2025	2020	2015	
7,504	7.152	6.663	6,167	5,769	Municipal & Industrial
32,187	33,378	36,294	40,089	46,090	[12]Agriculture
0.329	0.329	0.329	0.329	0.329	Fish Farms and Livestock
5.825	6,395	6,554	7,037	5,388	Total Marshlands Consumption
3,391	4,402	4,514	4.691	3.934	Flow to the Gulf via the Shatt Al Arab River
0.959	0.959	0.959	0.959	0.959	Evaporation from Rivers
4.287	5,368	5.766	6,488	9.653	Evaporation from reservoirs
54,482	**57,983**	**61,080**	**65,761**	**72,122**	**Total Freshwater Consumption**

[10]The item "Water generated within Iraq" includes water exchanged with groundwater. The item "Water from return flow" includes agricultural flows and Household and industrial flows. Household and industrial flows represent the total consumption volume, assuming that141 billion cubic meters of The water needed for oil well re-injection is taken from the sea.

[11]The volume is 245.2 billion m3This is the natural flow to Lake Tharthar, as calculated in the groundwater study. This entire volume will evaporate. From the lake and is included in the amount of water evaporated from the reservoirs and is therefore considered unavailable for any other uses.

[12]Water requirements for agriculture include the decrease that may occur over the years when the available water quantities are less than the needs. Water for irrigation

GROUND WATER CONSUMPTION [BCM/Year]

2035	2030	2025	2020	2015	
0.400	0.369	0.337	0.304	0.272	Municipal & Industrial
1.882	**1.838**	**1.835**	**2.659**	**3,499**	Agriculture
0.103	0.097	0.095	0.089	0.099	From springs
0.300	0.261	0.261	0.256	0.251	From wells serving official irrigation projects
1.479	1.479	1.479	2.314	3,149	From wells serving areas outside official irrigation Projects
2.282	**2,207**	**2.172**	**2.963**	**3.771**	**Total Groundwater Consumption**

DRAINAGE WATER RE-USE [BCM/Year]

2035	2030	2025	2020	2015	
0.550	0.521	0.338	0.211	0.162	Oil Sector
3.693	3.834	4.166	3,899	3,306	Hammar Marsh (via MOD) + Shatt Al Arab (via ETD)
0.313	0.313	0.313	0.313	0.313	Green Belts
4,556	**4.667**	**4,817**	**4.423**	**3,781**	**Total Drainage Water Consumption**

If development in the Upper River countries does not reach 0.11%, but only 2%[13]Iraq will gain an additional 4.204 billion cubic meters of fresh water annually. This means that there are 4.8 billion cubic meters[4]The water will flow from Syria to Iraq through the Euphrates River, exceeding the amount Iraq is expected to receive under the current agreement. With this additional water, Iraq could develop approximately 11% of all proposed new irrigation projects. This would provide an additional $0.1 billion annually in food production.[14] Alternatively, Iraq could achieve 81% development of the marshlands, which would provide a minimum of $4 billion in estimated ecosystem services. If the water were left in the rivers, this would allow for a minimum environmental flow in the Shatt al-Arab of approximately 410 m^4/th, which means that more than 111,000 tons of salt per year will enter Iraq's fresh water supply.

droughtIn the coming decades, drought prevention and mitigation approaches in Iraq will revolve around more effective management of water reservoirs. Monthly calculations will be made on the amount held in reservoirs so that adequate water supplies can be allocated to manage drought (or flood) conditions. The study strategy has been dividedIraq's reservoirs to three levels SWLRI Controls and corresponding reductions in water allocations can be made when drought conditions exist.

[13]See Appendix C for more details on this scenario.

[14]This value was calculated on the basis of the increase in production that Iraq could obtain if 122% of the areas were exploited. Available

In addition, calculations will be conducted once a year, beginning in May, to determine the water availability for the agricultural sector for the summer season. Based on the results of this calculation, reservoir managers can plan the appropriate amount to store. If the results are properly communicated to the public, farmers, and others who rely on the available water, they can plan and select crops that are appropriate for the available water for that season.

FloodsThe flood control strategy includes: (0) Improving existing control facilities (4) Increasing the carrying capacity of rivers and canals where flow is restricted (4) Ensuring that storage sites not connected to streams are in a sound condition to receive floodwater. More specifically, the flood escape and canal at Samarra Barrage should be expanded to accommodate 4,211 m_4/th, the capacity of the Warrar Canal and the Majarra Regulator will be verified. No new dams are required for flood control, and the Tharthar and Razzaza lakes will be used primarily as non-river storage facilities in the event of flooding.

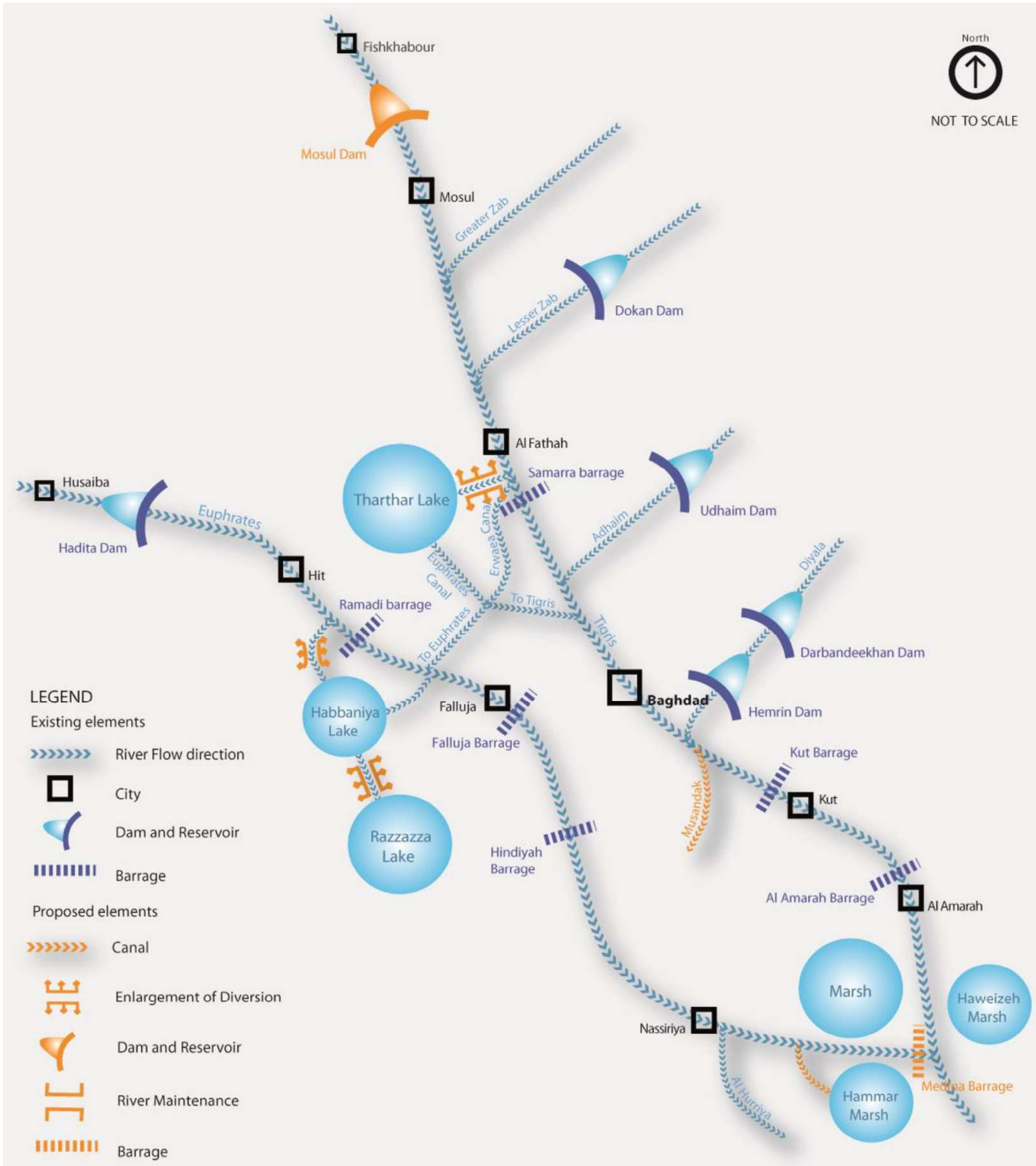


Illustration4-2: Proposed point map where the flood management strategy should be applied along the Tigris system

Municipal and industrial needs Meeting the water needs of the municipal and industrial sectors is taken as an absolute priority in the strategy. In addition, various policies have been identified for water reuse, rationalization and better monitoring of water consumption, and assistance in protecting the environment. This includes: (1) Increasing the number of water treatment facilities so that by 2022, they will be able to supply 8.142 billion cubic meters annually to the municipal sector (this amount does not anticipate any gains in consumption efficiency). (2) Improving and expanding the water pipeline network and achieving a steady decrease in distribution network losses. (3) Using meters to monitor consumption. (4) Expanding the number of wastewater treatment facilities so that by 2022, the facilities will be able to treat 1.8 billion cubic meters.

Cubic meters per year to be returned to rivers. (2) By the year 4142, industries that reuse water today will increase their reuse by 42%.

surface water In order to protect the quality of surface water in Iraq, the Ministry of Water Resources' existing water quality monitoring program will be improved, and sampling sites will be expanded to cover the Upper Zab, Lower Zab, Adhimiya, and Diyala rivers. To reduce salinity, 42 major irrigation projects will be gradually connected to drainage canals or evaporation basins so that agricultural drainage water does not flow into rivers and freshwater supplies. Finally, a 21-mL per day flow will be maintained.4/th along the Shatt al-Arab to stop the salinity in the Basra area. If this flow rate cannot be achieved, a dam must be built. If a dam is to be built, the best location is just upstream of the proposed port at Al-Faw, and it would be appropriate for it to be a joint project with Iran.

groundwaterBy 2042, the maximum sustainable groundwater withdrawal will be approximately 2.444 billion cubic meters (BCM), representing approximately 8.8% of freshwater resources by that time. This represents new groundwater withdrawals of approximately 0.44 BCM per year across the five groundwater systems. Some aquifers appear to be overexploited, so further studies are needed to assess the appropriateness of further extraction in some cases. Additional research will also be conducted on groundwater recharge basins to help restore groundwater stocks and improve conditions for sustainable withdrawal.

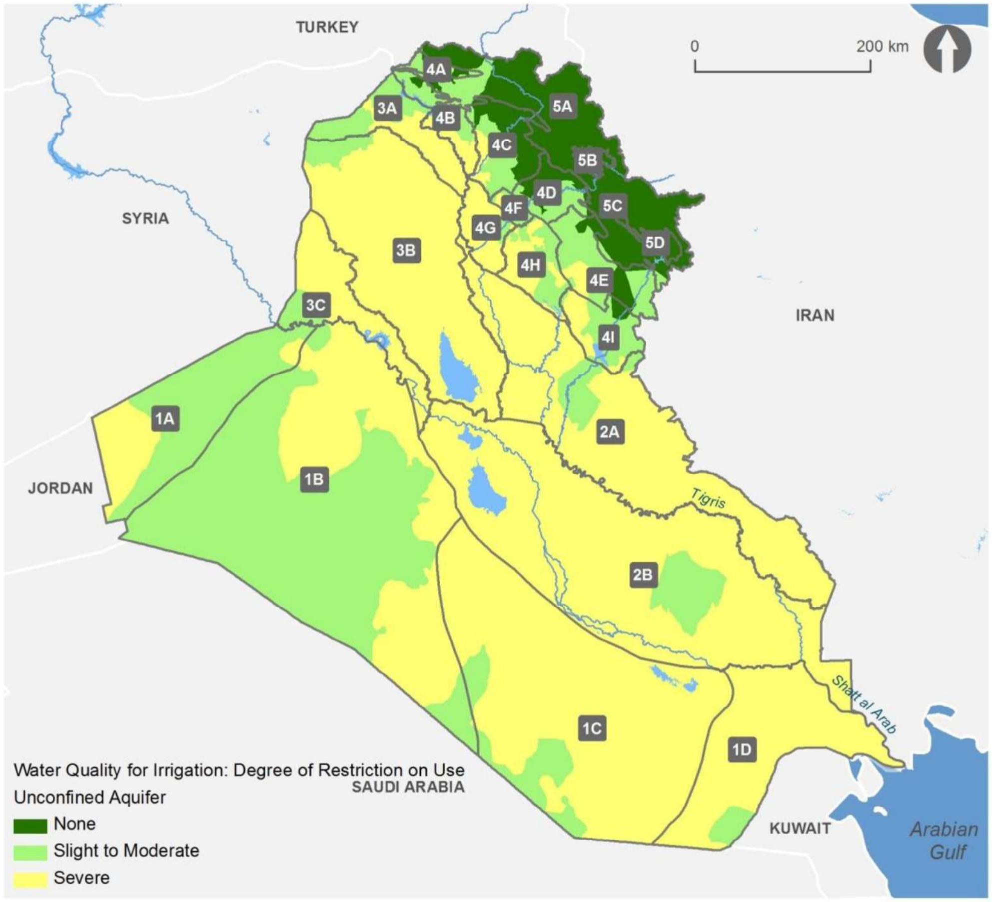


Illustration4-3: Classification of unconfined groundwater reservoirs according to their suitability for irrigation

NavigationBy cleaning the Shatt al-Arab section, it will be possible to ensure that ships can enter Basra from the sea. Water from the general outlet will be used to support municipal, industrial, and environmental needs. It will therefore not be used as a navigation channel beyond the Shatt al-Arab, which is considered uneconomical unless additional water supplies are secured from riparian countries. This strategy assumes that navigation will not be developed along the Tigris and Euphrates rivers at this time, although this will need to be reevaluated in the future.

Food strategy

AgricultureThe strategy divides the country into eight agro-climatic zones (ACZs) based on climate and crop suitability. Each agro-climatic zone has a specific cropping profile consisting of 44 strategic crops, which were selected in close consultation between the Ministry of Agriculture and the Ministry of Water Resources. In addition, the strategy identifies three different cropping patterns with different levels of cropping intensity and irrigation efficiency that the Iraqi government could adopt.GoI

Gradually, to improve agricultural production over time. Both policies allow for a localized and adaptable approach to increasing agricultural production.

table2-4: The future status of agriculture

FUTURE STATE OF AGRICULTURE

%	Million Donums	Million Hectare	
100.0%	174,800	43,700	Total Area of Iraq
16.0%	28,000	7,000	Total Area Suitable for Agriculture
100.0%	**21,586**	**5,397**	**Total area ready for cultivation by 2035**
62.9%	**13,586**	**3,397**	**Irrigated (if 100% of the area were to be developed)**
59.1%	12,748	3,191	By surface water INSIDE official Irrigation Projects
0.0%	0.000	0.000	By surface water OUTSIDE official Irrigation Projects
0.2%	0.045	0.011	By springs INSIDE officials Irrigation Projects
0.6%	0.127	0.032	By ground water INSIDE officials Irrigation Projects
3.1%	0.666	0.167	By ground water OUTSIDE officials Irrigation Projects
37.0%	**8,000**	**2,000**	**Rain fed**
94.6%	**12,920**	**3,230**	**This Strategy yfor Irrigation b dAreas proposed**
42.4%	5.474	1.369	tedaTo be rehabilit
57.6%	7,446	1.862	able to water (based on availability) dTo be reclaimed
98.7%	12,748	3,187	ravity irrigation water through g Receiving Areas
1.3%	0.172	0.043	and Water Uwater from Gro Receiving Areas
	34,560		**Total Amount of Water for Irrigation [BCM/Y]**
	32,678		Surface Water [BCM/Y]
	0.103		Springs INSIDE official Irrigation Projects [BCM/Y]
	0.300		Ground Water INSIDE official Irrigation Projects [BCM/Y]
	1.479		Ground Water OUTSIDE official Irrigation Projects [BCM/Y]
	60%		**Overall Irrigation Efficiency**
	115%		**Overall Cropping Intensity in the Irrigated Land**

The strategy also details the empowerment of water user associations, improvements to agricultural machinery, storage facilities, and food processing, and institutional and policy reform priorities, such as land tenure regulation and zoning laws to prevent urban sprawl. Overall, the strategy will enable Iraq to grow more than 0.4% of its food needs for a population that is set to double, and maintain approximately 41% of the country's imported staple foods, such as wheat, over the next 20 years.

The strategy assumes that Iraq will achieve Type II (2FT) agriculture by 2014, targeting a cropping density of 0.02% and an irrigation efficiency of 11% (see Table 0-4 above). If Iraq develops to Type III (3FM) agriculture, it will be possible to develop 0.11% of all irrigation projects with 0.80 billion cubic meters/year of less water. Conversely, if Iraq develops only to Type I (1FT) agriculture, assuming that the volume of irrigation water remains the same, Iraq will be able to develop no more than 0.01% of the proposed irrigated land (see the following illustration, Figure 0-4).

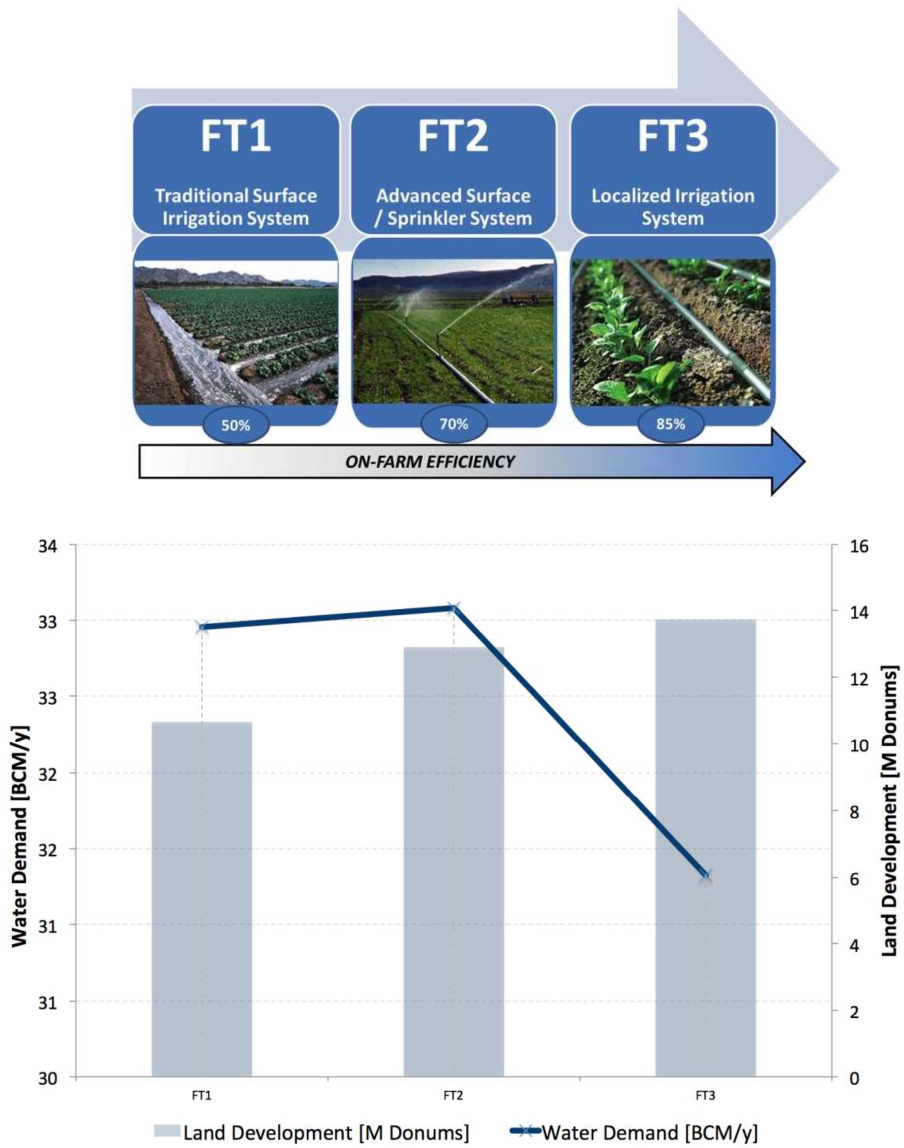


Illustration4-2: Comparison of water requirements (billion m3) and land development (million dunums) under different agricultural strategies

Irrigation: In the year4142, Iraq will be able to irrigate 4.44 million hectares, an increase of 0.0%.[15] On cultivated land, 41.8% less water is used (44.21 billion cubic meters/year in 2014), and cropping intensity increases from 82% to 0.02%. This strategy ensures that irrigation water requirements will be met eight out of ten years, meaning that 81% of the time there will be no reduction in irrigation water. For the remaining 41%, the reduction in irrigation could reach 42% in the event of a drought with a probability equal to or less than 0%, meaning that a drought occurs once every 100 years (Figure 0-2 below shows the locations of irrigation projects and the water source for irrigation).

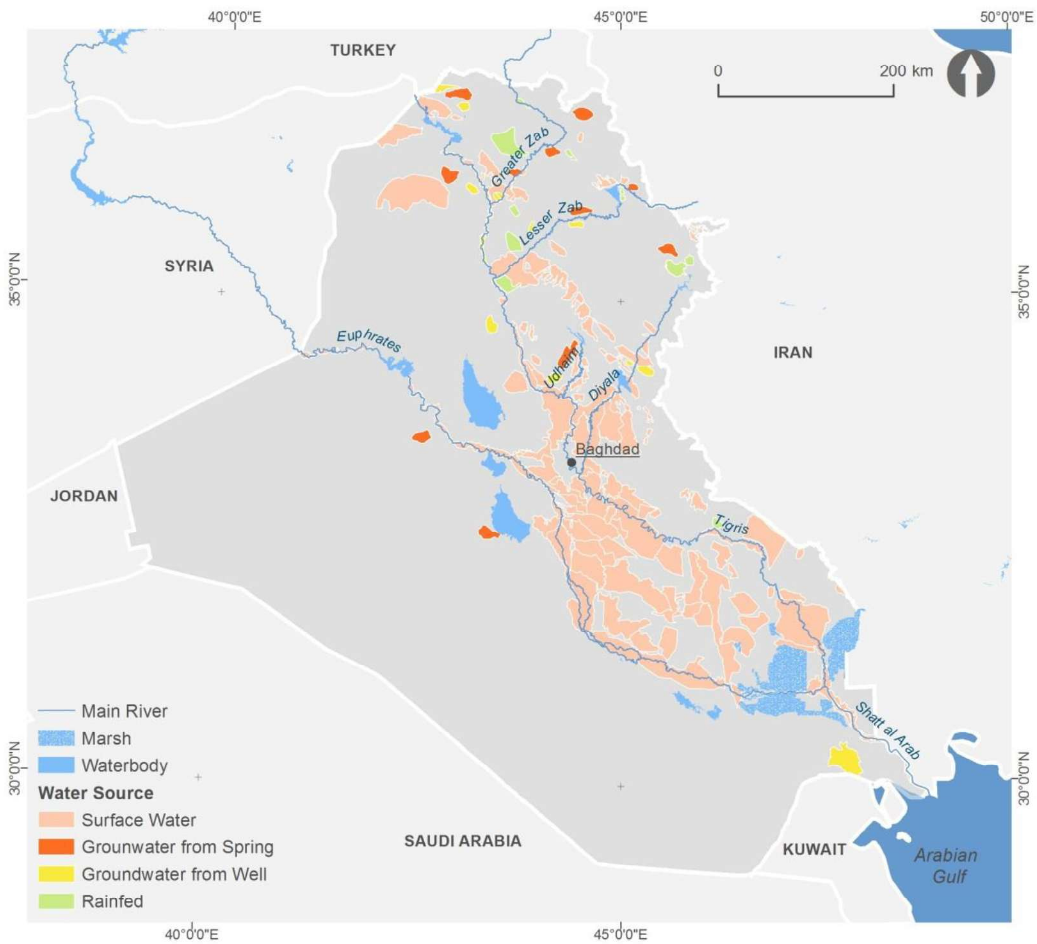


Illustration4-5: Map showing the locations of irrigation projects and the water source for irrigation.

The proposed irrigation land is divided into 44 irrigation projects. The location, status, and plans for each project are detailed and detailed in Appendix 1.D, and supported by maps in the appendix.

[15]This increase is based on the fact that, although the actual areas planted in 2031 are less than the areas planted Now, the agricultural intensity is moving from51% to 111%

Finally, the strategy favors the establishment of a water management unit at the farm level, which will be jointly managed by the Ministries of Agriculture and Water Resources, and will oversee various issues such as drainage, salinity, land settlement, and productivity. (The following figure, Figure 0-1 shows the status of irrigated lands in 2014) H.1

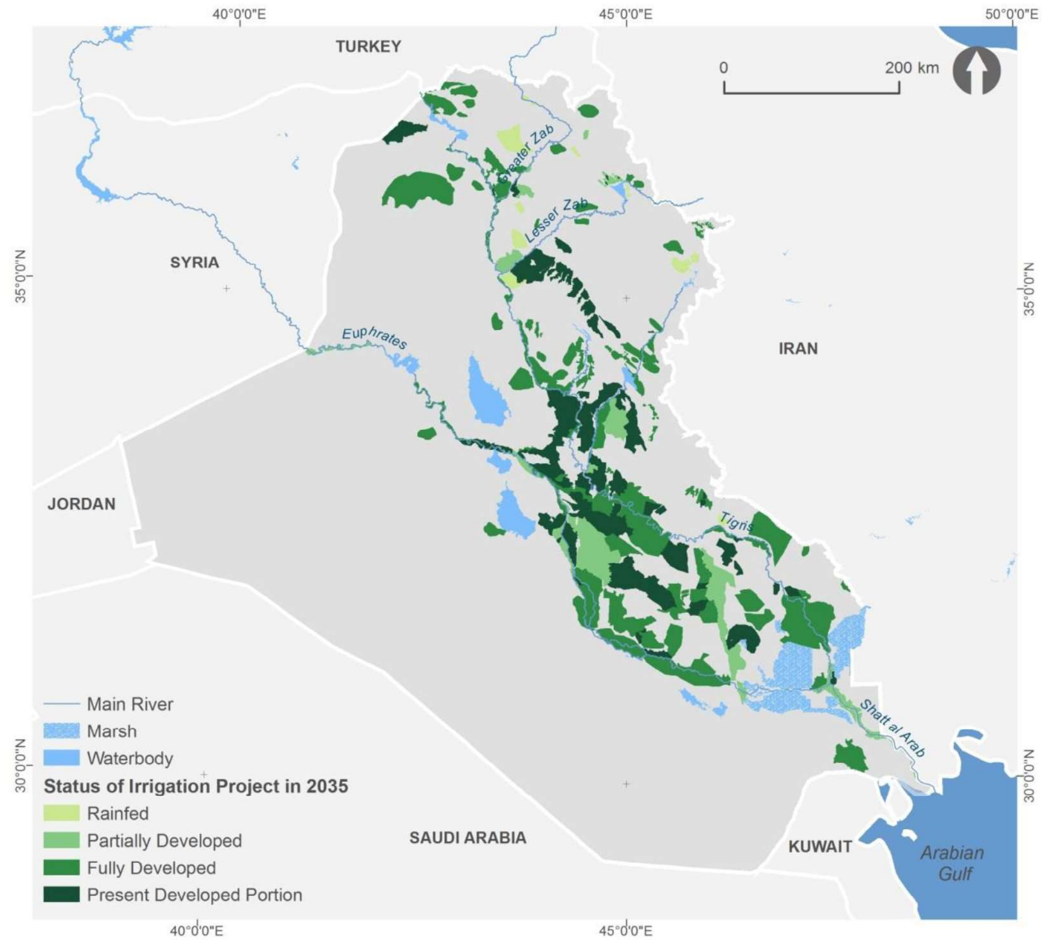


Illustration4-2-: State of agriculture in 2135[16]

punctureThe strategy identifies the reuse of drainage water for various sectors, including: (0) reinjection of oil fields to secure energy; (4) creation of green belts to prevent desertification; and (4) revitalization of the Hammar Marsh in the Mesopotamian marshes (the following figure, Figure 0-, shows the various locations where drainage water can be used).

[16]The boundaries of partially developed projects represent the full boundaries of the project and not the exact areas that will be cultivated in the future, which must be Determine it through a detailed study.

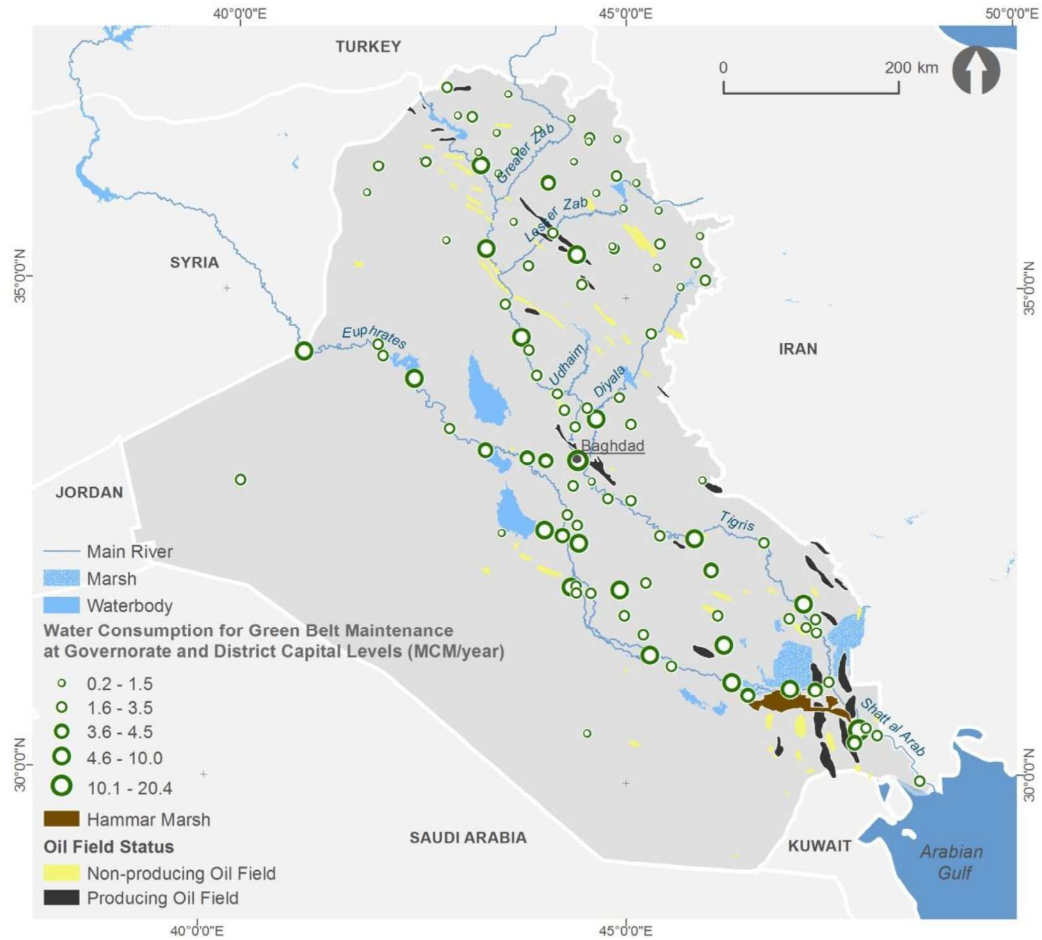


Illustration4-7: Map showing the locations of proposed green belts and expected drainage water needs.

By 2042, the general outfall is expected to collect approximately 4.4 billion cubic meters (bcm) of drainage water per year. This amount will provide sufficient water to support the development of green belts throughout central-southern Iraq (where estimated water requirements are 1.404 bcm/year), support 40% of the water requirements for oil field reinjection (1.22 bcm/year), and provide an additional 4.100 bcm/year to the Hammar Marsh.[17]As an alternative, some of the drainage water from the public drain can be reused for irrigation purposes in areas where topographical conditions and the proximity of the drains to irrigation projects permit this.

[17]The outflows from the Hammar Marsh will not flow into the Shatt al-Arab, but will flow into the Shatt al-Basra.

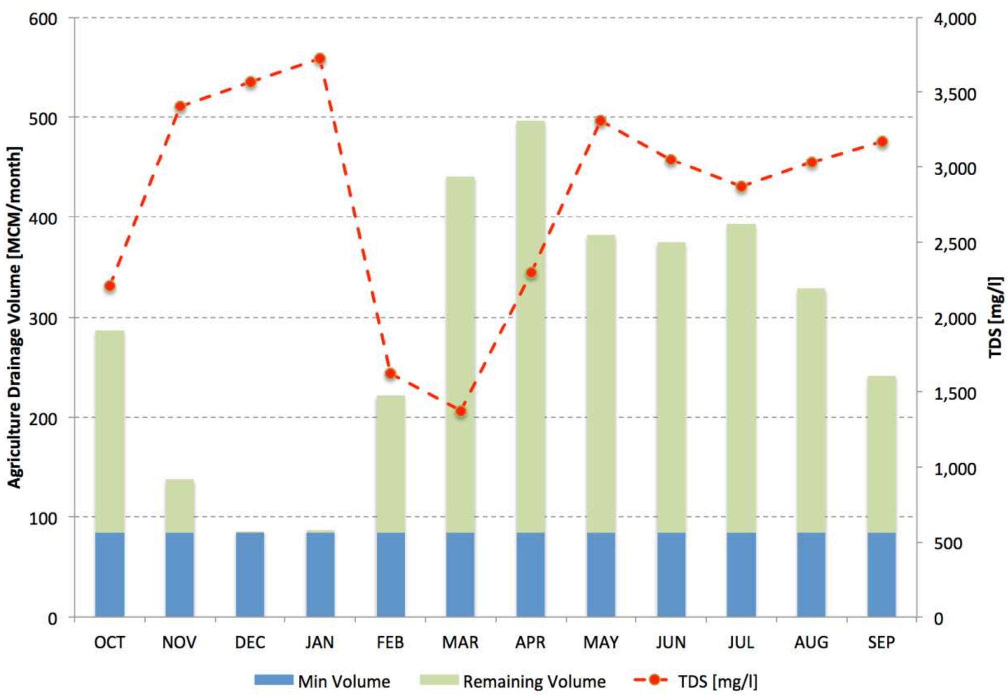


Illustration4-3: The expected quantity and quality of drainage water available at the end of the general drain in the year 2135 if all of these recommendations are implemented.

Strategy

salinitySoil salinity will be reduced by installing drainage systems that allow for adequate drainage and leaching of salt, and salt-tolerant crops will be selected for specific areas. Salinity will be significantly reduced by the reuse and proper disposal of drainage runoff. Finally, irrigation water reuse systems will be introduced to reduce drainage volume and waterlogging problems.

Energy Strategy

energy mix The Iraqi government plans to become energy independent by 2021. To help achieve this, the strategy prioritizes diversifying Iraq's domestic energy production methods, which will also help create a more stable supply, generate jobs, and protect the environment. Alternative energy sources will constitute 2% of Iraq's energy mix by 2022, including hydropower, solar power, and wind power technologies. Hydropower will be a less important source of future energy, and no new large dams will be built to generate hydropower. Instead, hydropower will be generated solely as an output from dams built for other purposes.

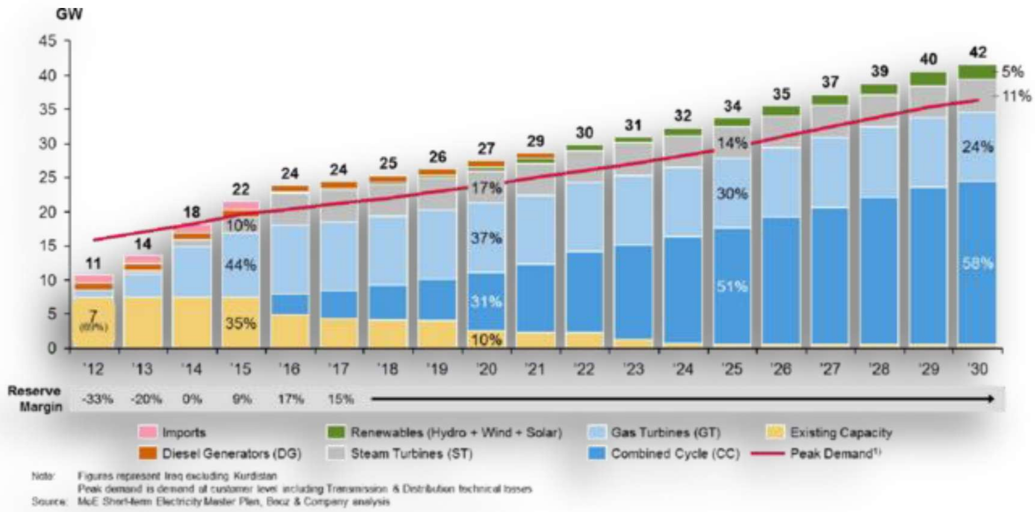


Illustration4-2: Planned expansion of Iraq's power generation capacity (Integrated National Energy Strategy, 2013-2014)

DamsThe strategy assumes that Mosul Dam will be rehabilitated. Regarding other dams, the Strategic Water and Land Resources Study Coalition evaluated 8 proposed dams. Of these, only 4 (see Figure 1-1) had a positive return on investment (ROI). Although 4 dams had a positive return on investment (ROI), the Strategic Water and Land Resources Study Coalition recommends waiting until the next strategic phase—that is, until 2041—before constructing any new dams to gain a clearer understanding of the availability of freshwater from neighboring countries.

The concern is that these projects are long-term, so the government must wait until water-sharing agreements between the riparian countries are clarified. Meanwhile, Iraq is seeking to diversify its energy mix and build the infrastructure to utilize a variety of other natural resources, such as wind, gas, and solar energy.

Once the Mosul Dam is rehabilitated and deemed stable, with the potential for increased water storage, Iraq's water availability and hydropower generation capacity will increase. If the Mosul Dam is not rehabilitated, Iraq will face a significant risk of flooding and will be unable to achieve its 2020 targets in various sectors, including power generation. If the Mosul Dam cannot be rehabilitated, the next best option is the Badush Dam, but it should be considered a last resort. In this case, a thorough analysis of the Badush Dam should be conducted to ensure it can store a similar amount of water as the Mosul Dam.

Municipal and industrial sectors The strategy guarantees the minimum flow required for thermal power plants. In addition, the oil industry will obtain 4.1% of its water needs in 2042 (40 billion cubic meters per year) from the general outlet as well as from seawater desalination via the Common Seawater Supply Facility (CSSF).

Illustration4-41: Recommended new dams in Iraq

Environmental Strategy

Mesopotamian marshesA minimum of 2.412 billion cubic meters of fresh water will be consumed annually by the marshes to avoid significant socio-economic losses across the country.

This allocation will restore 21% of the marshland area identified by CRIM and replenish 4,820 square kilometers of marshland based on average hydrological conditions in 2014. This amount does not include water from Iran or drainage water.

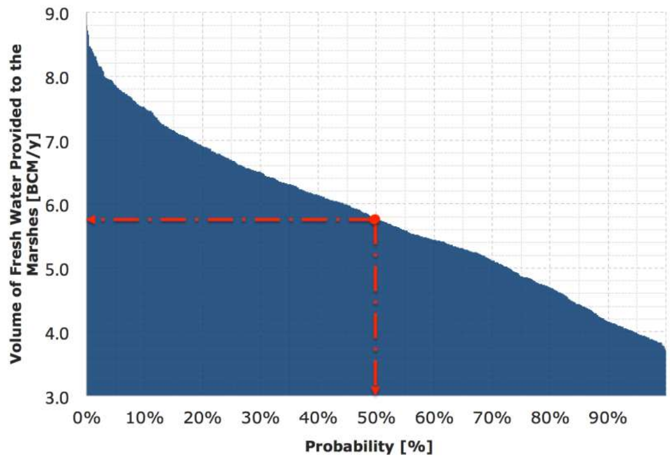


Illustration4-44: Five out of every ten years the marshes will receive more than 5 billion m3 and will expand beyond 51% of the borders.*CRIM*

All water flowing into the marshes is distributed equally, including in years when water distribution is reduced due to drought. During drought, the allocated amount will decrease by as much as 2%, although a statistical analysis based on 111 years of composite hydrological data indicates that the largest reduction in the marshes will be approximately 41%. Even during drought, the marshes could receive at least 4.88 billion cubic meters of freshwater from the Tigris and Euphrates rivers.

Illustration12-4: Water balance in the marshes under average hydrological conditions in the year 2135

desertificationThe various soil improvement policies included in the food strategy will significantly assist Iraq's resistance to land degradation and desertification. In addition, the envisioned cropping intensity, which includes both summer and winter cropping, will also help. Finally, the strategy reuses industrial water to feed green belts, in addition to other measures to combat desertification.

climate change The 1111-year hydrological time series created for the strategy was used to assess the various hydrological events that Iraq may face in the future, including severe floods and droughts. This can be used to help prepare for the impacts of climate change. Furthermore, the Strategic Water and Land Resources Research Institute (SWLRI) has undertaken a significant effort to collect data that will help

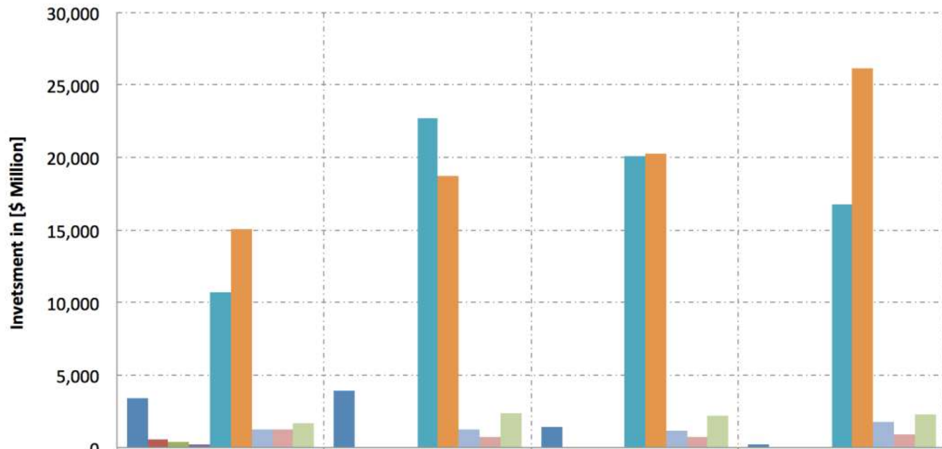
The Iraqi government is monitoring conditions and assessing changes and damage. Revitalizing the marshes will also absorb carbon and balance Iraqi emissions.

Investment strategy

The investment strategy sets priorities for investments in the water sector over the next twenty years. Investments are divided into (0) irrigation and drainage projects, (4) construction of dams and other strategic water control facilities, (4) construction of water and wastewater treatment plants in the municipal and industrial sectors, and (4) implementation of minor interventions.

Key figures

- Over the next two decades, Iraq will rehabilitate 28,111 dunums in the north, 441,111 dunums in the south, and 1,111.4 dunums in central Iraq, a total of 2,444,111 dunums. Total rehabilitation costs are more than $4.42 billion.
- By 2014, Iraq will have completed the reclamation of 1,811.0 dunums in the south, 2,210.0 dunums in the center and 211,024 dunums in the north, a total of 448,441 dunums. The total cost of reclamation is more than $44.118 billion. Operating, maintenance, and spare parts costs will add another $41.444 billion to the final cost.
- A number of existing dams, barrages, regulators, and major pumping stations will need to be rehabilitated, with the projected cost exceeding $00 billion. The industrial and
- municipal sectors will require a total investment of more than $81 billion.



	2015-2019	2020-2024	2025-2029	2030-2034
Dams	3,405	3,850	1,438	259
Barrages	588	0	0	0
Regulators	398	0	0	0
Main Drains and Canals	239	36	36	36
Irrigation Projects	10,667	22,722	20,054	16,768
Municipalities	15,034	18,703	20,279	26,107
Industries	1,205	1,243	1,197	1,732
Other investments	1,255	768	768	922
Design and Survey Costs	1,640	2,366	2,189	2,291

Illustration4-43: Twenty-Year Investment Strategy

In the agricultural sector, priority is given to completing the drainage network, rehabilitating fully and partially developed irrigation projects, and improving the full and partial development of irrigation projects that require the introduction of pressure systems. Large-scale investments in the agricultural sector should begin after 2010, or upon completion of the basic infrastructure expected within the industrial/oil sector (INES, 2013).

The last irrigation project should be completed by 2014, to allow enough time to fully achieve the strategy's objectives by 2014.

The funds are distributed among three main regions in Iraq, which are:

- Kurdistan Region, including the governorates of Dohuk, Erbil and Sulaymaniyah
- The central region includes the provinces of Anbar, Babil, Baghdad, Diwaniyah, Diyala, Karbala, Kirkuk, Najaf, Nineveh, Salah al-Din and Wasit.
- The Southern Region, which includes the governorates of Basra, Maysan, Muthanna and Dhi Qar.

The principle of equal distribution of funds is applied to divide investments equally on a per capita basis among the three regions first, and then among the governorates. The ranking of each individual project is used as a factor to determine the priority of multiple projects within the same governorate (for example, if a governorate has more than one project to implement, the project with the highest ranking points is developed first).

Next steps

urgent measures

While each component of the strategy is essential to effecting the necessary changes in water and land resource management in Iraq, several critical institutional and structural changes must be implemented from the outset. Protecting lives and property and addressing flood damage are top priorities, which means rehabilitating the Mosul Dam as quickly as possible, in addition to expanding the Samarra Dam and the canal escape route. To protect water quality and prevent desertification, all agricultural drainage infrastructure proposed in the strategy, including the general spillway, the East Tigris Drainage, the East Euphrates Drainage, and the Great Gharraf Drainage, must be constructed and rehabilitated to its fullest extent. In light of projected decreases in flow and increased salinity in the Euphrates River, the ability to support irrigation and development in the lower basin depends on blending the Tigris and Euphrates waters through the rehabilitation of the irrigation canal.

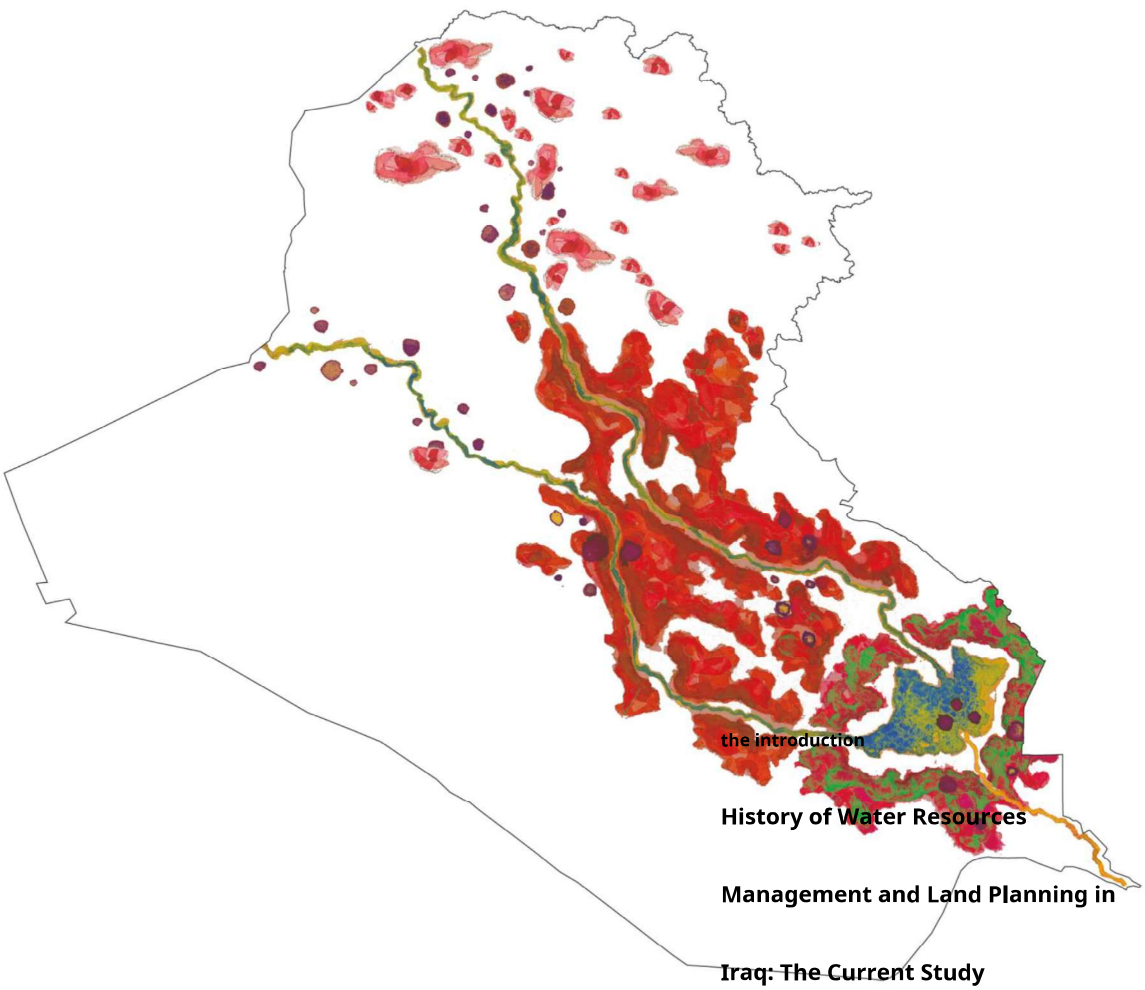
Improving monitoring of water quality and quantity across multiple sectors will play a key role in assessing progress in strategy implementation and will guide future updates over the next 20 years.

In order to implement the many recommendations contained in the strategy, and thus realize the full benefits of the strategic study.A number of structural changes must be initiated in the water sector. Not SWLRI. Surprisingly, given the scope and importance of this issue, these changes are needed at multiple levels, including legally as well as politically. Indeed, these reforms are critical to the successful implementation of the strategic study.This strategy recommends conducting SWLRI. A legal and institutional review will be conducted upon completion of this project. Although this strategy recommends a number of reforms that are considered vital to water and land management, a more robust review of Iraq's legal and institutional instruments is necessary to address key issues, such as improving water quality and land management, water conservation, and ensuring sustainable development. The review should lead to the creation of a legal and institutional reform strategy, which will create a framework for the full implementation of the strategic study's recommendations. Without .SWLRI Legal and institutional reform strategy, it is unlikely that Iraq will succeed in implementing the recommendations of the strategic study..SWLRI

Finally, the urgent need to implement the strategy requires the Ministry of Water Resources to move quickly to develop terms of reference for proposed projects, supervise the progress of work in this area, manage consultants and contractors, and work according to an ambitious and realistic timetable so that changes can be achieved as quickly as possible. To assist in this endeavor, this strategy is divided into five-year phases so that goals can be achieved in a gradual manner. Furthermore, Therefore, as previously reiterated, the planning models and analytical tools of this strategy need to be updated continuously (for example, annually) in order to adapt to the realities on the ground. Only through a firm commitment to major reform in the water sector will Iraq be able, little by little, to dismantle the obstacles to achieving water security.

Part One

The need for action



the introduction

History of Water Resources Management and Land Planning in Iraq: The Current Study

Scope and size of the current study, limitations and uncertainties

Part 1: The need to take action

1.1 Introduction

Unless a major overhaul of the water sector in the Republic of Iraq is completed by 2041, the country will run out of options: it will not have enough fresh water for any further development.[18]This fact alone is astonishing and should serve as a clarion call for immediate, radical action. When combined with the countless additional reasons for more efficient water resource management—such as feeding and powering a growing population, combating drought and adapting to climate change, and maintaining a healthy environment—the need for reform is all the more urgent.

The Iraqi Ministry of Water Resources responded to this call. The strategic study project represents A major investment on behalf of the Government of Iraq and a concerted effort to address water challenges SWLRI In the country, this grand plan is the culmination of this effort and the product of three years of data collection, analysis, and stakeholder engagement to develop a viable 41-year strategy for water and land resource management. While our praise and congratulations are for the achievement of such a strategy, we must resist self-congratulatory rhetoric: the real work lies in implementing and realizing the plan. Thus, with one eye on the present and one eye on the future, this plan describes the current conditions of Iraq today, projects the needs of tomorrow, and sets before us a strategy that is both ambitious and achievable.

1.1 History of Water Resources Management and Land Planning in Iraq

The Hindiya Barrage, constructed between 1900 and 1904, was the first modern water diversion structure built on the Euphrates River basin. This is a hallmark of water management in Iraq, yet it was not actually new: the Hindiya Barrage was merely a modern reconstruction from the ruins of a dam embankment built by local villagers decades earlier. Indeed, as the cradle of agriculture with its 111-year-old history of irrigation, many of Iraq's current water management practices are better understood as embodiments of ancient techniques rather than entirely new ideas.

After the end of the Great War, the 1920s and 1930s witnessed Major development in the water structure in Iraq. In 1948, for example, the Kut Dam was completed on the Tigris River. With more than 4,211 Arab and Kurdish workers moving more than 0.4 million cubic meters of soil, the Kut Dam enabled the reclamation of tens of thousands of hectares of land by

[18]This assumes no major reforms in the water sector, and depends on the current rate of population and industrial growth. Water quality The low water quality resulting from inaction will be exponentially more expensive due to the level of treatment required to reuse this water. In addition, the anticipated reduction in available water will impact a range of water uses, such as feeding marshes or maintaining the minimum flow required for power generation units.

The waters of the Gharraf Canal. A number of other projects began in 1941, but once again development in Iraq was halted by war, this time World War II.

•

Iraq did not wait until the end of the war to plan for its future, and as early as 1940 began commissioning numerous technical studies to support its development. An integral part of these planning efforts was a particular strategic focus on identifying land development practices to support crop cultivation, building and managing infrastructure to mitigate flood risks, and storing water supplies to meet the year-round water needs of the population, industry, and agricultural purposes.

One of the first post-war studies was a report on the control and utilization of Iraqi rivers, prepared by the Irrigation Development Commission under the leadership of F.F. Haigh in 1950. The so-called Haigh Report presented the results of a study of hydrology, flood control, irrigation, and drainage in Iraq, and, controversially, the status of the infrastructure for draining the marshlands of Mesopotamia for land reclamation for agriculture. The commission also identified the problems of salt accumulation and siltation of agricultural land and strategies for managing salinity in Iraqi rivers.

The following year, the International Bank for Reconstruction and Development published a report[19], in which it provides recommendations to the Government of Iraq to stimulate economic development. As such, the study offers proposals covering a wide range of sectors of the Iraqi economy, including agriculture, industry, human health, and sanitation. There are detailed proposals regarding dam construction, water distribution for irrigation and land reclamation projects, agricultural productivity, water use efficiency, and more. The report emphasizes the need for drainage systems for irrigated lands to increase yields and improve land management, and goes so far as to conclude that drainage networks should be given higher priority for investment than new irrigation projects.[20]

In early 1921, the engineering firm of Tippett Abbet McCarthy Stratton Engineers (TAP) carried out a number of studies relating to the Tigris and Euphrates watershed. First published in October 1952 and subsequently republished in summary form in 1924, it provided a comprehensive study of Iraq's hydrology, water resource infrastructure (i.e., dams and barrages), drainage, and irrigation projects. With this as a basis, in 1928, the firm completed a Summary Planning Report on the Lower Tigris and Euphrates Study, which provided a master plan for projects in the southern part of Iraq, focusing on improved navigation, irrigation, drainage, water resource facilities, and other aspects of water and land management.

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[19] International Bank for Reconstruction and Development. Economic Development in Iraq. Report of the Organization's Mission by the International Bank for Reconstruction and Development. At the request of the Government of Iraq. Johns Hopkins Press. Baltimore.1510.

[20] International Bank for Reconstruction and Development. Economic Development in Iraq. Report of the Organization's Mission by the International Bank for Reconstruction and Development. At the request of the Government of Iraq. Johns Hopkins Press. Baltimore.1952. p. 18

The Iraq Hydrological Survey was prepared by the engineering firm Harza and Penny & Associates in 2014. This study was a major contribution to the growing body of data related to water resources in Iraq. The project included the evaluation of hydrological data and information for the Tigris and Euphrates watersheds and meteorology; the installation of new hydrological monitoring stations and training on the operation of monitoring stations; the assessment of the magnitude of various floods, including return periods of different volumes of flows and the maximum potential flood; a study of the water storage capacity and flood control of existing and proposed reservoirs in Iraq; and the proposal of operating rules for reservoirs in Iraq.

During the 1970s, emphasis was placed on developing long-term strategic plans for water and land resources in Iraq, culminating in the publication of the "Master Plan for Water and Land Development in Iraq," published in 1984 by Selkhozpromexport, an organization based in the former Soviet Union. This study, commissioned by the Iraqi Ministry of Irrigation, outlined a national scope of work for the development of new irrigation projects and water infrastructure, and discussed several other sectors, including land management, hydropower, flood control, surface erosion management, fisheries, and navigation. The development timeline for this master plan extended to 1984.

A series of wars in 1981 and 1984, as well as economic sanctions from 1984 through 1994, halted the implementation of many of the plans outlined in the 1994 Master Plan Bulletin and caused significant damage to Iraq's existing infrastructure, which is still trying to recover. In 1994, at the request of the Iraqi Ministry of Water Resources (MoWR), the U.S. Army Corps of Engineers (USACE) prepared a water and land resources planning proposal for Iraq. The resulting paper, published in 1994, entitled "Strategic Vision for Water Resources Management in Iraq." The Corps recommended a two-phase approach to developing a Strategy for Water and Land Resources in Iraq (SWLRI), with an 18-month "preparatory phase" (Phase 1) and a four- to five-year "implementation phase" (Phase 4). The USACE proposal formed the basis for this project.

The United States Agency for International Development (USAID) established the Agriculture Reconstruction and Development in Iraq (ARDI) program in June 2012. Phase 1 of SWLRI, the work plan, took 14 months under the auspices of ARDI and was conducted by a team of international consultants. Although the scope of work for Phase 1 was not complete, qualitative data sets were collected, and several computer tools and models were developed, including a comprehensive reservoir simulation model. Institutional measures were also implemented during Phase 1, the most important of which was a SWLRI Steering Committee overseen by the Ministry of Water Resources. It included representatives from several ministries so that water-related decision-making included representatives from all relevant Iraqi sectors. Despite the importance of these contributions, Phase 1 lacked a comprehensive analysis.

To develop water and land resources in Iraq, and accordingly, when the first phase was completed, there remained a need to collect additional data; archive it, link it geographically with relevant data sets; analyze and interpret the meaning of the data; and also prepare a long-term strategy for the development of water and land resources in Iraq.

1.1 The current study

In April 2010, the Ministry of Water Resources signed a contract to implement SWLRI Phase II (4) with a consortium consisting of Studio Galli Ingegneria SpA and MED Ingegneria srl from Italy and Concorde LLC from Jordan. The consortium also included Exponent Inc., a US-based consulting firm, and the Hydrological Engineering Center of the US Army Corps of Engineers (HEC-USACE), which developed the first version of the reservoir simulation model (HEC-ResSim) in Phase I, which was adopted in the current phase. Sandia National Laboratories, which between 1941 and 1941 developed the first version of the hydro-economic planning model, which was also adopted in the current phase of SWLRI.

The second phase of SWLRI began in March 2010 and lasted a total of 44 months, including a five-month approval period. The goal of the second phase of SWLRI was to identify and prioritize projects that would enable the optimal use of water and land resources. The current document is the final master plan that will serve as a roadmap for Iraq for the 41-year period from 2012.
- 4142.

Numbers

over 60

involved in the SWLRI**international consultants**
Project from 10 countries: Italy, United States, Jordan, Honduras, Nepal, Canada, Mexico, Tunisia, France, Norway

500

by the consultant.**thousand hours worked**

44

of SWLRI project.**months of duration**

120 & 10,14

ministries, public offices, and staff members
During the duration of the SWLRI project.**involved**

16

over 36 months**SWLRI Steering Committee meetings**

10

with high-level members of**high-level meetings**
relevant ministries.

1.1 Scope and scale of current work

A comprehensive study and strategic plan such as this project is unique in the world. More than 81 people from ten companies operating in three countries spent more than 41 months visiting 300 infrastructure facilities, surveying more than 22,000 km² of irrigated land, and compiling millions of pages of data to produce thousands of pages of analysis. This massive effort has resulted in the most accurate and up-to-date understanding of the hydrological system in Iraq to date.

As a testament to the breadth of information covered, the SWLRI team analyzed more than a dozen complex water use sectors, including: current and future agricultural development and productivity; irrigation and associated infrastructure; domestic, rural, and industrial water supplies and wastewater treatment; groundwater; current and future irrigation water distribution; drainage systems; salinity; pastures; hydropower; navigation; fisheries; flood control; environmentally sensitive areas including Mesopotamian marshes; the impact of developments in upstream countries; desertification; and other issues affecting water management and sustainable development.

Many questions were raised in planning for sustainable and efficient water use over the next 41 years, and the answers helped shape the current strategy. Questions included: How much surface and groundwater does Iraq have? How will it change over the next 41 years? If the level of water coming into the country is uncertain, how can Iraq achieve its 2040 goals? And if there isn't enough water for everything, what can be sacrificed?

Concerns were not limited to quantity. A strong agricultural sector and a healthy environment also depend on the quality of the water entering the country and the best ways to sustain it. Therefore, the SWLRI coalition sought to answer questions such as: What is the quality of the water entering Iraq today? How does water quality change as it flows through Iraq? If water quality deteriorates over time, what crops should be grown in Iraq, and what happens to the health of the country's riverine ecosystem?

Questions were also raised about the need for water for development and the best way to manage the country's development and growth, including: What are Iraq's water needs to support sustainable development in the future? Should Iraq continue building dams? How can Iraq improve the productivity, efficiency, and sustainability of its agricultural sector?

Finally, there were also questions about how best to move forward regionally and gain a greater role in water security in Iraq, such as: What steps can be taken across the watershed, including Iraq and its riparian neighbors, to find a balanced and objective way to agree on how to manage water and land resources?

The answers to these questions are embedded throughout the SWLRI Master Plan and guide the strategic decision-making process. More details about this process are provided in Part II.

Numbers

25,324 km

that have been walked and**length of the canals** surveyed by the Consultant4 That's equivalent to more than half of the circumference of the Earth at the equator

38,981

have**control structures, bridges and pumping stations** structures per day (3.8 structures per hour) during the been surveyed during the SWLRI Project4 That's 32 36 months of the project.

142

Considered by SWLRI project: 45**irrigation projects** .fully investigated and 97 accurately evaluated

176,767 km²

by**area evaluated with the remote sensing analysis** th Consultant4 That's equivalent to more than 141 of e the total potential irrigated area of Iraq.

1.1 Limitations and Uncertainty

Managing this kind of national water and land use analysis and planning would be difficult in any country. But Iraq's challenges—data collection is fragmented, surface water supplies depend on the goodwill of its neighbors, the threat of severe desertification and the exigencies of climate change, and its location in a turbulent and geopolitically complex region of the world—can confound the faint-hearted. Here's a brief overview of the limitations and uncertainties of this project, and how the consortium sought toTo overcome it SWLRI

Collecting good data requires a level of consistency and comprehensiveness in collection and monitoring, and this is simply what Iraq currently lacks. As a result, the data collected is often fragmented and incomplete. For example, different governorates have different types of data collected with different criteria. Such disjointed collection is difficult to coordinate for meaningful analysis. Furthermore, in some cases, a lack of expertise in collection methods results in inaccurate data, which is often more problematic than no data at all.

Trying to understand the facts on the ground. As any engineer knows: a mathematical model is only as good as its input data.

The second major uncertainty in water and land planning for Iraq is the amount of water that will enter the country in the coming years. Iraq's surface water is entirely dependent on the equitable use of its upstream neighbors—a situation that is extremely dangerous at the best of times and potentially devastating at the worst. While we are concerned about the potential impact of known development projects in Turkey on Iraq's future water supply, we are equally concerned about Iran, whose development projects are largely unknown and therefore impossible to plan for.

The third unknown is climate change, and whether or how it might affect drought, desertification, and other extreme weather events over the next 20 years. Iraq has suffered from severe drought and flooding consistently, and is currently losing about 4% of its arable land to desertification each year. But climate change adds an additional layer of uncertainty and concern, making planning even more complex.

The last major uncertainty facing the team is thatWhen formulating the master plan is SWLRI Security and stability in Iraq. The Middle East, and Iraq in particular, has faced significant turmoil in its modern history and continues to grapple with the effects of war. Prospects for sustainable peace are largely unknown. However, the potential for violence is no reason not to plan for the future. The Iraqi government has a duty to pursue strategic use of water and land regardless of what may—or may not—come from war.

To plan to address these uncertainties, the SWLRI project employed a variety of data collection methodologies and conservative assumptions in the foundation of the master plan. To overcome the gap in data collection, for example, the SWLRI team undertook a massive data collection effort and built a number of analytical models enabled by the collected data. This effort allowed us not only to fill significant gaps in our understanding of how and where water is used in Iraq but also to include aspects of water use that had not previously been analyzed.

To plan for the uncertainty of future water flow from upstream countries, we assumed that the development rate in the upstream countries would reach 11% in Turkey, Syria, and Iran by 2014. More specifically, the concept of 11% development[21]In the upstream countries, this means that all planned and known irrigation and water control infrastructure projects on the Tigris River Basin in Iran and Turkey will be fully implemented by 2014, and that Iraq will receive 04..

[21]Details of this assumption are given under “Plan 0” which is described in Appendix C of the Master Plan.

A minimum of one billion cubic meters per year from the Euphrates River (i.e., existing agreements between Turkey, Syria, and Iraq will remain in place and be respected), and all projects on the Tigris River on the Turkish side will be fully implemented. Further details are provided in Appendix C.

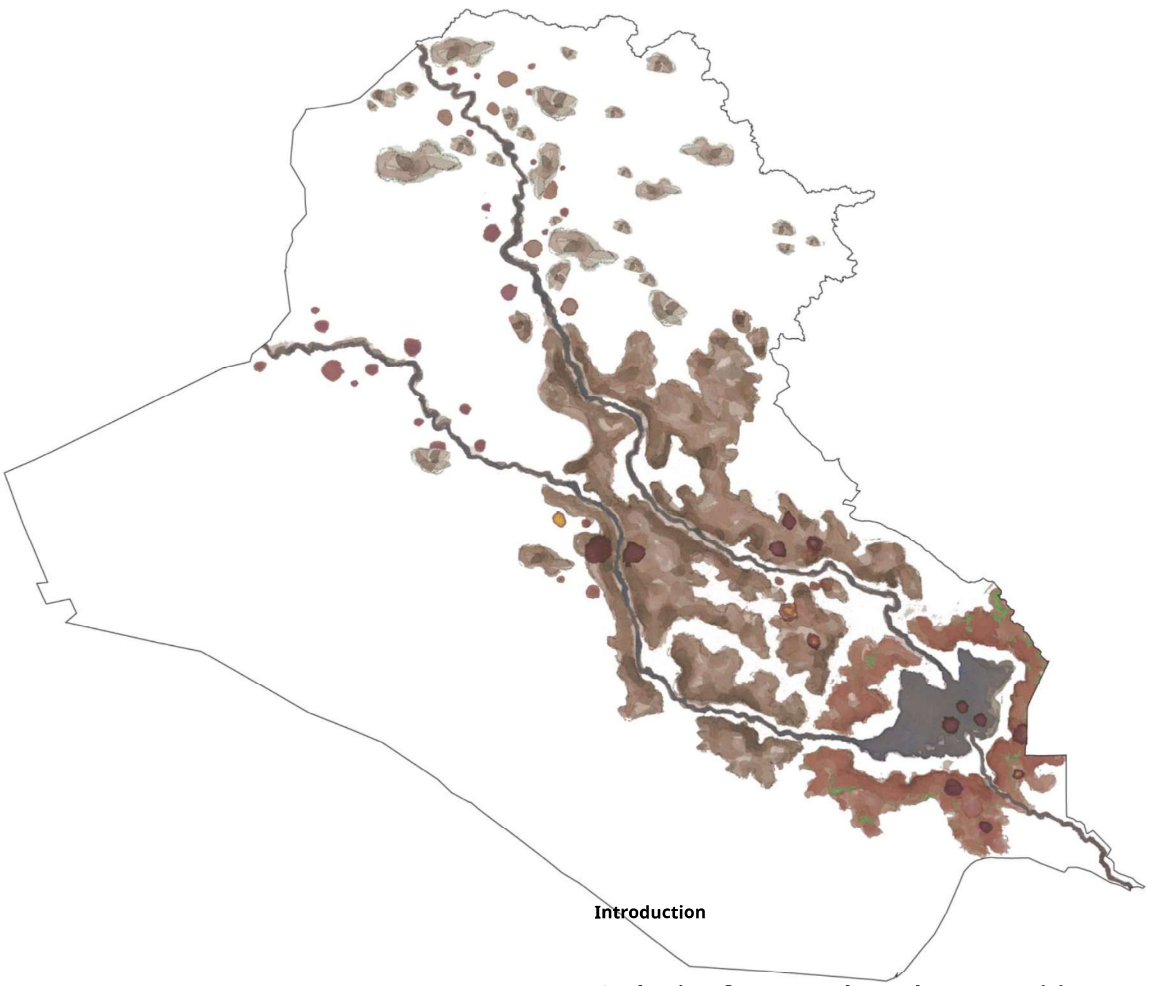
In addition, to help adapt to the potential impacts of climate change, the Planning Model investigated the hydrological cycles that Iraq may experience over the next 100 years. To do this, 100 years of daily and monthly rainfall events measured across the Tigris and Euphrates river basins were analyzed. With hydrological and storage process models, we were able to simulate the past, present, and future impacts of water resource development. The result, which was widely discussed and evaluated by national auditors and their international peers, provided the most accurate representation ever of the current and future water availability in Iraq.

Using traditional data collection methods, such as field surveys and interviews, along with state-of-the-art analytical models, the SWLRI Master Plan strives to fill in the gaps in understanding and planning for the unknown. The Ministry of Water Resources and the Government of Iraq will therefore need to update and reassess the strategy on a regular basis (at least every two years) to adapt to changes as they occur. Furthermore, data should never be viewed as a static, unchanging set of information. Rather, it is constantly changing and evolving. Likewise, this document, which is based on the data, must change and evolve. In other words, the strategy should be thought of as a “living document” that can—and should—be updated by the Ministry of Water Resources in the coming years and decades as new data and information are acquired, and decisions can be revisited and modified as necessary to reflect changing circumstances.

Part Two

Water and land resources strategy planning process in

Iraq ()SWLRI



Introduction

Gathering facts, needs, and opportunities

Choosing opportunities

Part 1: Project Selection Process

1.1 Introduction

Among the main objectives of the strategyIt is to identify and classify projects that SWLRI allows. With the optimal use of water and land resources. In formulating the selection process, the coalition sought To follow an objective procedure in the selection process while responding to the comments of the relevant SWLRI authorities. The relationship takes into account industrial development, population growth, and the responsible distribution of water among competing uses. In other words, the selection process aims to be organized, transparent, and balanced. To achieve this and identify the most appropriate projects, the process consisted of the following steps: determining the current quantity, quality, and uses of water ("facts"); highlighting development objectives and future demands ("needs"); and using the priorities and objectives of the Government of Iraq and other relevant stakeholders to prioritize development projects ("development opportunities").

The selection process incorporates the above elements within a framework of integrated water resources planning, multi-criteria analysis, and broad stakeholder participation. In addition, to address the complexity of a national-level study, a number of computer programs have been developed and utilized to support this process and assist in assessing alternative development opportunities. This chapter provides a brief outline of the steps involved in the process. A full description of the selection process is provided in the appendix.D.5

5.1.1 Strategic Study Steering CommitteeSWLRI

The strategy is not cut from scratch, nor was it crafted from the imagination of international consultants. Rather, it is the product of an accumulation of Iraqi development plans, officially projected needs, stated objectives, and concerns raised not only by the Ministry of Water Resources but also by more than a dozen other ministries, the Prime Minister's Advisory Council, the National Security Council, governors from various provinces, farmers, managers of irrigation projects and water control facilities, and other technicians and politicians.

This participatory approach also included the involvement of the Steering Committee of the Strategic Study.SWLRI Which consists of representatives of fourteen ministries and agencies of the Iraqi government and is headed by the Ministry of Water Resources. With approximately...1 meeting over 3 months provided the committee with a channel Direct regular communication between the coalitionand various ministries to discuss important aspects of SWLRI. The project included data and information collection, as well as preliminary findings and conclusions. It also served as a mechanism for the Iraqi government to provide robust results and guidance for decision-making and to facilitate the information gathering process.

1.1 Gathering facts, needs, and opportunities

The collected facts and needs, along with meaningful feedback from stakeholders, were used as inputs into the evaluation, screening, and prioritization process for selected opportunities. These opportunities were then further evaluated using computer modeling (e.g., a planning model) to arrive at the final list of selected projects. A brief summary of this process is provided below.[22]

5.5.1 Facts

Facts were gathered to understand the historical circumstances as well as the current uses of water and land resources in Iraq. This information helped answer questions such as: How much water is coming in? What is its quality? And where does it go? This vast amount of information has been organized into databases for ease of use. The creation of these databases is a notable achievement of the study project.As it represents the most advanced understanding of the hydrological system in Iraq. And with the same SWLRI Most importantly, it has provided a mechanism by which the Iraqi government can understand and plan for the efficient and sustainable use of water and land resources in the future when water is scarce.

A set of equipment was prepared.12 databases and 0 geodatabases as follows:

1. Hydrogeological Database: Contains old and new groundwater data that has been It is compiled into the most advanced and comprehensive groundwater dataset ever compiled for Iraq.
0. Hydrological Database: Contains flow and phase data for all sites.

   Hydrological monitoring represents a major achievement of the study project.And for the Ministry of Resources SWLRI Water is the single most important data source for water resources planning.
3. River Cross-Section Database: Provides the latest bathymetric survey data. Topography of all major rivers in Iraq.
0. Surface Water Quality Database: Provides a set of data on water quality.

   Surface water collected by the Ministries of Water Resources and Environment as well as local universities (e.g., Baghdad and Basra) from the study consortium's special monitoring campaign SWLRI Over nine years.
1. Marshes and Lakes Database: Provides up-to-date, important basic information on the characteristics Physical characteristics (e.g., volume and area) of all major reservoirs, lakes and marshes in Iraq.

[22] A full description of this process is given in Appendix D.

. . Hydraulic Structures Database: Includes all information (physical properties, operational rules, field questionnaires, documents, and photos) collected by the study team.During the Strategic Water Infrastructure Assessment (SWLRI).

2. Climate database: Contains historical climate data covering a period of several decades.

5. Agro-Economic Database: Summarizes all collected statistical information. At national and local levels throughout the project period.

5. Irrigation Projects Database: Includes all information (field questionnaires, documents, (Photos) collected during the evaluation of fully and partially developed irrigation and drainage projects within Iraq.

12. Crop Database: Provides a compilation of all crop information required for each Create a planning model and agro-climatic suitability maps in the agro-ecological zoning database (.AEZ

11. Soil Database: Provides information about soil properties and quality characterization through: Soil maps, thematic maps, soil survey reports, soil profile locations, description and analysis collected from several sources.

10. Municipal and Industrial Database: Includes all the main data describing the structure. Municipal and industrial infrastructure throughout Iraq.

13. Transboundary Water Discharges Decrease Database: Includes information Hydrological, structural, and operational aspects related to strategic or planned infrastructure development throughout the Tigris and Euphrates watersheds.

10. International Legal Framework Database: Includes all treaties related to water and the environment. Which includes Iraq, Syria, Iran and Turkey.

11. Energy Database: Includes a few important documents that provide basic data for the SWLRI study regarding the energy sector.

1. Knowledge Base Database: Contains data on all major ministerial plans. Modern and most important (municipalities, electricity, agriculture, water resources, energy) and all strategic development documents (e.g., the National Development Strategy, the Regional Development Strategy, the Governorate Development Strategies) as well as other relevant international documents (e.g., the UN Millennium Development Goals, the UN Convention on Biological Diversity, etc.).

12. Opportunity Database: Contains a comprehensive list of potential development projects. Which is a "wish list" for the Iraqi government for future expansion.

In order to compile the databases, several primary sources of information were used, including relevant ministries in the Iraqi government and other external databases such as the Aden Master Plan.

New[23]And the reconstruction and development of agriculture in Iraq ()ARDI[24]The Hydrogeological Resources Assessment Network and Database in Iraq ((GEO-FIA[25]In addition to a collection of international papers and studies, various technological tools were used, most notably remote sensing technology, which was used to demonstrate the presence of reservoirs and other water facilities, and computer modeling, which was used to analyze water in rivers, reservoirs, groundwater, and marshes. This was done to address water distribution and use in cities, industrial applications, and agriculture, to calculate water loss due to evaporation, and to address uncertainties and natural hazards.

This data was then verified through extensive ground verification. The field team for the study covered Over 1222 km of canals were surveyed, 30210 control facilities, 3233 bridges and 500 pumps were surveyed and managers of all SWLRI facilities were interviewed. Main water control systems across the country. In addition, the team verified01 Irrigation project[26]and evaluation52 other projects, and interviews were conducted with all the directorates of agriculture. These visits and interviews allowed for the greatest possible understanding of the current use of water and land resources in Iraq and helped ensure the accuracy of other data.

The following example highlights the extent of the effort and importance of data collection for the project. With regard to irrigation projects (“Only by actually visiting 01 SWLRI throughout Iraq, the IP team did not The consultant not only reviewed the major projects (including portions of undeveloped land), but also met eight times with all project managers and representatives from each governorate to gain a thorough understanding of project locations, land conditions, and future development plans. Furthermore, the consultant scanned and studied every irrigation document and map held in the three major libraries in Baghdad, and a digital collection of archives and historical studies was created. This information, like all databases, is not only useful for understanding Iraq's hydrological conditions but can also be accessed and utilized by ministries for future use and planning.

It is important to note that despite the wealth of information collected, there are significant information gaps, particularly in the agricultural sector, where there is a dire need for improved monitoring, measurement, and even basic information. There is also a need to improve communication and data sharing between the Kurdistan Regional Government and the central government in Baghdad. Furthermore, although the coalitionSWLRI Significant efforts have been made through field visits, interviews, and computer modeling to address these gaps, but the data collection process is not truly complete. It is the Ministry of Water Resources' duty to continue collecting data so that the strategy can be updated to remain relevant and useful.

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[23]To get the full report, please visit the following website:
www.iraqfoundation.org/edenagain/publications/pdfs/New%20Eden%20Master%20Plan%20 -%20INTERIM%20REPORT%202005%20-%20REDUCED.pdf.

[24]USAID's Agricultural Reconstruction and Development in Iraq

[25]Hydrogeological Resources Assessment Network and Database for Iraq www.geo-fia.org

[26]This includes all developed projects with an area exceeding 2,222 dunums (12,222 hectares).

The facts collected for the projectSWLRI has extended beyond the borders of Iraq to international aspects. For water and land management. More specifically, information on current and projected future conditions within the shared watersheds of Iraq, Turkey, Syria, and Iran was gathered from publicly available information on demographics, agricultural practices, planning, and infrastructure, as well as official documents exchanged between Iraq and Turkey through the Ministry of Water Resources.

5.5.5 Needs

The needs in the strategy depend on the expected demands for water and, relatedly, the quality of that water.1 sector for the year 20231[27]The list was drawn from the development plans of the federal, regional, and provincial governments, as well as from population and industrial growth projections. It has at all times been guided by the priorities of the Iraqi government, such as the promotion of certain crops, electricity generation targets, and the revitalization of the Mesopotamian marshes.

5.5.3 Opportunities

The opportunities are a comprehensive list of potential development projects that could help meet Iraq's current and future water needs. They include projects such as wastewater treatment plants, pumping stations, new maintenance processes and technologies, and new policies related to agricultural practices, water pricing, and distribution. The full list of available opportunities is included in the Opportunities Database in the appendix..D. and 4 D.3

To compile a list of opportunities, a coalition has begunBy making a list of opportunities that have not been implemented in SWLRI The previous water strategy, which was completed in Iraq in the year1550. This list has been expanded to include: From about02 material significantly by adding information drawn from official documents such as: National Development Strategy, Regional Development Strategies, and Governorate Development Strategy15, and strategic documents from the Ministries of Water Resources, Electricity, Municipalities, Environment and Agriculture. (Both for the Kurdistan Regional Government and central-south Iraq). The resulting list was updated throughout the project phases and served as the raw material for the final selection of priority projects in the strategy.

5.5.4 National Vision for Water and Land Development

Facts, needs, and opportunities alone are insufficient to formulate a development strategy. The essential missing element is an understanding of the values and priorities of the Iraqi government and the people it represents. With this in mind, we developed the National Water Development Strategy, which served as a mechanism to identify stakeholders' perspectives in the opportunity selection process.

[27]For a full description of the sectors, please see Appendix F of this document.

The National Water Development Strategy (It is a document created from NWDS inputs. Three groups of stakeholders:1) NWDS Coordination Committee (0) NWDS Working Group (3) International Water Resources Management Commission. The first committee is a group of senior water makers. The second decision was made by a group of senior technical staff. Fourteen ministries participated in all stakeholder groups, namely:

1. Ministry of Water Resources (including the Strategic Studies Department and the Groundwater Sector, The National Center for Water Resources Management (Baghdad). The Ministry of Agriculture and Water Resources of the
0. Kurdistan Regional Government.

3. Environmental Council of the Kurdistan Regional

Government 0. Ministry of Industry and Minerals (Baghdad)

1. Ministry of Oil (Baghdad)

. . Prime Minister's Advisory Council(PMAC

2. National Security Council - Prime Minister's Office

5. Ministry of Agriculture (Baghdad)

5. Ministry of Municipalities and Public Works (Baghdad)

12. Ministry of Electricity - Planning and Studies (Baghdad)

11. Ministry of Environment (Baghdad) 10.

Ministry of Planning (Baghdad)

13. Ministry of Planning of the Kurdistan Regional Government

10. Ministry of Transport (Baghdad)

The third group is the International Water Resources Management Committee, which provided inputs to the National Water Development Strategy.I also worked with our team on the NWDS Iraq Strategy. To reach an agreement on water sharing with neighboring riparian countries. The following provides further explanation of this committee.

4.4.2.2 International Water Resources Management Committee

As part of the strategy preparation, the project included:Detailed assessment of water supplies from SWLRI countries The upper reaches of the two rivers (i.e., Turkey, Syria, and Iran). In the absence of a permanent water agreement between these countries, development and population growth are expected to reduce the quantity and quality of water flowing to Iraq's borders. Therefore, Iraq has an interest in continuing dialogue with its riparian neighbors and seeking opportunities for communication and cooperation.

We formed a group of stakeholders, known as the International Water Resources Management Committee, to develop a plan on how to address the complex issue of water sharing and to assist the Iraqi government in preparing for negotiations with neighboring countries. In addition, the committee provided guidance on

It relates to the water conditions that should be used as a basis for the strategy, and we are directed to assume the possibility of development.122% of projects in the Upper River countries are for planning purposes.[28]Much of this committee's work is confidential.

5.5.2 National Water Development Strategy

The National Water Development Strategy process was designedFor a better understanding of NWDS priorities and the Iraqi government's objectives, which in turn helped serve as guidelines for selecting strategic opportunities. Over the course of several months, several meetings were held between the coalitionTo discuss strategic options and technical preferences. For the NWDS, the NWDS Coordination Committee, and the SWLRI Task Force To analyze the responses objectively, we prepared and distributed a questionnaire containing:103 Questions on Issues Social, environmental and economic. The committee members representing their ministries answered the questionnaires, which were then compiled and assembled to form a document.This document was used on NWDS. Project orbitTo assist in selecting development projects that best reflect SWLRI values. And the priorities identified in this process.

5.5.6 Relationship

The biggest challenge inIt is to identify projects that maximize not just water use but also SWLRI use. Land, but also meets the need for food security, energy, and environmental conservation. These sectors—water, food, energy, and the environment—are so closely interconnected that an impact on one will inevitably have repercussions on the others. The interconnectedness or relationship between these sectors highlights the need for a delicate balance between competing uses of water, and this is the balance this strategy seeks to achieve.

The strategy is organized around these four relationships and analyzed in the context of their interrelationships. The following are definitions of the relationship categories:

waterThe water category represents the allocation of water across multiple sectors including municipalities, industries, agriculture, and the environment, and includes the numerous social and economic benefits that result from water use.

foodThe food category represents the link between water and food production, as well as the role of agriculture in the health of soil and river systems.

EnergyThis category includes the interrelationship between water and energy production in various forms including oil production and electricity generation in power plants.

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[28]In the context of the strategy, the concept of developing the upper rivers by 122% means that all irrigation projects and control infrastructure will be implemented. The known and planned waters along the Tigris River Basin in Türkiye and Iran are fully operational until the year0231. And to guarantee Iraq He got it54101 billion m3/year as a minimum along the Euphrates River (which means that the agreements concluded between Türkiye and Syria and between Syria and Iraq, how much are they? And all projects in Türkiye on the Tigris River will be fully developed. More details are in the appendix..C

the environment This category focuses on the relationship between water and environmental conservation, biodiversity protection, and the sustainable use of ecosystem services.

The relationship between water, food, energy and the environment

Document summaryPriorities, goals and objectives for the 10 ministries that participated in each NWDS The four categories, summarized by future vision statements)Vision Statements. The future vision (one for each of: water, food, energy, and environment) represents the Iraqi government's goals for this sector over the next twenty years and is located at the beginning of each associated chapter in this strategy.

5.5.7 Opportunity Evaluation

Not every opportunity can or should be pursued. Therefore, it was necessary to narrow the expanded list of opportunities down to a more concise, prioritized version. To do this, an assessment was first conducted to identify projects currently under development or those deemed essential to public safety. Practically speaking, it made sense to start with projects currently under construction.And those related to public safety are supposed to be of utmost importance, projects shovel-ready. For the Iraqi government. Both are identified within the selection process as constraints, meaning they are automatically included as selected projects.

A multi-criteria screening process was then conducted to evaluate the dams and irrigation projects on the list. "Strategic Evaluation Criteria" were created, which are values calculated on

The physical factors for both hydropower dams and irrigation projects were based on numerical representation of the technical, social, environmental, and economic aspects of the opportunities. Weights were then calculated for each criterion using the priorities identified by the stakeholder committees for the National Water Development Strategy.Finally, the overall score for each project was calculated as NWDS. The sum of the weights, which provided an objective and systematic method for ranking the list of hydroelectric dams and irrigation projects[29].

The observations from the relevant authorities resulted in theAbout identifying three additional NWDS factors To consider when selecting irrigation project opportunities:1) Reducing poverty (0) Maintaining national security On the border through the development of irrigation projects near the Iraqi border (3) Reducing displacement or migration Rural population. It is noteworthy that these three criteria are the main national priorities (These priorities can be used in conjunction with the National Priorities Key evaluation criteria. The strategy is to arrange irrigation projects in a purposeful manner that also reflects the feedback of the relevant parties.

4.4.2.2 The advisory process

Because we were committed to a highly flexible and participatory approach while selecting opportunities for the strategy, the National Water Development Strategy has been transformedTo be a starting point only. After completion NWDS From the reportIn order to respond to the requests submitted by the Ministry of Water Resources and the Ministries NWDS Other changes were made to the strategic assessment criteria for hydroelectric dams and irrigation projects, changes were made to the weights assigned to key national priorities, and new constraints were introduced on water allocation between different sectors.

In addition, several technical meetings were held between February0213 and September 0213 where Team representatives discussedThe Ministry has various topics such as crop composition, density and SWLRI. Agricultural, infrastructure development cost functions, land management practices, hydropower production, existing and planned irrigation projects, drainage infrastructure, marshland management, flood risk mitigation, and drought management strategies. Information from these meetings was used as input into a planning model to evaluate alternative development options and determine their impact on water and land use.

4.4.2.4 High-level meetings

There was anxiety throughout the study process.To avoid creating an optimal engineering strategy from SWLRI Technically, to solve the issues of water and land management in Iraq, which have no hope of success because they are far away

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[29]Details of the calculation of the strategic assessment criteria and the classification of opportunities are provided in Appendix 5.D. The multi-criteria approach was chosen in order to: Balancing responsibility between competing uses of water across different sectors was the biggest challenge in the planning process.

About the social and political realities of the country. Instead, the goal was to develop a strategy not only in the context of Iraq's development goals, but also their limitations, understanding its history as well as current and future challenges. To do this, we sought, above all, to create a document*Suitable for use*It is renewable and acceptable at the same time.

In addition, as the project progresses,It has become clear that some decisions regarding SWLRI Water and land use were much more political than technical. Therefore, first, to provide the technical solutions envisioned, we conducted a reality check, and second, we allowed Iraqi politicians to answer Iraqi political questions. A coalition was organizedSeven meetings of Tishreen SWLRI the first0213 to February 0210 with high-level members from relevant ministries. In this At the meetings, attendees discussed and decided on the approach to be taken, and the decisions resulting from these meetings were used as fixed parameters for selecting opportunities in the strategy.[30]The results of these high-level meetings were subsequently presented and discussed with the Head of the Prime Minister's Advisory Board.

Topics discussed and decisions reached at these meetings include:

1.**Land Management**It was decided that Iraq should continue its development path, which strives to minimize the displacement of farmers as much as possible. This means that some areas where agriculture was practiced outside the lands originally identified by the Iraqi government will be included in future development within the strategy as areas requiring investment between now and 2020.0231. Accordingly, the boundaries of irrigation projects have been modified. used in the studyTo accommodate this strategy SWLRI

0.**agricultural density**Regarding land in the agricultural sector, agricultural density is: The target will be111%

3.**Flood control**It was determined that, assuming the Mosul Dam is repaired, the only additional water control works necessary to control flooding are the widening of the Samarra spillway and the diversion structure.

0.**hydroelectric power**Hydropower will continue to be a primary means of generating energy. Electricity in Iraq and the Kurdistan Region. For the Kurdistan Regional Government, the goal is to meet15% of the region's electricity needs will be met by hydropower by 2031. In the rest of Iraq, the goal is to meet1% of its electricity needs are from energy Hydroelectric.

1.**Marshlands Management**It was agreed that revitalizing the marshes is feasible and desirable, as it provides a range of direct and indirect social and economic benefits and produces a higher economic return compared to agriculture in the three governorates of southern Iraq.

[30]Decisions made during the high-level meetings were subsequently discussed and approved by the study's steering committee.

The decision is to allocate from1 to 0 billion cubic meters of fresh water for the marshes per year Average hydrology.

- **Drought management**The decision was to reduce the amount of water retained by the Ministry of Water Resources at the end of the summer season to a minimum, allowing the Iraqi government to achieve its agricultural targets for the year.0231 while maintaining municipal and industrial needs. In addition to Reducing the amount of water at the end of summer. It was decided that drought policies would be updated every five years and that reservoirs would be managed more effectively throughout the year.

2.**International Water Resources Management**A framework was presented for how the Iraqi government could coordinate a water-sharing agreement with its riparian neighbors. The scope and outcomes of this meeting remain confidential and are not included in this report.

1.1 Selecting opportunities

After identifying the current uses of water and land resources, expected future needs, and the priorities and objectives of the Iraqi government, the study coalition reachedWhat is SWLRI classified as? Selected for opportunities. This selection is then fed into a computer model called a planning model (PM) As well as other analytical tools to test different combinations to arrive at the most effective final project selection. Below is a list of the various analytical tools used:

5.3.1 Analytical tools

Many advanced analytical tools have been developed to allow the team to:To test a set of SWLRI Selected opportunities. These modeling tools include:

Schematic model (PM) It is a hydro-economic model capable of simulating, over monthly timescales, the impacts of different planning scenarios (e.g. introduction of different dams, irrigation projects, policies, etc.).

Water Management System Model (WMSM: It provides the ability to verify the hydraulic feasibility of the analyzed scenario with the planning model, as a tool for simulating the water resources management process.

Water quality models (WQ): It includes: (a) One-dimensional water quality models for all major rivers (b) Two-dimensional vertical water quality models for all major reservoirs and the Shatt al-Arab River (c) Three-dimensional water quality model for Lake Tharthar.

Groundwater model (GW): The modelIt is an integral part of the planning model for GW. Helps estimate the groundwater balance of aquifer systems and subsystems. The groundwater model can be used to analyze individual components of water movement and the impact of hydrological scenarios.

Specifically, this model allows for estimating the amount of groundwater available for extraction and provides a description of water quality in terms of salinity.

Surface water models ()SW: Model series (rainwater model based onHEC-HMS The disability model is based on,) and a randomness generator created for specific purposes HEC-ResSiM It gives the ability to test different hydrological scenarios of water availability in Iraq (different flood years and different drought years) as well as to investigate climate change factors.

Flood models (FM) There are two alternative flood models: a one-dimensional hydrodynamic model for all major river systems, and a two-dimensional flood model to study the potential collapse of the Mosul Dam.

Agroecological division:(AEZA large collection of thematic maps has been created including: Agro-ecological suitability maps for30 strategic crops were selected for the SWLRI study, as well as: About production maps for all crops, land suitability, land suitability for different types of irrigation techniques...etc.

Finally, after this comprehensive process of fact gathering and verification, needs assessment and forecasting, stakeholder engagement and collaboration, computer modeling and screening, a final list of opportunities in this strategy for water and land use in Iraq was presented.

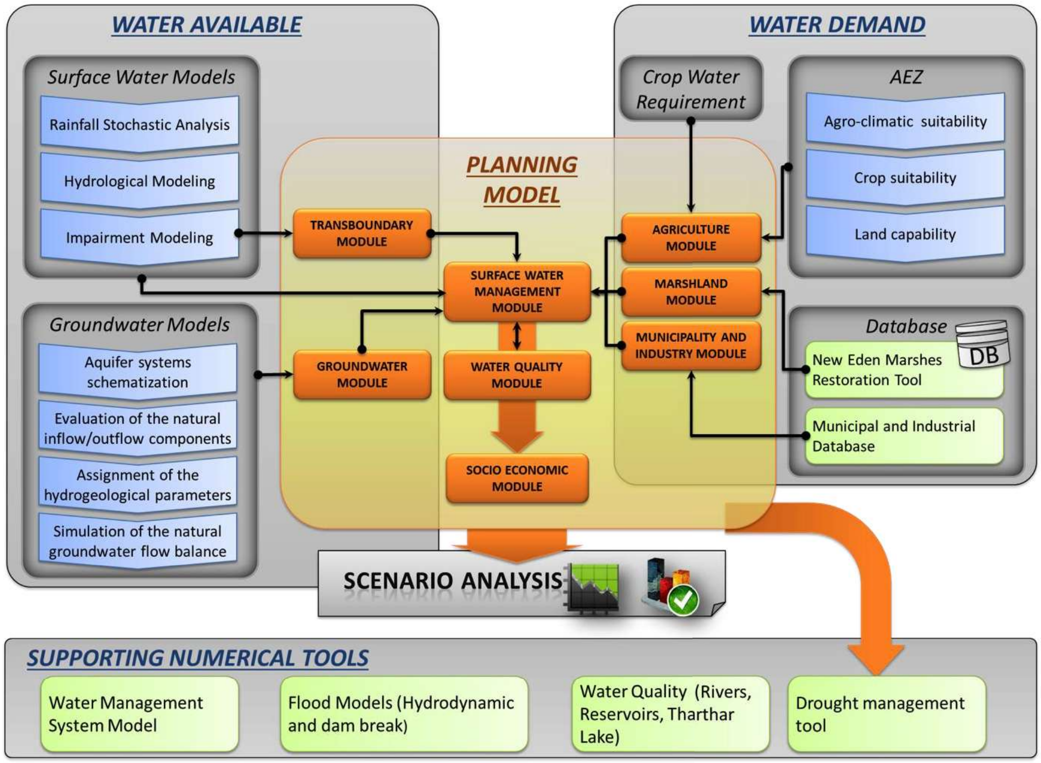
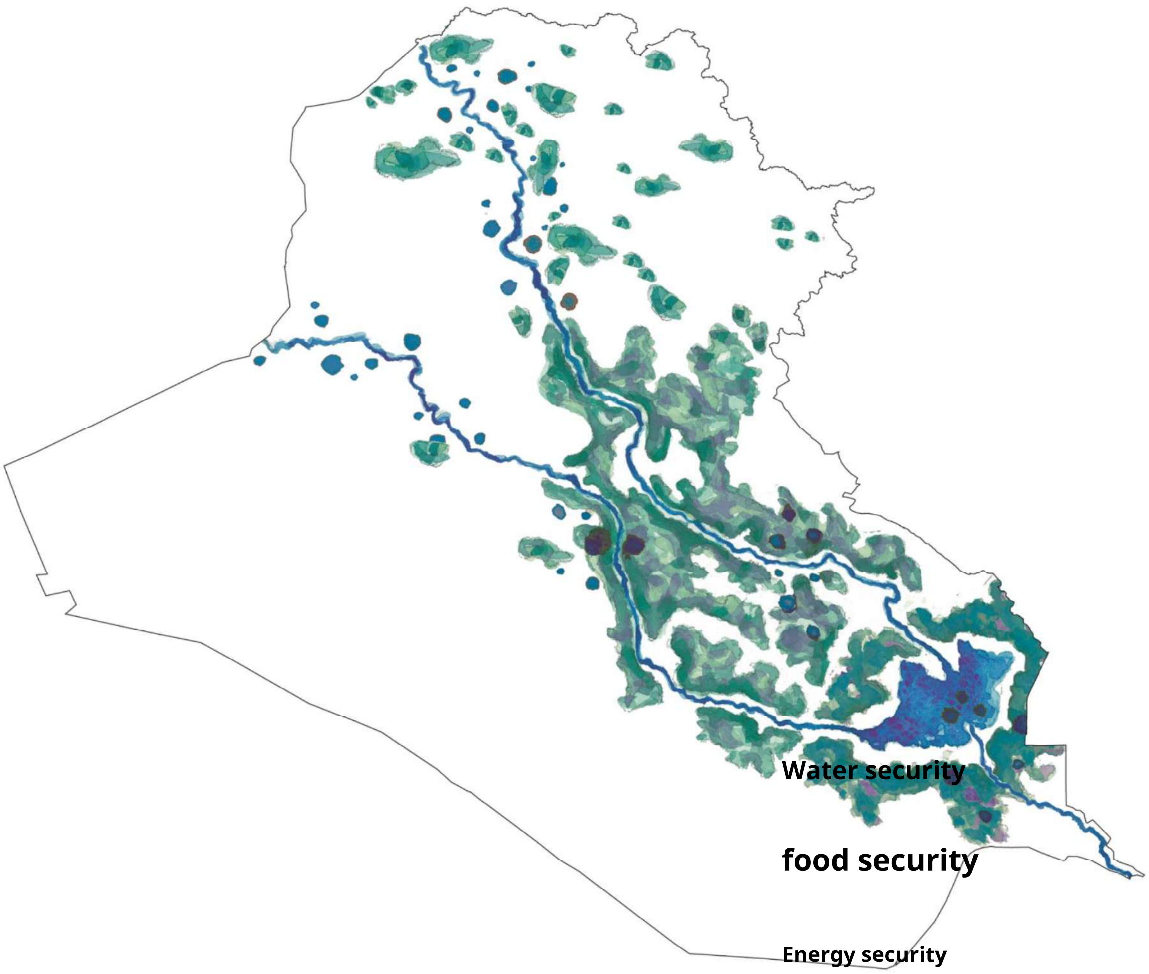


Illustration14/ Figure 2-1: A diagram illustrating the interrelationship between the various analytical tools developed for the strategy.

Part Three

Strategy for the Management of Iraqi Water and Land Resources

2102-2112



Water security

food security

Energy security

Environmental conservation

Part 1: Strategy for Water and Land Resources Management

Iraqi1111-1111

1.1 Water security

Iraq's vision for water security encompasses a wide range of objectives. First and foremost, it is to ensure adequate water supplies to the Iraqi population, both in quantity and quality. To advance this goal, specific measures must be taken, including flood risk management, the distribution and allocation of water resources, the use of technologies for more efficient water use, water recycling, drought mitigation, navigational support, and cooperation with Iraq's riparian neighbors.

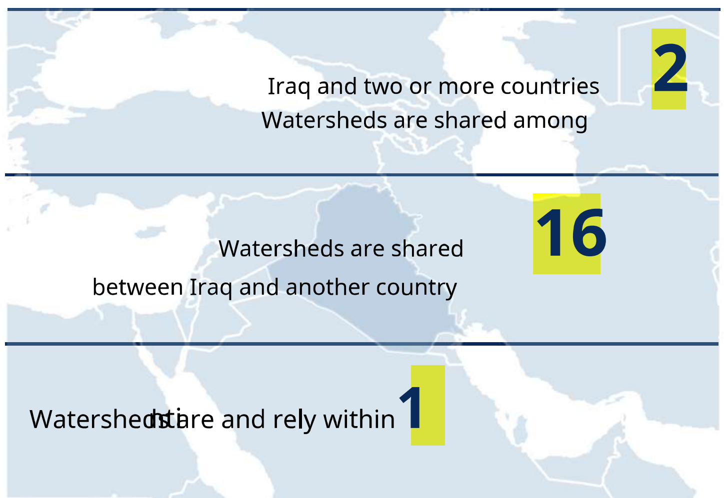
3.1.1 Introduction

The institutions, policies, and practices that help achieve water security in Iraq simultaneously help protect and enhance other essential areas such as human health, social and economic development, and ecosystem services. Although a complex process, water security is a necessary component of sustainable growth as well as peace and security in the region. A strategy that optimizes supply and demand across the full range of water users is an integral part of

Water security is also considered, as hydrological variability and drought exacerbate water scarcity issues.

Cooperation on shared water resources, both locally and internationally, is essential to achieving water security in Iraq. Today, approximately3% of Iraq's surface water supply comes from outside. Its borders and it is expected that the development of the upper rivers will greatly reduce the amount of water reaching its borders from now until the year0231. Türkiye, Syria, and Iran are all seeking independent plans to address... Its objectives are social and economic development through the expansion of irrigated agriculture, industrial activities, and power generation. The establishment of infrastructure to support these objectives has impacted the hydrology and water quality of the shared watershed, as have dams and other water diversions. Development is underway in the riparian states and will continue to strain Iraq's efforts to achieve water security unless cooperative measures are taken.

[31]INTERNATIONAL WATERS



Over the next 20 years, the combined population of those parts of Turkey, Syria, and Iran located within the watershed boundaries of the Tigris and Euphrates rivers is expected to increase by more than nine million people. Concurrent with this population growth, Turkey, Syria, and Iran will add more than141 million hectares of agricultural land in the Euphrates and Tigris basins. On it and by the year0231, the total cultivated lands in Türkiye, Syria and Iran will

[31]The administrative boundaries and location of watersheds are provided in the "Water Security-21" and "Water Security-20" annexes, respectively. This report

It reaches approximately41 million hectares in the event of achieving full agricultural development[32]Intensive agricultural expansion will significantly increase water consumption from outside Iraq, thus deteriorating water quality and reducing the amount of water coming into Iraq.

[32]Elsewhere in this document, this situation is referred to as “122% Upper River Development.” Full details of this are given below. Calculations and their assumptions in the appendixFor this document C.

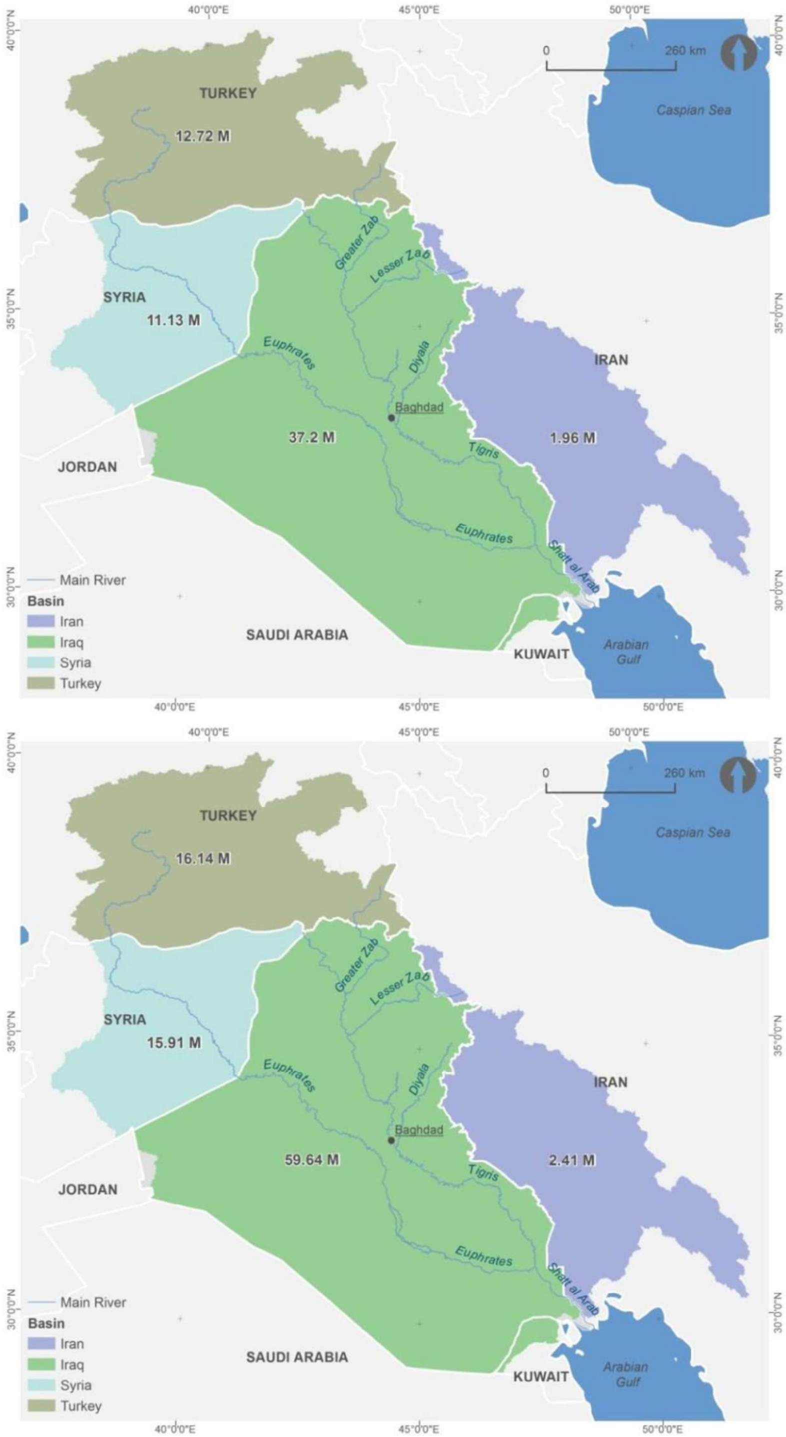


Illustration *15* **appearance4-3: Current (above) and future (below) population distribution inside and outside Iraq along the watersheds.**

Tigris and Euphrates rivers

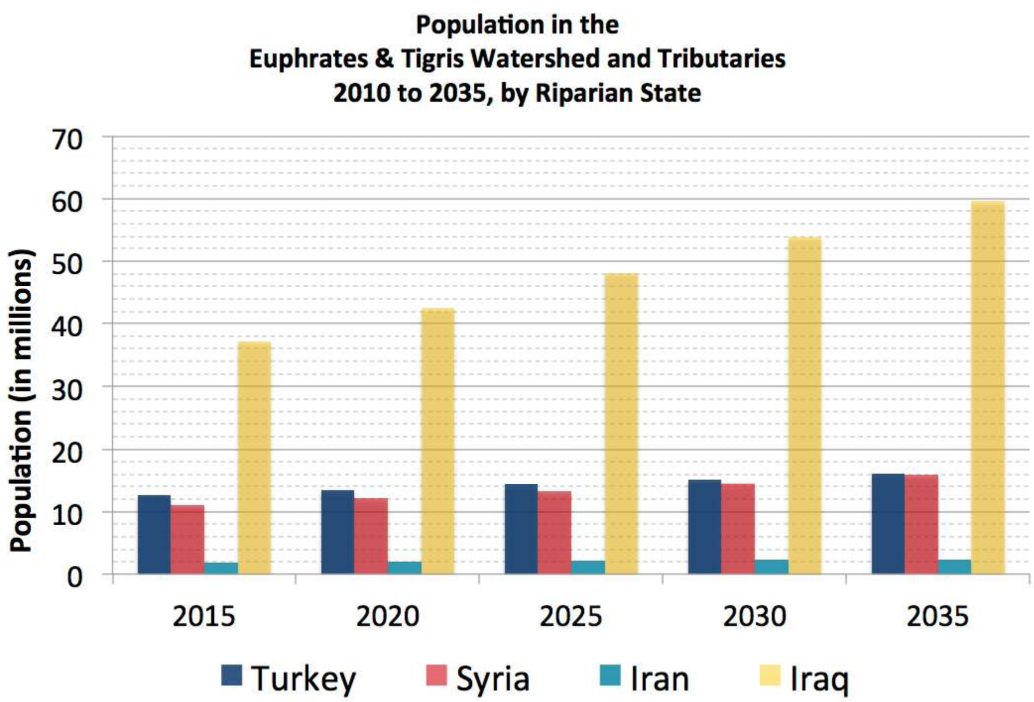


Illustration16Figure 3-0: Population growth in the watersheds of the Tigris and Euphrates rivers and their tributaries

As Türkiye, Syria, and Iran intensify their use of water and land resources, Iraq's population is expected to grow by more than one million people annually on average over the next twenty years. By 2020,0231 The population is expected to reach approximately 2. One million people. As a result, there will be significant pressure on water resources, especially for Iraq's agricultural sector.

Moreover, later in the year0231, the water available to Iraq will continue to decline. The figure shows3-3 The following is that the quantities of water available will decrease due to population growth within Outside Iraq, while demand for water in Iraq will increase, this is mostly due to increased municipal and industrial needs.

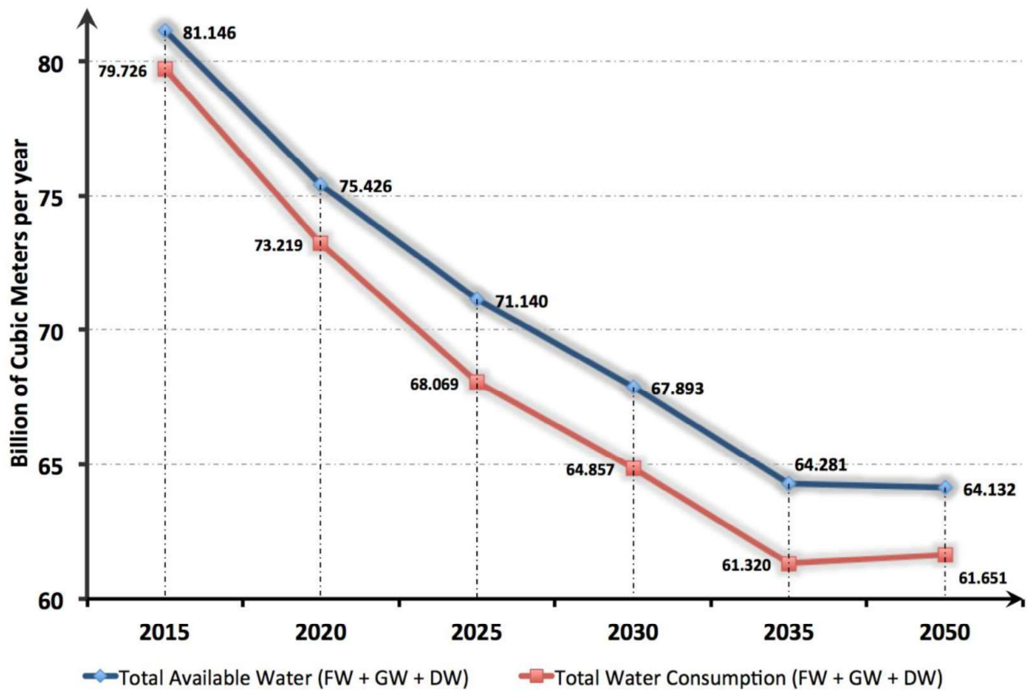


Illustration 17appearance3-3: Water availability versus water consumption beyond 2135

With this in mind, achieving water security in Iraq requires developing strategies to maintain diplomatic relations with its riparian neighbors, explore opportunities for cooperation, and establish a mechanism to ensure accurate and reliable information on the future quantity and quality of water reaching Iraq's borders. Furthermore, Iraq's water security also depends on adopting strategies that improve water consumption efficiency in cities, towns, villages, industries, and irrigation projects.

3.1.5 Development of the Upper Rivers

Iraq depends on water flowing into the country from the Euphrates, Tigris, Upper Zab, Lesser Zab, Diyala, Karun, and Karkheh rivers, along with water coming from a number of smaller tributaries. Currently, approximately3% of Iraq's available fresh water enters the country along the These rivers are stored in a reservoir system to support their water needs throughout the year and store excess water during periods of high flow. As a result of this reliance on upstream flows, declines in flows from these rivers resulting from upstream agricultural development, population growth, industrial development, dam construction, and other water diversions place Iraq in a vulnerable position. This vulnerability is exacerbated by the lack of permanent agreements on water allocation from the major rivers or the quality of water reaching Iraq's borders. Climate change, declining snowpack, and increased evaporation resulting from rising temperatures threaten to add an additional layer of concern.

Even without climate change, by the year0211 It is likely that the demand for water will exceed Fresh water in Iraq is the amount of water available.

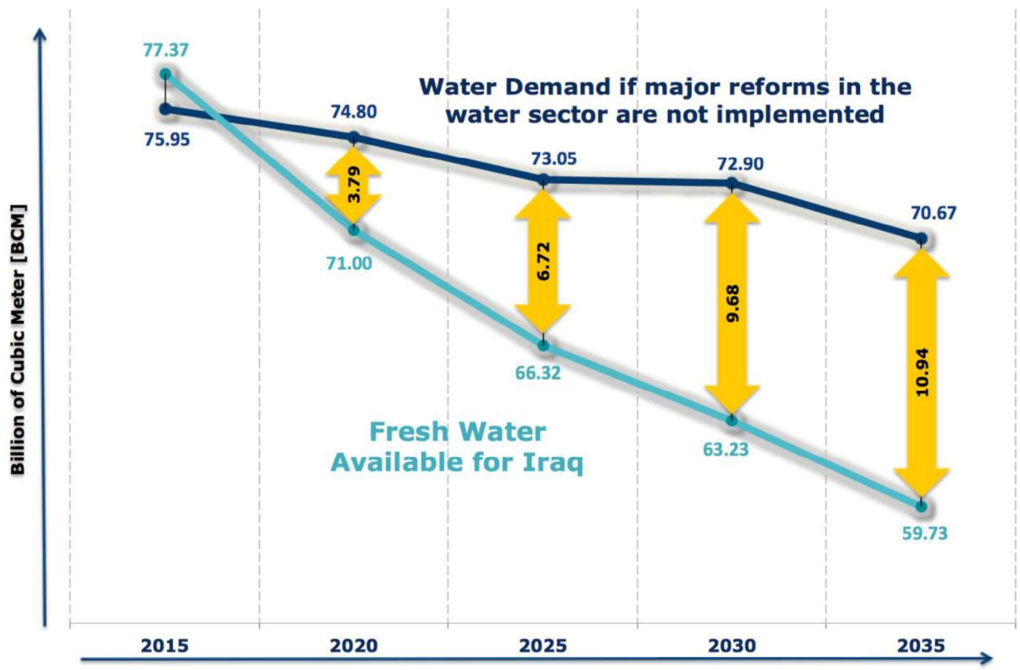


Illustration *18* **appearance2-3: Iraq's water budget without implementing a strategy** *SWLRI*

In case of investigation122% of planned irrigation and water diversion projects by upstream countries The two rivers adjacent to Iraq, by the year0231 Water availability in Iraq will be 0.041% lower than it is today. Even if only 21% of the planned projects are implemented, it will Water availability to Iraq0.245% less than today. Equally important, the intensification Agricultural practices in the upper reaches of the two rivers are expected to significantly reduce the quality of water reaching Iraq through the gradual salinization of freshwater. The average concentration of dissolved solids Which represents the salinity along the Euphrates River at the Syrian-Iraqi border is approximately (TDS) from102 mg/L and deteriorating to approximately 532 mg/L by 2031, if Development of the upper reaches of the two rivers by122% in Türkiye and Syria (or 502 mg/L in the scenario Development by21%). As for the Tigris River, the average salinity on the Turkish-Syrian border is Iraqi approximately302 mg/L, deteriorating to approximately 122 mg/L by 2031 if the upper reaches of the two rivers in Türkiye are developed by 122% (or 0.2 mg/L in the scenario Development by21%).

The anticipated deterioration in water quality and quantity creates an urgent need for Iraq to comprehensively manage its water situation, both through dialogue with its upstream neighbors and through managing its domestic water consumption.

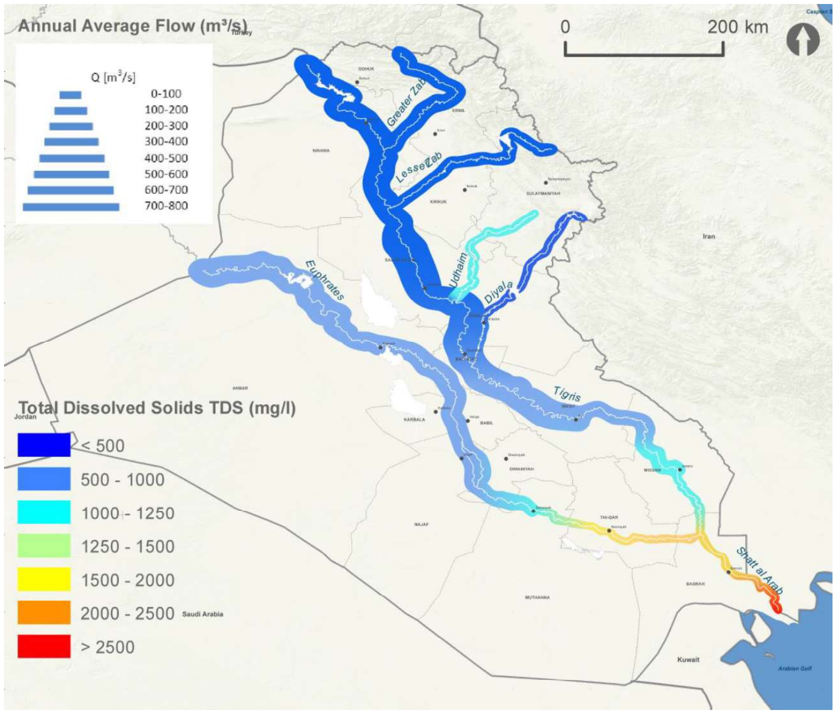
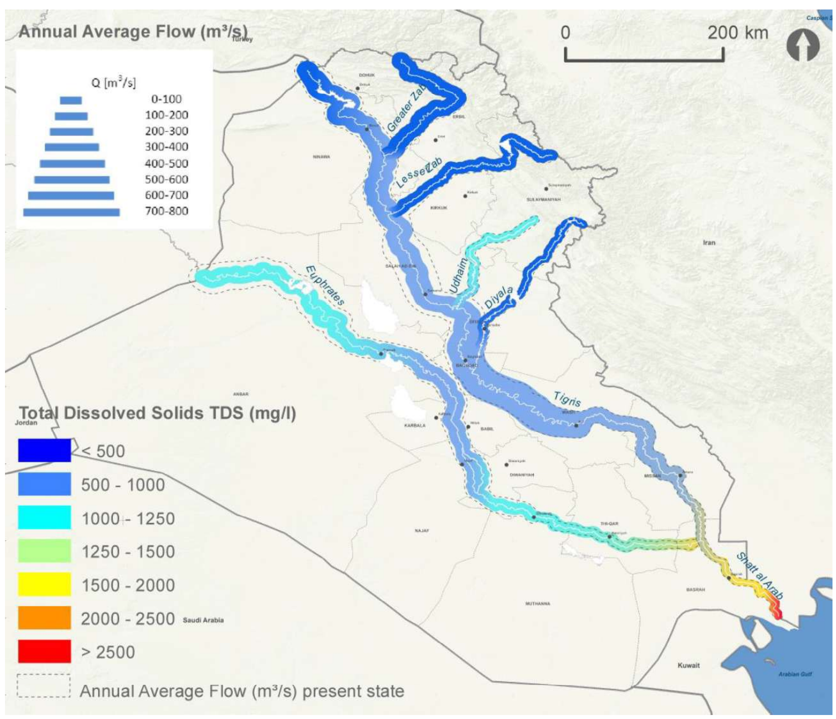


Illustration19Figure 3-1: Current water quality and quantity[33]



[33] This map has been enlarged in the "Water Security Map 23" attached to the main report.

Illustration*20*appearance2-3: Future water quality and quantity[34]

1.2.4.2 Future needs

Achieving water security in Iraq requires pursuing one or more agreements with Turkey and Syria that address the quantity and quality of water entering Iraq from the Tigris and Euphrates rivers. Furthermore, because Iraq's water needs will exceed available water in the near term, a future plan must be developed that optimizes the use of Iraq's projected water supplies, including improved storage and increased water consumption efficiency.

1.2.4.4 Opportunities and Strategies

The proposed strategy for managing the development of the upper reaches of the two rivers and international water resources issues in the Tigris and Euphrates watersheds (and tributary areas) consists of two independent components:

1The first element is a country-wide integrated water resources management plan that addresses water security in Iraq independently of the possibility of reaching an agreement on international rivers sometime between 2015 and 2017.0211 and 0231. Iraq's Water and Land Resources Strategy 0211-0231 provides a roadmap for implementing this plan, assuming two different levels of development outside Iraq and thus two alternative scenarios for water availability. The strategy assumes that development will occur in the upper reaches of the two rivers by122%[35]But it also looks at the development strategy that shows what Iraq could do if there was more water when the development of the upper rivers reaches21% of Maximum expected.

2The second element is the implementation of a negotiation strategy that pursues diplomatic dialogue with Turkey, Syria, and Iran, which will improve water use and quality and support social and economic development in each country. Discussions based on comprehensive knowledge of the facts about the state of water resources in the watersheds, as well as future needs, are now possible due to the data collected to prepare the strategy. The confidentiality of the negotiation strategy prevents its inclusion in this document, so that it can be implemented at the discretion of the Government of Iraq.

Water supply and demand management

To meet Iraq's future water needs, it is necessary to explore strategies on both the supply and demand side. Supply-side strategies include increasing the amount of fresh water available from

[34]This map has been enlarged in the "Water Security Map 20" attached to the main report.

[35]In the context of the strategy, the 122% upstream development concept means that all known planned irrigation and infrastructure projects are controlled by Water along the Tigris River watershed in Iran and Turkey will be completely depleted by 2020.0231, and Iraq will guarantee no less than 5101 billion cubic meters annually along the Euphrates River (i.e., existing agreements between Türkiye and Syria and Iraq and Syria will remain in place) All projects along the Tigris River in Türkiye will be fully developed. More details are available in the attachment..C

By improving the use of existing and proposed dams, implementing new water distribution strategies, and operating reservoirs, both surface water and groundwater will be important contributors to Iraq's overall freshwater supply, providing 50% of the country's total freshwater needs.5140% and 545% respectively of fresh water Available by0231. Controlling water demand in Iraq is equally important. To ensure that every sector is provided with a reliable water supply, cooperation is needed between Iraq, Turkey, Syria, and Iran so that collective efforts can be made to conserve water and introduce water efficiencies into consumption in each country.

water quality

Addressing the water quality issues facing Iraq requires two distinct efforts. First, an agreement must be reached with Turkey, Syria, and Iran that imposes restrictions on the quality of water reaching Iraq's borders on all international rivers shared with Iraq, with a particular focus on the Euphrates and Tigris rivers. It is also important for Iraq to separate untreated agricultural, municipal, and industrial runoff from its freshwater sources.

3.1.3 Integrated Water Resources Management Strategy

The philosophical framework of this strategy embodies the principles of integrated water resources management, which assumes the full range of water users across the country and addresses their water needs to the greatest extent possible relative to the forecasting of water availability. The strategy has been tested against1,000 years of A synthetic hydrological dataset is designed to ensure reliable water supplies, even during droughts, to meet minimum needs for municipal and industrial sectors, with reduced allocations implemented objectively and with advance warning for the agricultural and environmental sectors. The table below shows the water allocations for Iraq that are part of this strategy. These allocations assume that the amount of water available for consumption in Iraq is consistent with the development of the upper reaches of the two rivers. 122% in coastal countries.

table3-4 Iraq's water budget for the years 2135-2145, assuming a development rate of 411% in the upper reaches of the two rivers in Türkiye Syria and Iran

[36]AVAILABLE WATER [BCM/Year]

2035	2030	2025	2020	2015	
28,487	**31,870**	**34,592**	**38,482**	**43,696**	Fresh Water from Riparian Countries
9.999	12,383	14,137	16,683	18,396	Euphrates
9.822	10,703	11,588	12,905	15,919	Tigris
3.294	3,316	3.375	3,377	3,378	Greater Zab
2,182	2.203	2,219	2.236	2.292	Lesser Zab

[36]The item "Water generated within Iraq" includes exchange with groundwater. The item "Water from return flow" includes return flow from Both agricultural, municipal, and industrial water. Municipal and industrial water represent the total consumption volume, assuming that141 billion Cubic meters of water needed to reinject oil fields are taken from the sea.

3,189	3.266	3.273	3,281	3,710	Diyala
21,919	**21,919**	**21,919**	**21,919**	**21,919**	Fresh Water Generated Inside Iraq
1.123	1.123	1.123	1.123	1.123	Euphrates Hadith Dam - Qur'an
5,073	5,073	5,073	5,073	5,073	Tigris
7,462	7,462	7,462	7,462	7,462	Greater Zab
4,551	4,551	4,551	4,551	4,551	Lesser Zab
0.956	0.956	0.956	0.956	0.956	Adhaim
1.788	1.788	1.788	1.788	1.788	Diyala
0.967	0.967	0.967	0.967	0.967	[37]Tharthar
4,076	**4,193**	**4,568**	**5,359**	**6,507**	Return flow to the Rivers
54,482	**57,983**	**61,080**	**65,761**	**72,122**	**Total Surface Water**
5.243	5.243	5.243	5.243	5.243	Sustainable Groundwater Withdrawals
4,556	4.667	4,817	4.423	3,781	Drainage Water
64,281	**67,893**	**71,140**	**75,426**	**81,146**	**Total Available Water (FW + GW + DW)**

FRESH SURFACE WATER CONSUMPTION [BCM/Year]

2035	2030	2025	2020	2015	
7,504	7.152	6.663	6,167	5,769	Municipal & Industrial
32,187	33,378	36,294	40,089	46,090	[38]Agriculture
0.329	0.329	0.329	0.329	0.329	Fish Farms and Livestock
5.825	6,395	6,554	7,037	5,388	Total Marshlands Consumption
3,391	4,402	4,514	4.691	3.934	Flow to the Gulf via the Shatt Al Arab River
0.959	0.959	0.959	0.959	0.959	Evaporation from Rivers
4,287	5,368	5.766	6,488	9.653	Evaporation from reservoirs
54,482	**57,983**	**61,080**	**65,761**	**72,122**	**Total Freshwater Consumption**

GROUND WATER CONSUMPTION [BCM/Year]

2035	2030	2025	2020	2015	
0.400	0.369	0.337	0.304	0.272	Municipal & Industrial
1.882	**1.838**	**1.835**	**2.659**	**3,499**	Agriculture
0.103	0.097	0.095	0.089	0.099	From springs
0.300	0.261	0.261	0.256	0.251	From wells serving official irrigation projects
1.479	1.479	1.479	2.314	3,149	From wells serving areas outside official irrigation Projects
2.282	**2,207**	**2.172**	**2.963**	**3.771**	**Total Groundwater Consumption**

DRAINAGE WATER RE-USE [BCM/Year]

2035	2030	2025	2020	2015	
0.550	0.521	0.338	0.211	0.162	Oil Sector

[37]The volume is 245.2 billion m^3This is the natural flow to Lake Tharthar, as calculated in the groundwater study. This entire volume will evaporate. From the lake and is included in the amount of water evaporated from the reservoirs and is therefore considered unavailable for any other uses.

[38]Water requirements for agriculture include the decrease that may occur over the years when the available water quantities are less than the needs. Water for irrigation.

3.693	3.834	4.166	3,899	3,306	Hammar Marshe (via MOD) + Shatt Al Arab (via ETD)
0.313	0.313	0.313	0.313	0.313	Green Belts
4,556	**4.667**	**4,817**	**4.423**	**3,781**	**Total Drainage Water Consumption**

The water budget, shown above, illustrates the approach to water availability and water demand in Iraq for the period between0211 and 0231. Available surface water consists of water entering Iraq from Its neighbors, riparian states along international rivers, surface water runoff within Iraq, and return flows from agricultural, municipal, and industrial sources. It is important to note that the water budget represents a long-term average available for water trends for the period between 2005 and 2006. 0211 and 0231. The available water mentioned is not a specification of the exact volume of water that will be received. Iraq in a given year, but rather the value is the average volume of water calculated through the use of the1,000 years of synthetic hydrological dataset and consumption calculations Water and reservoir management will take place outside Iraq in Türkiye, Syria and Iran during the time periods (five years) shown in the table.

1.2.1.2 Available water in Iraq

Available surface water is expected to decrease by about124.02 billion cubic meters or approximately from0.41% over the next twenty years. And water consumption from outside Iraq is The reason for the shortage11,401 billion cubic meters. When new infrastructure is built for drainage and agriculture. Necessary to protect water quality throughout the country, there is a lack of agricultural runoff returning to Iraq's rivers, which will lead to a decrease04031 billion cubic meters of water In the rivers of Iraq.

1.2.1.4 Surface water consumption

Between the years0211 and 0231 and by implementing various water efficiency measures it is Surface water consumption is expected to follow a declining trend (further details are also available in the "Water Security Map -12). Some sectors will witness an increase in consumption, while others will experience a decrease. Other sectors will decrease or remain stable. In municipalities and industries, reductions in water loss through water distribution networks are expected to improve the delivery of fresh water to these users. If the strategy is implemented properly, a reduction of 10% is expected.%0041 in Freshwater consumption between now and 20150231 Even if there is an increase in population Iraq. The expected increase in water needs for municipalities and industries is more than1.231 One billion cubic meters in the next twenty years.

There will be a significant reduction in freshwater consumption in the agricultural sector in Iraq. As reclamation and rehabilitation efforts in this sector develop, new agricultural patterns and structures will be implemented.

New crops will be developed according to the agro-climatic zones, and the efficiency of water use on the farm will increase to achieve22%, increasing water transfer efficiency to 52%, and increasing operational efficiency to 51% to achieve Total irrigation efficiency of2.% Surface water consumption in the agricultural sector should decrease by about 114,315 billion cubic meters, or 3245%, from 2011 to 2031. Consumption is expected to remain Water through fish farms and livestock farming is almost the same between the current situation and 0231. Existing fish farms will be maintained in the future, and new fish farms will adopt floating cage culture, according to the Ministry of Agriculture's plans. Therefore, fish farms will not consume additional water in the future. Water requirements for livestock have been calculated as a function of crop production, and a slight increase in livestock production is expected in the future.

Evaporation losses from rivers and reservoirs are a function of the surface area of these water bodies. Implementing new reservoir management strategies in the future will reduce evaporation losses from Iraq's reservoirs. Lakes Tharthar and Habbaniyah are currently responsible for more than 12% of evaporation losses from reservoirs in Iraq, but in the future, the Tharthar Lakes will be used and Habbaniyah for flood control purposes only. The proposed drought management strategy also contributes to reducing the volume of water stored in reservoirs at the end of the summer season, which means that more water from the reservoirs will be supplied to water users throughout the year, and in winter in particular, leading to the expansion of agricultural land during the winter period. Because less water is stored in reservoirs, less water will be lost to evaporation. As a result of implementing these strategies, annual evaporation losses from reservoirs will be reduced by more than %02. And Water losses from rivers due to evaporation are expected to remain roughly the same in the future because river surface waters are not expected to change significantly in the future.

The strategy recommends that an average of not less than14,501 billion cubic meters of Water is supplied annually to the marshes. Due to hydrological variability, in five out of ten years, the marshes will be able to receive more than this amount of fresh water. Therefore, the water proposed for consumption by the marshes is water that would have been lost to evaporation in Lake Tharthar.

The flow along the Shatt al-Arab must be maintained at no less than12 cubic meters per second Tigris River, which is equivalent to an annual flow volume of1415 billion cubic meters, to ensure that no water reaches The salt front from the Gulf to Basra. Based on the current strategy, this volume of water is supplied by the Tigris River alone. However, efforts must be made in the upper Shatt al-Arab to increase flow along the river so that water quality can be maintained. The amount of water reaching the Shatt al-Arab depends entirely on the volume of water consumed in the upstream areas. During the implementation of the strategy, it was found that the average volume of water reaching the Shatt al-Arab would exceed1415 billion meters cubic meters annually by the year0231, and approximately 04 billion cubic meters could reach the Gulf in Middle year

1.2.1.1 Groundwater consumption

Groundwater extraction by municipalities and industries is expected to increase.24020 billion meters cubic meters annually in2011 to 240 billion cubic meters by 2031. It is expected to decrease.[39] Groundwater consumption by the agricultural sector3.055 billion cubic meters annually in Current circumstances to14,550 billion cubic meters annually by 2031 (more details Also available in the "Water Security Map -11 Attached). Groundwater is supposed to continue to Irrigating the vast cultivated areas outside the official boundaries of irrigation projects, which consume the same total volume of water over the next twenty years. Many official irrigation projects that rely on groundwater for irrigation purposes will be subject to the same water efficiency standards as irrigation projects irrigated with surface water. The strategy limits groundwater consumption by the municipal, industrial, and agricultural sectors, combined, to the estimated sustainable groundwater withdrawal amount.14003 billion cubic meters per year.

1.2.1.2 Reuse of drainage water

Currently, available drainage water reaches exclusively the Hammar Marsh and the Shatt al-Basra River. The strategy proposes that drainage water be redistributed so that it can be reused in the oil sector, the Hammar Marsh, the Shatt al-Arab, and the green belts (further details are also available in the "Water Security Map -10 attached). In addition, the drainage water can be used for irrigation purposes if The terrain allowed for this. In the near term, the consumption of drainage water will increase (until the year 0202) If the increases in irrigation efficiencies on farms improve, the amount of drainage water will decrease. College available by0231. The Hammar and Shatt al-Arab marshes will continue to use most of the drainage water in In the future, the volume of reused wastewater by these users will reach 34553 billion cubic meters annually by 2031 (34020 billion cubic meters/year of The main drain to Marsh Al Hammar and24025 billion cubic meters/year from the East Tigris Drain to Shatt al-Arab River.

The oil sector will rely on dredging water to re-inject oil wells as well as water coming through the joint seawater supply facility, which is a water pipeline that will transport the treated seawater. 122 km underground for use in the oil industry. Between now and 2020, the oil sector

[39] The decrease in groundwater consumption for agriculture starting from 2011 to subsequent years can be explained as follows: In the current situation (2011) groundwater consumption for agriculture is high as a result of agriculture outside the official irrigation boundaries of irrigation projects, and then it will begin The decline will occur in subsequent years as agriculture (initially informal) becomes deprived of groundwater in these catchments where consumption exceeds sustainable groundwater withdrawals. Therefore, the overall effect is a general decline in groundwater consumption for agriculture, while sustainable groundwater withdrawals remain constant.

It will increase its consumption of sewage water to reach24112 billion cubic meters by 2020. And when The joint seawater supply facility will become a reality in the coming years and will be able to provide an increased supply of re-injected water.

1.2.1.3 Minimum water levels and discharges

In addition to the water quantities specified above, the minimum discharges required to ensure that water levels in Iraqi rivers are in line with the intakes of municipal and industrial water facilities are as follows:

table4/2-3 Minimum water levels to be ensured at selected sites

MINIMUM WATER LEVELS

Minimum water level required (masl.)	River	Governorate	Steam Power Station Name
30.7	Euphrates	Baby	Al-Mussayab Steam
2.8	Euphrates	Dhi Qar	Al-Nassiriya Steam
27	Tigris	Baghdad	Al-Doura Steam
27.5	Tigris	Baghdad	Baghdad South Steam
109	Tigris	Salah El Deen	Baiji Steam
9	Shatt Al Arab	Basrah	Al-Hartha Steam
7	Shatt Al Arab	Basrah	Al-Najibiya Steam

The minimum discharges required to support the above mentioned minimum water levels are as follows:

table5/3-3 Constraints on minimum water discharges at selected locations for supplying municipalities and industries

/s)3MINIMUM FLOW CONSTRAINTS (m	LOCATION
	Tigris
220	Mosul City
275	Baiji
350	Baghdad
140	Downstream Kut Barrage
35	Downstream Amara Barrage
20	Qalat Saleh
	Euphrates
150	Haditha City
70	Downstream Hindiyah Barrage
40	Nasiriyah
	Shatt Al-Arab
50	Basrah (water from Tigris River)

Additional details can be found in the appendix.Potential limitations of use - F.Report 5, F Water

3.1.4 Water Resources Infrastructure

Iraq's vast reservoirs represent its ability to manage available water resources and deliver water to all sectors. The dams are operated by three independent systems: System No.1) Includes the Euphrates and Tigris The upper Zab and the lower Zab. System No. (0) Includes the Great Watershed and System No. (3) It encompasses the Diyala watershed. Each system is operated to manage water distribution to municipal, industrial, agricultural, and environmental users and to protect against the risk of downstream flooding. The existing system of reservoirs has served Iraq well over the past decades, but the potential for declining water availability makes it clear that a new approach to water management in Iraq is necessary.

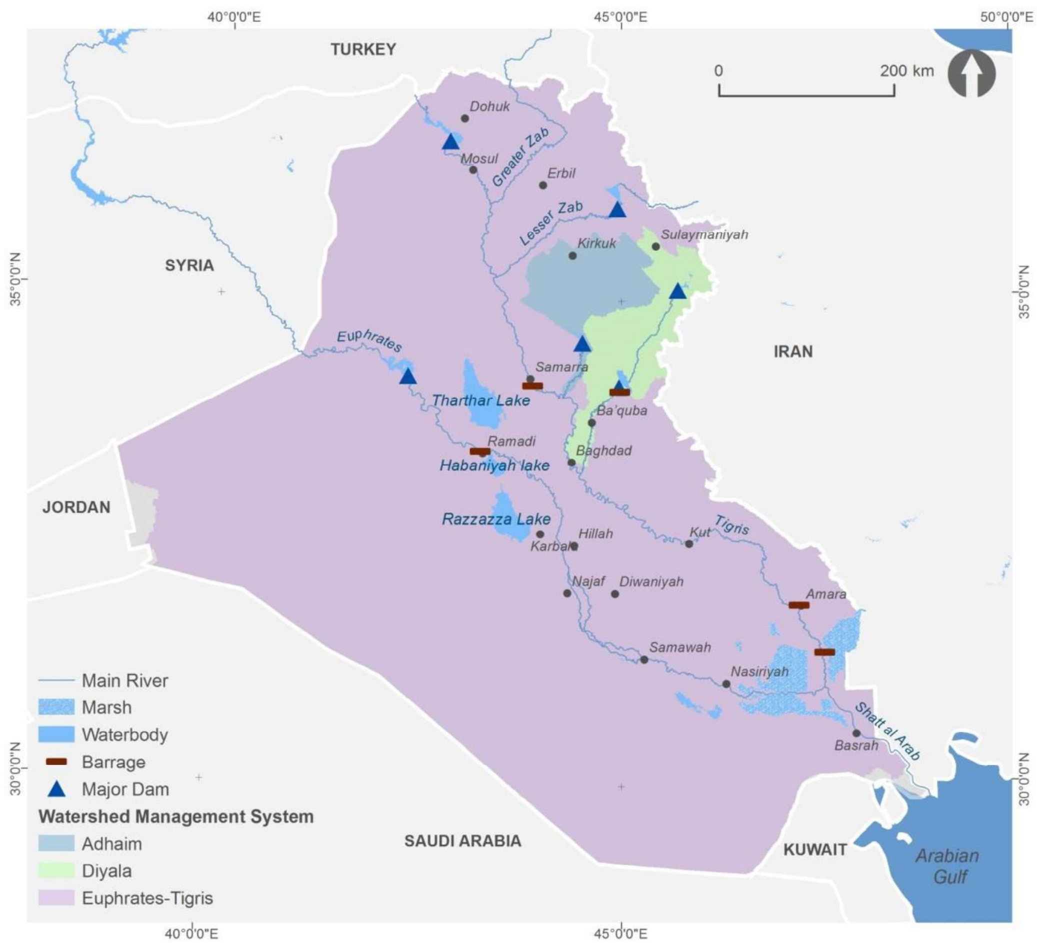


Illustration24/Figure 3-7: Tank management system shown with three independent tank management systems

1.2.2.2 Needs for the future

There is a need to identify new opportunities to build water resources infrastructure, modify existing infrastructure, and establish new operating rules for Iraq to successfully manage its water supply in the future.

1.2.2.4 Opportunities and Strategies

Mosul Dam rehabilitation

The Mosul Dam, a multi-purpose dam that provides hydroelectric power and storage benefits, is vulnerable to flooding, posing a significant risk to lives and property in Iraq. The dam is currently operating at a reduced storage level due to concerns about the instability of its gypsum foundation.[40] Operating the dam at a lower storage level reduces, but does not eliminate, flood risks. It is known that there is a consensus within the Iraqi government that rehabilitating the Mosul Dam is a top priority, and that rehabilitating the Mosul Dam will increase storage capacity because it currently operates at a maximum elevation of315 meters above mean sea level instead of level Maximum operating within its design is332 meters above sea level. Once this is resolved, The problem is that it will be possible to increase the water stored in the dam reservoir by more than12% compared In the current situation, thus increasing the storage capacity of fresh water in Iraq by about345 billion meters cube.

Control of evaporation losses

Evaporation losses in Iraq are significant due to high temperatures. The current water management system is approximately5 billion cubic meters of water are lost annually through evaporation from reservoirs. Iraq, which represents13% of the country's total fresh water availability. These losses are both waste and non-waste. Viable in a future of water scarcity. As a result of the low inflows into Iraq, the increasing demand for downstream flow, and proposed changes in reservoir operation, the use of Lake Tharthar is no longer a viable water storage strategy. After a year0202 If done Storing water in this lake would not only lose it through evaporation but would also become useless due to its high salinity. Therefore, Lake Tharthar would be used only for flood control in the future. It is proposed to conduct an environmental impact assessment in advance of decommissioning these reservoirs to determine the necessary mitigation measures.

In addition, as noted above, improvements to reservoir and drought management for this strategy have been calculated to reduce evaporation losses from reservoirs by more than12%.

Improving existing channels

The capacity of the irrigation canal should be expanded to convey drainage of approximately0.12 cubic meters per second. And re

Rehabilitation of this existing channel is very important because annually until the year0231 You will need this channel to transmit

[40]Bali Amit: Iraqi Dam at Risk of Deadly Collapse 02/22/2032 Washington Post http://www.washingtonpost.com/wp-dyn/content/article/2007/10/29/AR2007102902193.html
Entered in10/12/2013

45 billion cubic meters of water from the Tigris to Euphrates system to support irrigation projects served by the river Euphrates (this amount represents(Approximately 0.2% of the required water). Unless it is rehabilitated to Under the design conditions, the irrigation canal will not be able to provide the quantity and quality of water needed to support agriculture, in addition to water for municipal uses below the Fallujah Dam in the future.

Construction of new dams

By the year0231 A total of 5 new medium-sized dams will be built in the region. Kurdistan and10 new dams (small to medium sized) may be built in the rest of the country. Most of these dams are located along the Tigris River. Designed primarily for hydroelectric power generation, these dams will provide conservation and some flood mitigation. Some, such as the Taq Taq Dam on the Lower Zab, will provide multi-purpose services.

The constructionThree new dams will increase Iraq's water storage capacity by approximately 11 billion cubic meters by 2031. The dams proposed in the strategy represent the full potential of medium-sized reservoirs. And the large size in Iraq.

Construction of new small dams

This strategy proposes that new small dams should only be constructed in Iraq for the purpose of rainwater harvesting (particularly in the Western and Eastern Desert regions). However, the construction of these small dams must be carefully studied and an environmental impact assessment must be carried out as part of the overall dam assessment process. Any other dams (for example, those under study in the Adham and Lesser Zab basins) will have an impact on the national strategy and thus reduce Iraq's ability to achieve national targets for 2020.0231.

Assessing the need for new large dams

Within the projectFrom a technical point of view, the need for new large SWLRI dams has been verified. In Iraq through the following:

1. Flood risk mitigation 0.
Enhancing water supplies

From a flood mitigation perspective, the main flood control infrastructure was analyzed to determine the needs for managing a flood event.122 years. There was a special focus on evaluation. Flood risks along the Tigris and Upper Zab Rivers, the last undammed river in Iraq. Flood management strategies are fully discussed in the Flood Management chapter.

Floods are part of this report. To assess the need for dams to increase water supply and mitigate drought, several new alternative dams were studied to determine the extent to which they could mitigate drought events. While these issues were being investigated, groundbreaking new discoveries were made regarding the hydrology of the Upper Zab River and the hydrology of all watersheds in Iraq, highlighting the need for a major new dam in Iraq.

By combining the use of a planning model with the best hydrological statistics technology, several different proposed dams were analyzed in relation to the central scenario in Iraq. The central scenario assumes that no new large dams are built in Iraq in the future, that Lake Tharthar is used primarily for flood control purposes, and that the Mosul Dam is rehabilitated so that it can operate at a higher elevation.315 above sea level. Four alternative scenarios for the formation of The dam and its comparison with the central scenario[41]:

1. Modify the central scenario by adding the Bakhma Dam on the Upper Zab (the scenario is called "Bakhma" in the following graphic forms),
0. Modify the central scenario by adding a large dam at an opening. (Named "Opening")
3. Modify the central scenario by assuming that the Mosul Dam will not be rehabilitated and the Badush Dam will be constructed. The top below Mosul Dam (called "Badush"), and
0. Modify the central scenario by assuming that the Mosul Dam will continue to operate at an elevation of 315 Above sea level (i.e. it will not be rehabilitated) and that Lake Tharthar will continue to be used for storage (called "Mosul").315").

For the past 40 years, Iraq has planned to build a large dam on the Upper Zab River. The potential to control large floods and store excess runoff prompted plans to build the Bakhma Dam on the Upper Zab. However, local communities and the Kurdish Regional Government oppose the dam, so construction has stalled. Analyses conducted inIt has been proven that if the SWLRI Dam is rehabilitated Mosul and the capacity of the main Tharthar regulator in the Samarra Dam has increased, so there is no need for a new large dam on the Upper Zab like the Bakhma Dam.

Therefore, the only reason to build a new large dam in Iraq is if it provides a benefit in mitigating water shortages during drought. Comparing the water shortages shown in the figure below for the five scenarios, the Bakhma Dam still represents the optimal location for building a large dam in Iraq, but it provides a small amount of water to reduce the water shortage in Iraq during an average year. Comparing the impact of a hydrological time series of10,222 years on the central scenario and the four alternative scenarios for formation The dam, the Bakhma Dam, reduces the average annual water deficit byOnly 2423 billion cubic meters.

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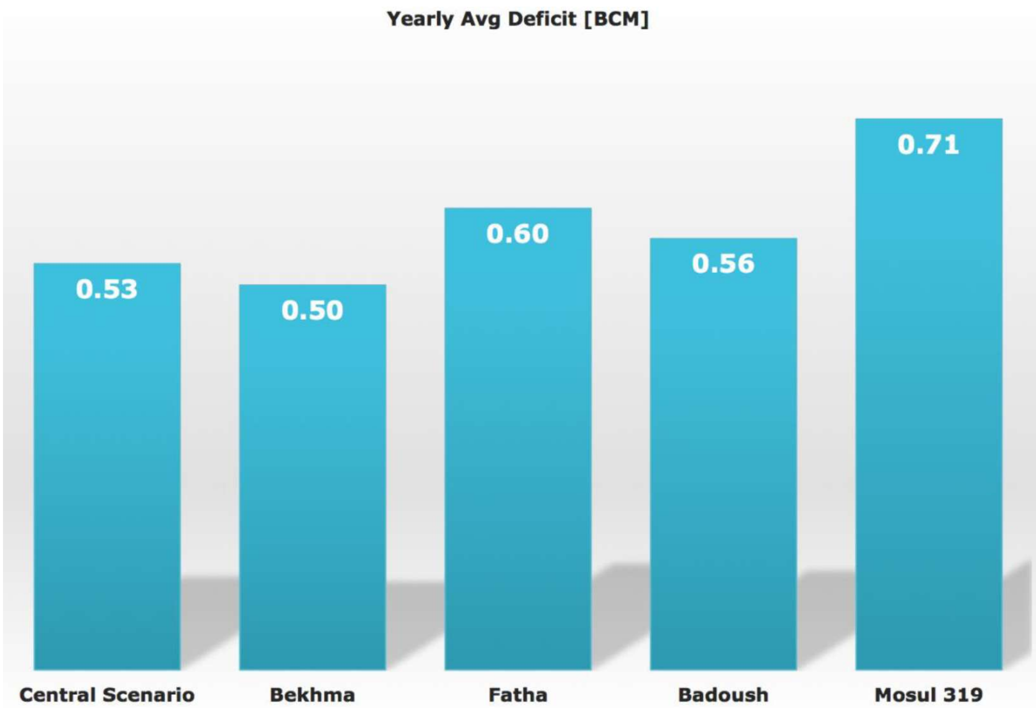
[41] The reader is reminded that the central scenario consists of all existing water resource control infrastructure being rehabilitated. Mosul Dam is being built in Iraq03 new small and medium-sized hydropower dams (12 in the Kurdish region and 10 in parts Other from Iraq) by the year0231.

During drought events that recur every01 years or more, the additional storage of Bakhma Dam provides Quantities up to approximately2.10 billion cubic meters, which represents less than one percent of Water balance by0231. These values indicate that minimal benefits would accrue from building the Bakhma Dam or Any other large dam in Iraq. Managing severe drought events in the future cannot be mitigated through the use of dams, and very strong institutional responses will be required to assist farmers and vulnerable communities. This assessment demonstrates that Iraq no longer has the hydrological capacity to justify the construction of new large dams.



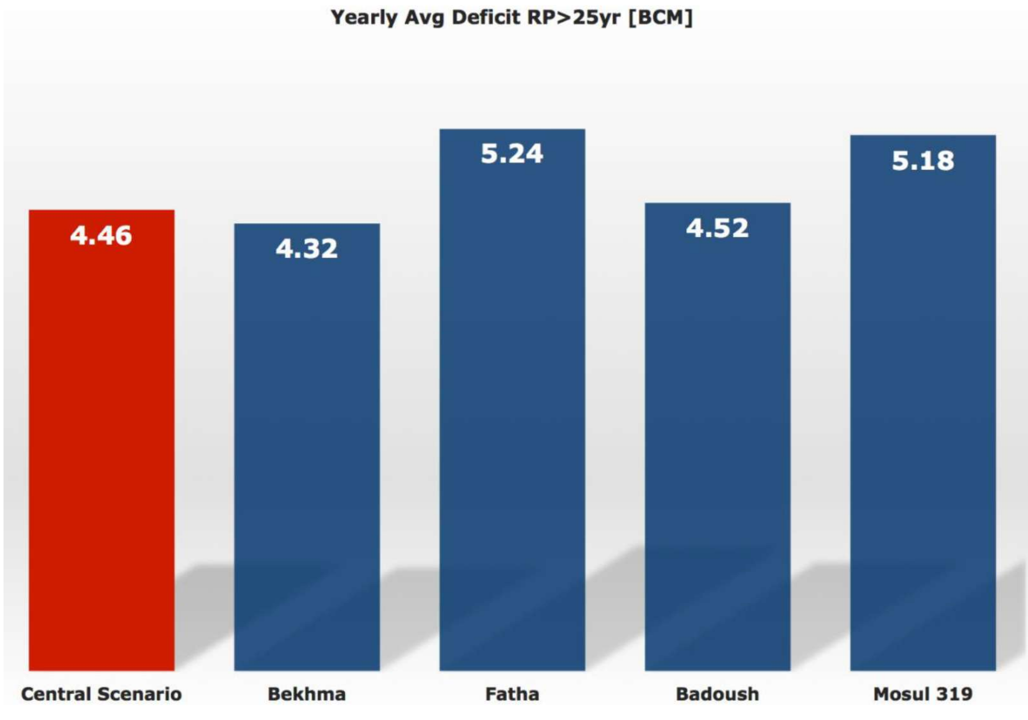


Illustration22/ appearance3-3: Comparison between the annual deficit rate (top figure) and the annual deficit of drought with a frequency of more than 25 years (figure (below) under different storage strategies.

The idea of building large reservoirs to manage Iraq's water resources is also being evaluated from the perspective of revitalizing the marshes. The following table clearly demonstrates that the central scenario is a viable alternative for ensuring the ability to divert larger quantities of freshwater to the marshes.

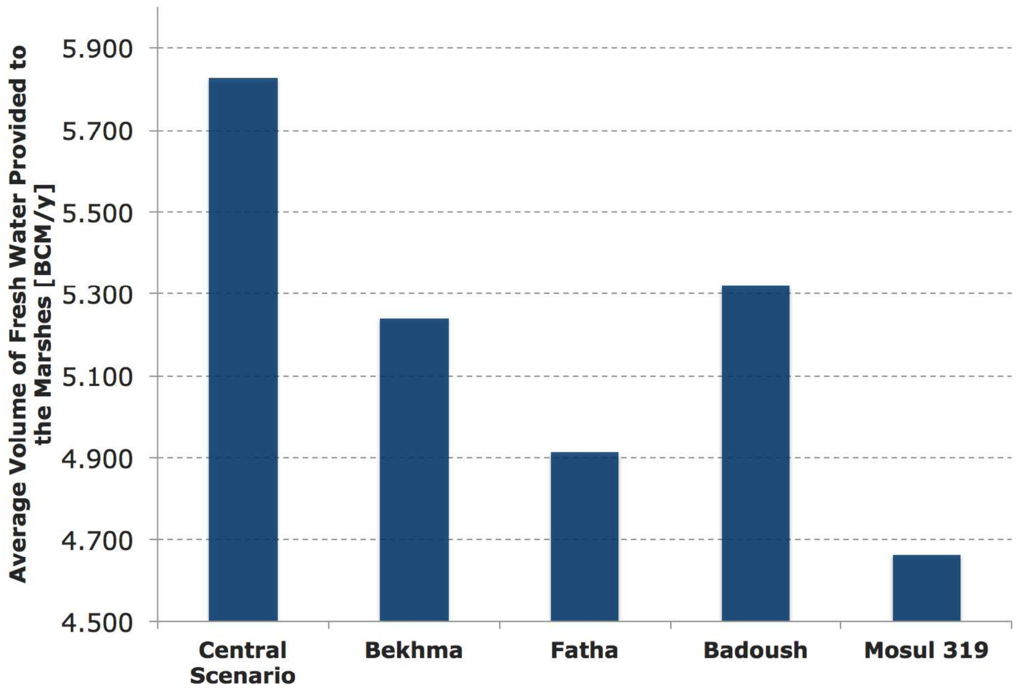


Illustration23/ Figure 3-2: Comparison between the average volume of water flowing into the marshes according to different water storage strategies.

The central scenario provides Iraq with the ability to convert an average of14,501 billion cubic meters Annual freshwater flows to the marshes on average in the future, as shown in the volume-duration curve below. In our hydrological assessment of10,222 years, the marshes will not receive less than 34,213 One billion cubic meters annually, and statistically, it is . years out of12 The available water will exceed Marshes1 billion cubic meters annually, and the worst possible state for the marshes will be if the dam is not rehabilitated. The connector instead continued to operate at maximum altitude.315 above ground level The sea. In this case, the ability to deliver the desired water to the marshes will decrease.

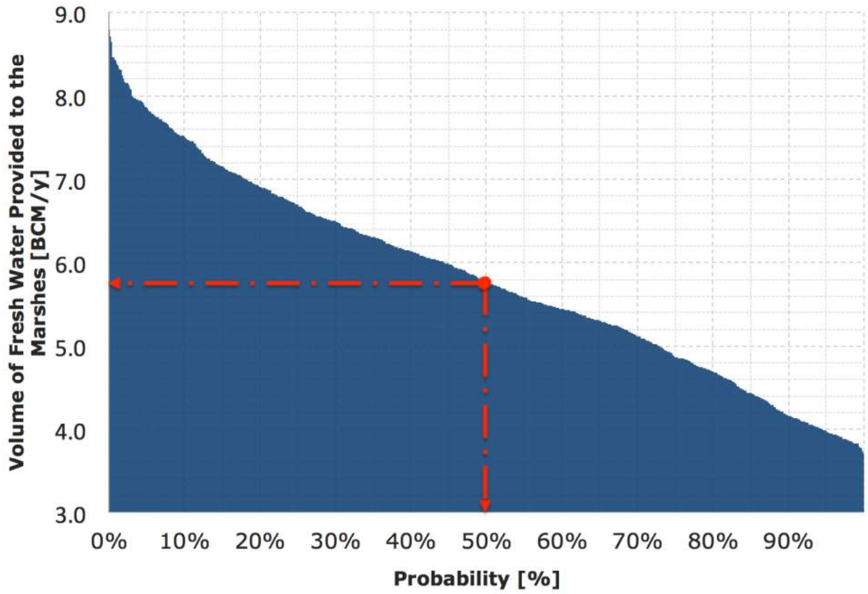


Illustration24/appearance41-3: The volume-duration curve shows the potential availability of fresh water from Iraq for marshland rehabilitation in the central scenario.

A similar assessment was conducted to understand the capacity of a new dam to ensure minimal discharges to the Shatt al-Arab. The central scenario shows that Iraq could ensure a discharge of12 cubic meters per second (or a size of .1412 billion cubic meters annually) and in all cases statistically 1 years Of origin12 It will have the capacity to divert larger flows along this river. More Specifically, and similar to the marshlands assessment, if Mosul Dam is rehabilitated, discharges greater than 12 cubic meters per second on the Shatt al-Arab will be possible.

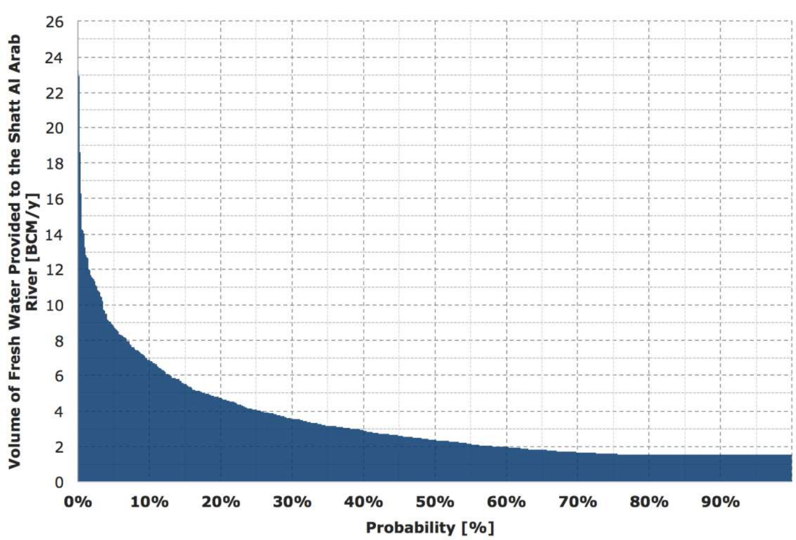


Illustration25/ Figure 3-44: Volume-duration curve showing the potential availability of fresh water for the Shatt al-Arab depending on different storage strategies.

Water

It should be emphasized that Mosul Dam must be rehabilitated, and that its foundation problems must be resolved as soon as possible. If Mosul Dam is not rehabilitated, or if the Badush Dam is not built downstream of Mosul Dam, Iraq will not be able to achieve the full objectives of this strategy. If rehabilitating Mosul Dam proves unrealistic, this strategy will recognize that the next best alternative for flood protection and water conservation is the Badush Dam. Other aspects of rehabilitating Mosul Dam in relation to flood risks are discussed in the Flood Management chapter of this document. If Mosul Dam is rehabilitated, adding a large new dam to Iraq will be counterproductive because more water will be lost to evaporation than will actually be stored behind the dam. In other words, the net effect of building a new dam will be negative.

3.1.2 Drought

1.2.3.2 Facts and needs

A drought is a period of time when the demand for water in a given location exceeds the amount of water available. Iraq is virtually in a state of permanent drought by scientific standards due to climate and domestic water demand. Drought is one of the most significant threats to Iraq's environment, economy, and social stability. Water allocations have taken the potential for drought into account, and a plan for drought reductions has been discussed within the strategy.

Iraq's existing reservoirs, coupled with a drought management strategy, are required to mitigate the severity of meteorological, hydrological, agricultural, social, or economic droughts. Therefore, the country has implemented drought management strategies to systematically assess water availability and implement water reductions to water users if supplies are insufficient to meet water needs. The purpose of reducing water supply during droughts is to conserve water to ensure that sufficient water is available to support municipalities and industries throughout the entire drought period. Water supply reductions target agricultural uses and environmental needs, while maintaining water supplies for domestic and industrial uses under all conditions.

table6/2-3: Water delivery priorities and sequencing of reductions during drought events.

Description	Present Drought Management Sequence of Reductions
Remaining flow reaches the marshes	1
Allocation to the rice crops	2
Allocation to the agricultural sector, excluding rice crops	3
/s3Minimum flow at the Shatt Al Arab 50 m	4
Municipalities and industries receive 100% of their water needs	n/a

Two drought management strategies are currently in effect. The summer drought management strategy determines the amount of water that can be provided to the agricultural sector for the summer growing season and requires storing an amount of water equivalent to two years' municipal and industrial water needs, in addition to

The amount of water needed to support the first winter crops of the season. There is also a drought management strategy for winter cropping based on comparing the amount of water stored in the reservoir at the beginning of winter with the long-term storage of the reservoir at the beginning of winter. The goal of the winter drought management strategy is to retain as much water as possible for use in the following summer season.

The current drought management strategy is insufficient to meet future water needs because the volume of water required to be stored during the summer season (equivalent to two years of municipal and industrial water and one month of winter crop water) will gradually increase from5 billion cubic meters in Current status to15 billion cubic meters in the future. Due to the burdensome storage requirements of what The equivalent of two years' worth of municipal and industrial water in Iraq's reservoirs as part of a summer drought management strategy means more water is held in reservoirs and unavailable for other uses. In particular, such a large storage requirement will frequently result in reductions in the volume of water available for the agricultural sector.

Moreover, dams in Iraq are used not only for irrigation but also for flood control. Therefore, there must be additional space in the reservoirs for excess water in the event of a flood. If the reservoirs are full due to the need to store15 billion cubic meters of water While sufficient for municipal and industrial needs for two years, they cannot fulfill their flood control function. If water is released to create a flood risk, it will most likely occur in winter, during the flood season. However, if large amounts of water are released in winter, it will lead to a permanent need to reduce the area under summer crops, which will have an adverse effect on increasing agricultural density and sustainable water resource management. Therefore, there is a need to develop an alternative strategy to mitigate the effects of drought. The following figure illustrates this issue.

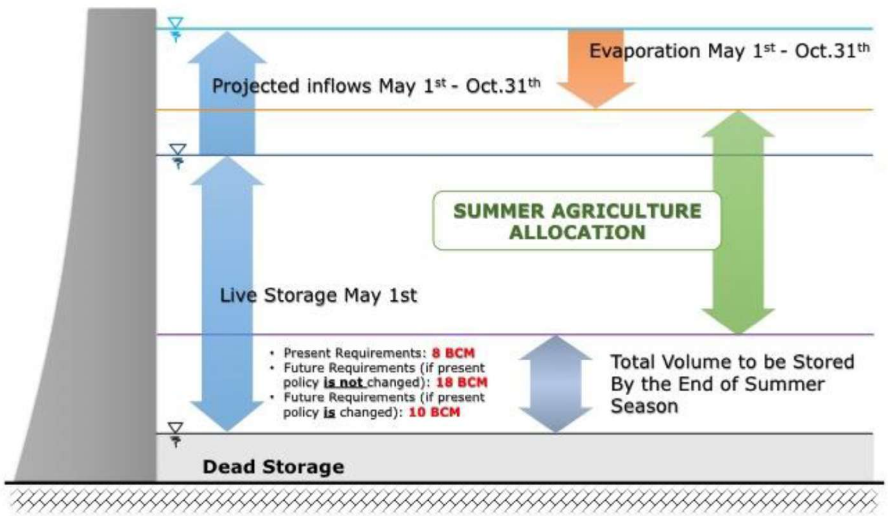


Illustration22/ Figure 3-42: The figure shows the concept that the reduction in the amount of water available for summer agriculture will decrease significantly in the future if What is the current situation regarding the summer drought management strategy?

1.2.3.4 Future needs

The new reservoir operation strategy and water allocation priorities can optimize the use of existing reservoirs and better utilize the water stored in reservoirs to support all water users. Coordinated and agile drought response mechanisms support Iraq's ongoing investments to promote economic development and prevent seasonal or annual losses in the agricultural sector.

1.2.3.1 Opportunities and Strategies

The proposed drought management strategy emphasizes the importance of improving water use efficiency in Iraq and assumes that Turkey, Syria, and Iran will fully develop their agricultural development plans, infrastructure, and water control plans. Consequently, the annual volume of freshwater (not including drainage and groundwater) available in Iraq by 2014 is estimated to be 24.484 billion cubic meters per year on average. The new drought management strategy starts with the following minimum water allocations:

1. Municipal and industrial sectors: Demand is met every year according to the needs identified in table0-3. To keep up with this demand, there are many points where the water level rises. It must be achieved to meet these water requirements as shown in the table.0-3.0. Minimum flow on the Shatt al-Arab: 12 cubic meters/second

In addition, the strategy focuses onOn Water Demand Control in the Sector SWLRI Agricultural so that it is achieved0 out of 1 years, or 52% of the time without needing any A significant reduction. This means that the reduction in the amount of water that can be delivered to the agricultural sector will occur once every five years on average. Furthermore, the reduction in the amount of water cannot be greater than or equal to25% of the sector's water share Agricultural on average more than once a year100 years. Such a drop. It is expected to occur only in the Diyala Basin. In the Tigris and Euphrates basin, on the other hand, the122 years is the period of drought return, which will be accompanied by an 18% decrease in it, as they are able To achieve a better water balance across multiple reservoirs and the large geographical area of the watershed, the area under cultivation and agricultural practices must be aligned with the agricultural plans set forth in the strategy.

Strategy for the summer agricultural season

The new summer strategy is applied to each of the three independent watershed systems and requires calculation once a year on the day ofMay 1 to determine the water available to the sector Agricultural water for the summer planting season. This amount is based on water storage in reservoirs, expected flows into reservoirs, expected losses due to evaporation, and the amount of water that must be stored in reservoirs to meet municipal, industrial, and agricultural needs at the end of the summer.

The ability to reduce the amount of water stored at the end of the summer is at the heart of the summer planting season strategy.

It is expected that the volume of water stored at the end of the summer season will be re-evaluated every five years, taking into account current and expected future conditions at the time of the review. The volume of water required to be stored at the end of the summer season for each of the proposed independent systems for the first five years of this strategy is5415 billion cubic meters for the Euphrates River System - Tigris, and 2430 billion cubic meters for the Great, and 2455 billion cubic meters for the Diyala system.

As a result, it will be possible to carry out summer farming in the future as well, and thus the goal set by the strategy can be achieved, which is to reach an agricultural density of111%

If less water is stored in reservoirs at the end of summer, there is a marginal risk that less water will be diverted to the municipal and industrial sectors during the following winter. The strategy mitigates this risk by imposing a reduction in the amount of water diverted to the environmental and agricultural sectors in such a scenario.

The purpose of calculating the available water for the agricultural sector for the summer cropping season is to provide farmers with a general indication of the expected water availability, in order to guide crop selection. The monthly dynamic drought management strategy outlined below will determine the precise water allocation to be made each month. To facilitate the delivery of seasonal water availability to the agricultural sector, strong institutions and policies must be established. Such a system should consist of agreements between the government and farmers in Iraq regarding water availability and compensation mechanisms that can be disbursed to farmers during drought periods.

Drought Management Strategy

The drought management strategy should be calculated for each month and based on the total volume of water stored in Iraq's reservoirs. The storage volume for each reservoir is divided into three levels between the maintenance volume and the maximum volume, as shown in the diagram below. If the water volume in Iraq's reservoirs exceeds the specified control volume, the3. There is no need to make reductions in Water quotas and the causes of drought are not present. However, if the volume of water in Iraq's reservoirs is less than the storage volume at the control level3, then drought conditions are considered to be in effect. The effect is that water quotas in the agricultural sector and in the marshes must be reduced.

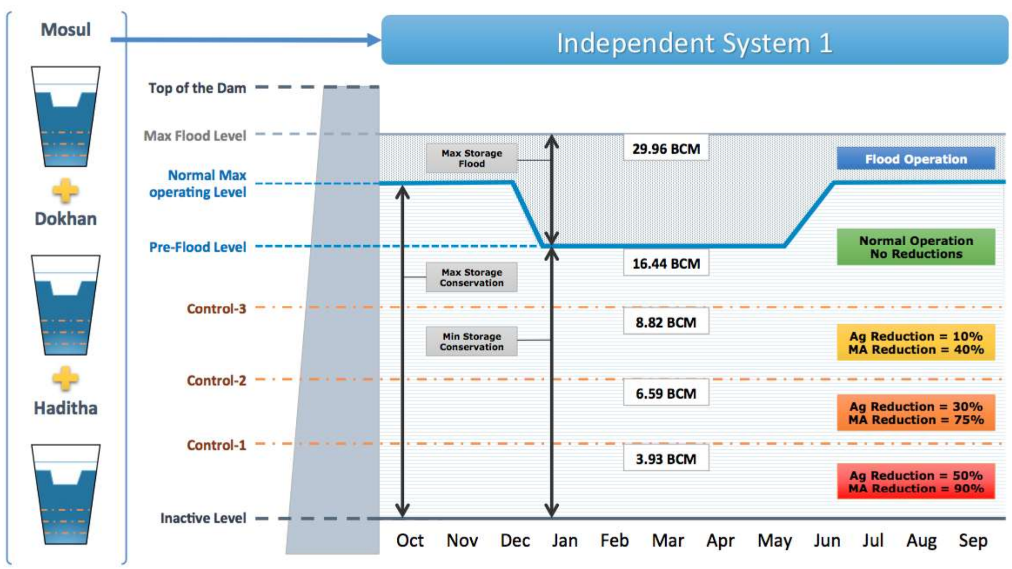


Illustration27/ Figure 3-43: An example of the control operations of tank system No. (4) showing the volume of water storage and the corresponding need to carry out Reductions in agriculture and marshes.

Drought Early Warning System

An early warning system that assesses weather conditions and reservoir storage conditions in relation to the expected demand for each water sector must be implemented in parallel with technical strategies for reservoir operation and determining water allocations during drought.

3.1.6 Flood control

1.2.1.2 Facts and needs

Flood risks in Iraq stem from a variety of sources. Historically, major flooding has occurred in the Euphrates and Tigris watersheds outside of Iraq, in Turkey, Syria, and Iran. Heavy rainfall in the mountainous parts of the watershed, coupled with snowmelt, generated significant flooding along the rivers. The natural shape of the river network is itself a result of these historical floods: the Mesopotamian plain is an ancient delta created by the Tigris and Euphrates rivers. For thousands of years, recurring floods transported sediments into the river floodplains, creating fertile ground where ancient civilizations began to practice agriculture. To better manage these flood risks, significant investments have been made both inside and outside Iraq in dam construction as a means of storing and controlling water. To some extent, dams and other water infrastructure in Türkiye and Syria mitigate the flood risks facing Iraq today.

Current situation

Despite the construction of dams in Turkey and Syria, flooding is still possible in Iraq, particularly along the tributaries of the Tigris River, such as the Greater Zab, which is the last major undammed river in Iraq. Other smaller eastern tributaries also lack flood control infrastructure and are known to be prone to flash floods.

At present, flood peaks in Iraq are managed using the storage capacity of dams and barrages within the river, as well as some topographic depressions outside the river. The Tigris is regulated by the Mosul Dam, the Dokan Dam on the Little Zab (a tributary of the Tigris), and the Samarra Dam. Although the river within Baghdad is capable of passing a peak discharge of up to00122 meters cubic meters per second, and the discharge that reaches Baghdad from the Tigris River is limited to00222 cubic meters/ Second, to accommodate simultaneous flooding that may occur along the Diyala and Azim rivers. The limited capacity of this river is the main constraint on the operation of the Tigris system upstream of Baghdad. In the event of extreme events where the Mosul and Dokan dams are unable to limit the flood peak to values acceptable for the point of arrival in Baghdad, the Samarra Barrage is the next point downstream that can manage the incoming flows from the upstream reservoirs as well as the incoming flows from the Greater Zab and can also divert water to Lake Tharthar. The Haditha and Ramadi Barrages regulate the discharges to the Euphrates River. The Ramadi Barrage can divert the discharges from the Euphrates to Lake

Habbaniyah and Majra Canal transfer discharges from Lake Habbaniyah to Lake Razzaza in the event of major floods.

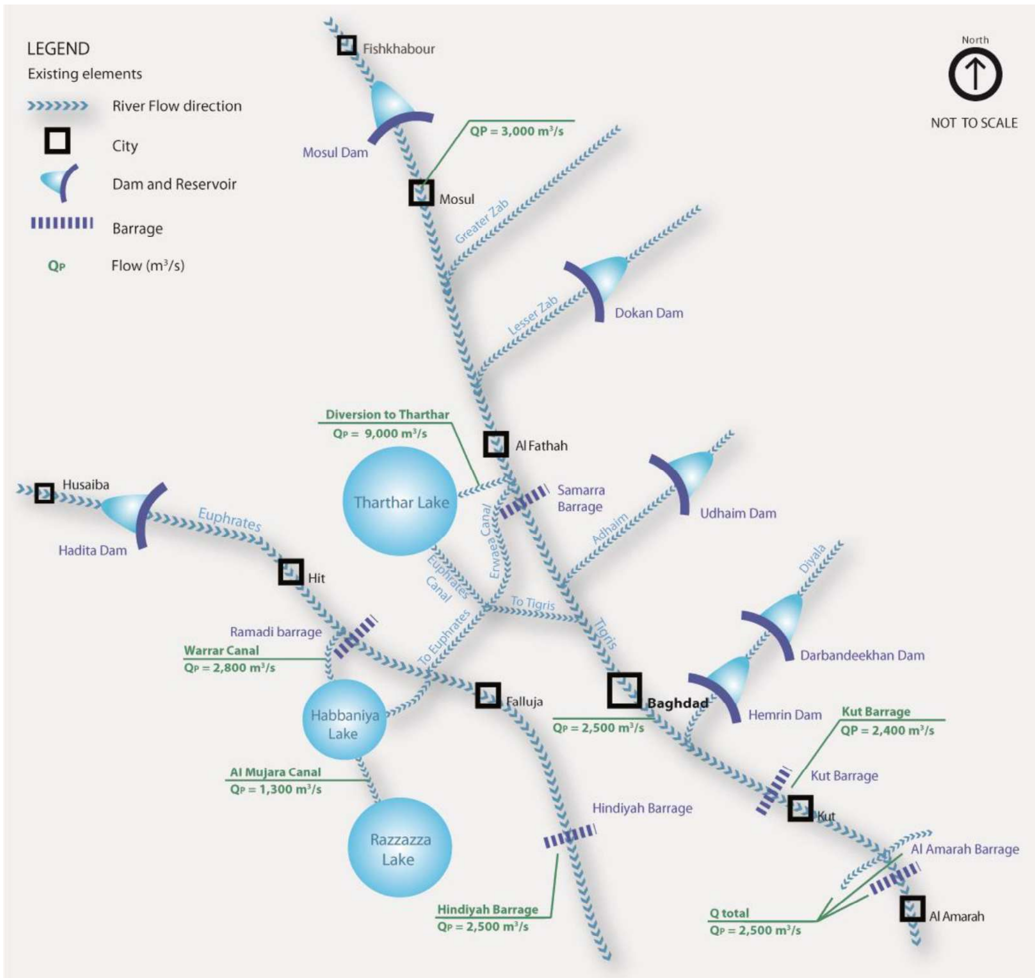


Illustration*28/* **appearance42-3: Schematic diagram of the main flood control infrastructure in Iraq where peak flows are limited**

The Darbandikhan and Hamrin Dams, on the Diyala River, are also flood control regulated to protect Baghdad. The Diyala River flows into the Tigris River directly below Baghdad. Due to the backwater effect, simultaneous flooding of the Tigris and Diyala Rivers could pose a flood hazard to Baghdad. The Darbandikhan Dam regulates the flow of the river upstream of the Diyala estuary. Normal dam operation can be controlled to store more water behind the dam and prevent flooding from reaching Baghdad.

1.2.1.4 Future needs

In the event of a very large flood, the Samarra Dam will lack the capacity to manage the flood peak, and will not be able to protect Baghdad. Expanding the Tharthar flood escape can reduce

Significantly reduce the burden on the Samarra Dam and thus serve as a means of reducing the risk of flooding in Baghdad. Increasing the diversion capacity of the Tharthar River Transit Regulator and the transmission channel from 50,222 cubic meters /second current to about13122 cubic meters/second, is a vital and strategic condition for controlling Flooding on the Tigris River, thus protecting the capital, Baghdad, and areas to its south. This strategy will be sufficient only if the Mosul Dam is fully rehabilitated. Otherwise, the strategy must be combined with the construction of a dam either along the Greater Zab or along the Tigris River.

All these considerations are based on the conservative assumption that flood control by neighboring countries (through their own dams) is negligible. As more information becomes available, the consultant suggests that the Iraqi government assess the impact of the Ilisu Dam on the Mosul Dam and provide an updated assessment of the country's flood risks.

1.2.1.1 Opportunities and Strategies

Flood management strategies for the Euphrates and Tigris consist of improving existing control facilities, increasing the carrying capacity of rivers and streams in areas of narrow flow, and ensuring that off-stream storage sites are prepared to receive floodwaters. There are no proposals for new large dams to meet Iraq's flood control needs.

Dams in Iraq and Samarra Dam will be operated to cope with the return of the flood event again.122 Year. The design of the return event for this period is conservative, provides a balance between the costs and benefits of such structures, and is consistent with international practices.

More specifically, major cities across Iraq will be protected against peak flooding for the period of the event's return.122 years under the following conditions:

- The design capacity of Samarra is greater than the peak flow for the return period.122 years. So who? It is assumed that in the event of a flood for a return period of122 years, it is better to drown The area around Samarra instead of trying to keep the excess flow (which could not be handled by the existing floodgates) in the river and thus flood the city of Baghdad.
- The Tigris River flood escape valve is activated during extreme events. The Crusaders and Umm al-
- Ma'arik (Freedom Channel) flood escape valves are activated on the Euphrates River during extreme events.
- Cracks in the barrier must be made.The main branch of the Euphrates, where the Levee channels are located. Connects the river with the Hammar marsh.
- A diversion has been constructed from the Euphrates to the Hammar Marsh, below Umm al-Ma'arik and above the Haffar Regulator. This diversion should be capable of transporting up to22. cubic meters/second to wet ground

- Cracks are made in the trench (The one who crosses the Euphrates River in Mada'in from (Dyke To direct the flow towards Al Qurna during floods.
- Therefore, in addition to expanding the Tharthar flood escape and the Samarra-Tharthar canal, the following additional key measures are considered strategic for flood control purposes:
- Recreate a flood escape valve, with a regulator or valve plug capable of diverting up to1212 m^3/s;
- Implementation of regulators on the front of the crosses (022 cubic meters per second) and Umm Al-Ma'arik canals (322 cubic meters per second).
- Implementing a diversion from the Euphrates to the Hammar Marsh below Umm Al-Ma'arik and the upper reaches of the Haffar Regulator, capable of transporting up to22. m^3/s to wetland. Implementation of a corresponding facility. The donkey outlet facility is capable of handling maximum flow.22. cubic meters/second. Implementation of a regulator on the trench (
- Dyke (who cuts through cities)

Flood management

To manage flooding along the Tigris River, the Mosul Dam must be rehabilitated to avoid the risk of its collapse. In addition, the flood escape and channel at the Samarra Dam must be widened to increase the amount of water that can be diverted away from the main course of the Tigris River to Lake Tharthar via the Tharthar Regulator. The Samarra Dam must be able to pass11122 cubic meters/second, where it is directing00222 m3/s to the Tigris River and 13122 m3/s is directed to Lake Tharthar.

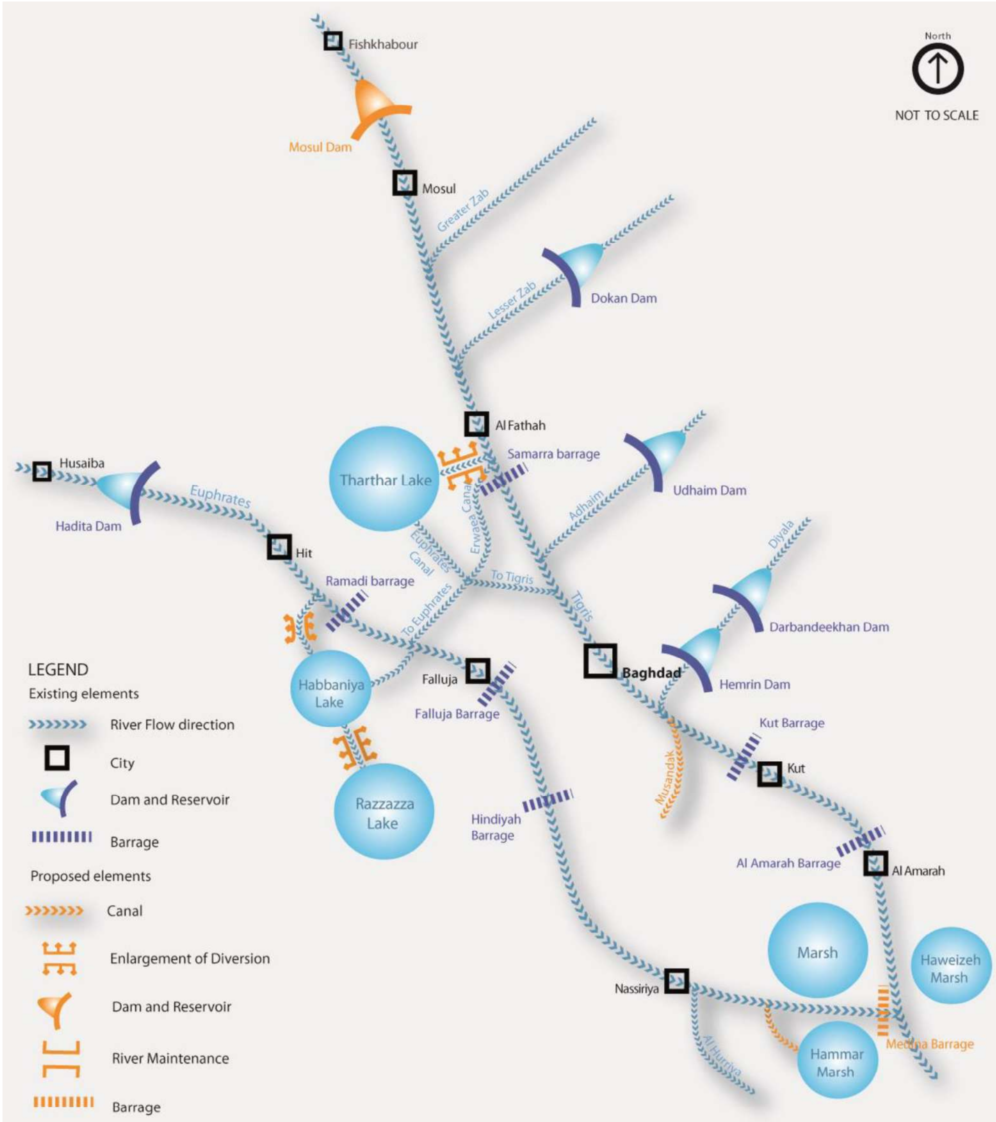


Illustration*29/* appearance45-3: Schematic diagram of proposed points where flood management strategies should be implemented along the Tigris River system

The Euphrates

In order to achieve this expansion of the Samarra Dam, this strategy recommends surveying and studying the current conveyance capacity of the Tharthar Canal flood escape as well as the cracking of the dam (necessary in (Levee breach) Lower Samarra to ensure passage0122 cubic meters/second through the city of Baghdad, and this is required until The Tharthar floodway is being expanded. A preliminary assessment shows that the potential storage area for this excess water could be the lower reaches of Lake Shari, with the Samarra diversion facilities in place, or, below Samarra, on the left bank of the floodplain south of Lake Shari, the outskirts of Balad.

Furthermore, based on the available information, there is no need to improve the flood management system of Lake Habbaniyah. However, we recommend that the capacity of the Warar Canal, which directs

The drainage from the Euphrates to Lake Habbaniyah should be evaluated and verified to ensure that it can be transported.0522 m³/s. The capacity of the sewer regulator, which transports Water from Lake Habbaniyah to Lake Razzaza to ensure that the discharge reaches0222 meters Cubic meter/second can be transferred immediately to Lake Razzaza and only522 cubic meters per second returns to the river The Euphrates during major floods on the Euphrates River. Lake Razzaza will only serve as an off-river reservoir in the event of a flood.

Instant Flood Forecasting System

Iraq, in cooperation with its upstream neighbors, should develop a real-time meteorological network supported by numerical hydrological and hydraulic models to forecast flood events. Real-time meteorological data are available online from the Turkish Meteorological Organization, so a flood warning system for Iraq could be integrated with this existing system. With advance flood warning, reservoir management could be adjusted to accommodate flood volumes and prevent adverse flood effects. In fact, such a real-time flood forecasting system could be integrated with the proposed early warning system for droughts. Integrating these two systems would allow for the assessment of extreme hydrological events and would greatly serve Iraq's needs for integrated water resources management.

Additional data collection, such as river cross-section surveys and the operation of water control facilities, should be conducted at various locations within Iraq as part of efforts to improve the reliability of flood assessment and planning, with particular attention paid to locations such as Mosul, Baghdad, the Euphrates River in the extreme southern part of Iraq, and the Tharthar flood channel.

Above all, the Iraqi government and the Ministry of Water Resources are required to make significant efforts to further improve the current hydrological monitoring system, including network analysis and time series consistency.

Table maintenance

Rivers, streams, and their adjacent floodplains should be inspected annually to verify that their capacities meet design requirements. The construction of unauthorized facilities or the presence of overgrown vegetation within or near a stream's floodplain can significantly reduce the volume of water that can be contained within the stream. In addition, sediment accumulation can also severely limit the volume of water that can be conveyed. Such conditions should be monitored, documented, and remediated annually to ensure that streams and bank buffer areas can deliver their design discharges.

Earthworks and excavations should also be surveyed and inspected annually, beginning in June. Maintenance should be performed as needed, including increasing and strengthening earthworks and excavations to meet design conditions. Only through proper management of earthworks and excavations will streams be able to fully deliver their design discharges.

Existing topographic data, although partial, show that under present conditions the levee peaks (They vary in height across the entire length of the Tigris River in Baghdad. (Levees) must be raised All plugs are to the same height to ensure the design flood pass through.

A topographic survey and subsequent hydrological study of all canals feeding the central Hawizeh marshes is necessary. The study will require an assessment of the full length of the canals (Arid, Al-Bateera, Al-Majar Al-Kabir, Mishrah, and Al-Kahla) diverting the Tigris River to the wetland inlet. In particular, for the feeders of the central marshes, the Al-Ezz River will be considered to assess whether the water diverted to the canals can be effectively transported to the central marshes.

A program should be developed to maintain and dredge all canals and flood escapes. In addition to the main rivers and tributaries, such a program is needed for the canals in the Samarra-Tharthar system (Tharthar flood escape), the Habbaniya system (Warrar, Majra, and Dhiban), the flood escape canals (Salibat, Musandaq), and those canals that feed the marshes (Al-Arid, Al-Bateera, Al-Majar Al-Kabir, Al-Mashrah, and Al-Kahla).

Similarly, a maintenance program for key internal facilities and regulators should be developed and implemented. Currently, no major hydraulic flood management facility appears capable of handling severe events.

The hydraulic capacity of the Euphrates network below Hindiyah should also be studied in order to verify the maximum permissible flow in Shatt al-Shamiyah and Shatt al-Kufa.0.22 m^3/s and 10.22 m^3/s, respectively). This study should assess whether there is a need To expand the capacity of the Majra Canal, which connects Lake Habbaniyah and Lake Razzaza.

Finally, a detailed study should be carried out to verify how to deliver a maximum flow of22. cubic meters per second from the Euphrates to the Hammar Marsh. This study should also aim to assess the water levels from the lower Samawah to the Hammar Marsh. This study could enable an analysis of the impact on water levels in the Abu Jadha Marsh to assess the potential benefits of this depression, located in Upper Nasiriyah on the left bank of the Euphrates River.

Further details on the proposed flood strategy are available in the appendix.B.5.1.

3.1.7 Municipal and industrial sectors

1.2.2.2 Facts and needs

Municipal water supply and treatment

Iraq's population is expected to grow from32 million people currently to nearly 60 million in general 0231. Urban areas in particular are expected to grow significantly during this period. Period, which will increase the total water needs in Iraq to support municipal water for domestic uses. Daily water consumption, for example, has been estimated to range from130 to002 liters of water per capita in rural and urban areas, respectively, and reducing it would be A big challenge.

Water consumption in the municipal and industrial sectors is about10% of total water consumption In Iraq today, with population growth, and assuming improvements in the efficiency of drinking water consumption and distribution, demand for water in the municipal sector is expected to rise from about . 4 billion cubic meters annually to more than 6.4 billion cubic meters annually by 2035. The need for water treatment facilities will also grow during this period to keep pace with demand.

Currently, water treatment services do not reach all Iraqis. Approximately .5% of the population Urban and surrounding areas62% of the rural population has access to improved water sources through a network. Water distribution in the country[42]The water treatment infrastructure in Iraq consists of treatment plants. waterSolar power plants that use CUs and WTPs, All surface and groundwater sources. Daily drinking water production today amounts to approximately 12.5 million cubic meters per day. In Baghdad Governorate, more than 341 million cubic meters can be treated. One cubic meter of water per day, while most other governorates can treat no more than one million cubic meters of water per day, and there are many that can treat up to241 million cubic meters per day.

[42]The calculation was based on information from: - Ministry of Planning, Central Organization for Statistics and Information, Environmental Survey in Iraq 2010. Ministry of Municipalities and Public Works, Ministry of Environment, Baghdad Municipality, Ministry of Planning, Kurdistan Regional Statistics Office, Ministry of Municipalities in the Kurdistan Region, Ministry of Environment in the Kurdistan Region in cooperation with UNICEF

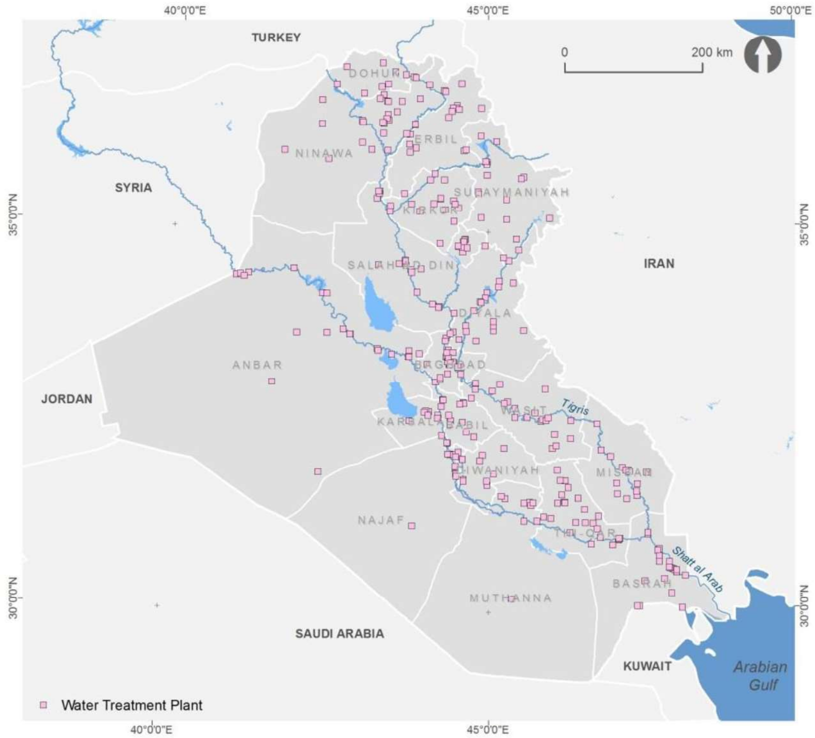


Illustration31/Figure 3-42: Locations of water treatment plants in Iraq today

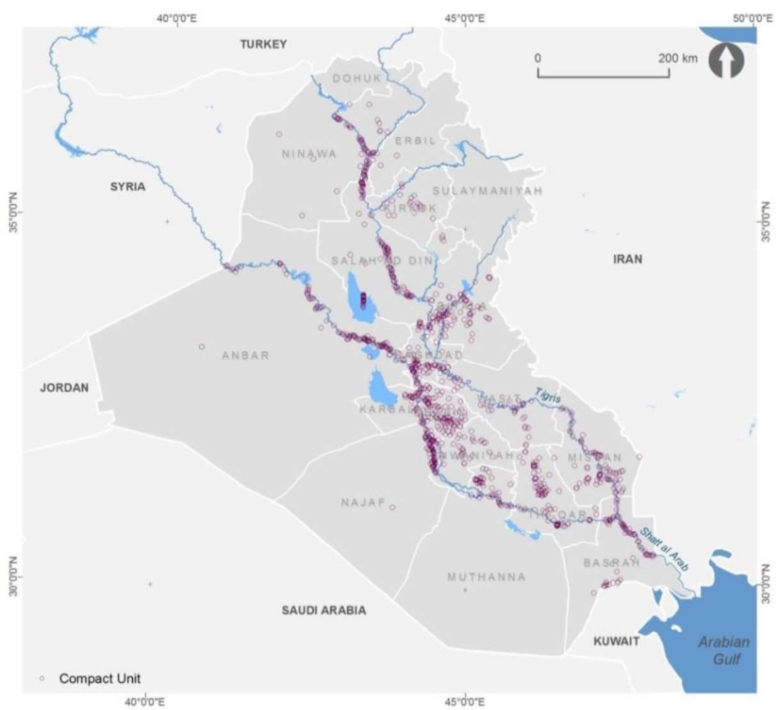


Illustration34/ Figure 3-47: Locations of pressurized treatment plants in Iraq today

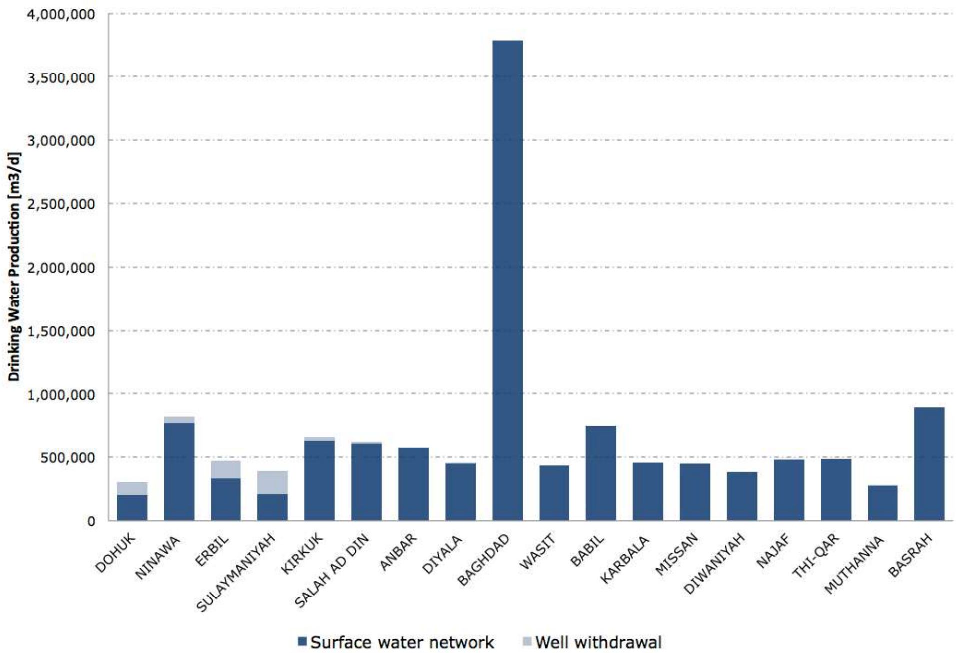


Illustration*32*/ appearance43-3: Drinking water production by governorate and water source

In addition to the limited capacity for water treatment, there are significant losses of treated water that occur through distribution networks due to leaking and aging pipes and unauthorized water withdrawals. Some governorates suffer losses of up to0.2% in treated drinking water along Water distribution networks as shown in the figure below[43].

[43]Environmental Survey - Central Statistical Organization of Iraq.

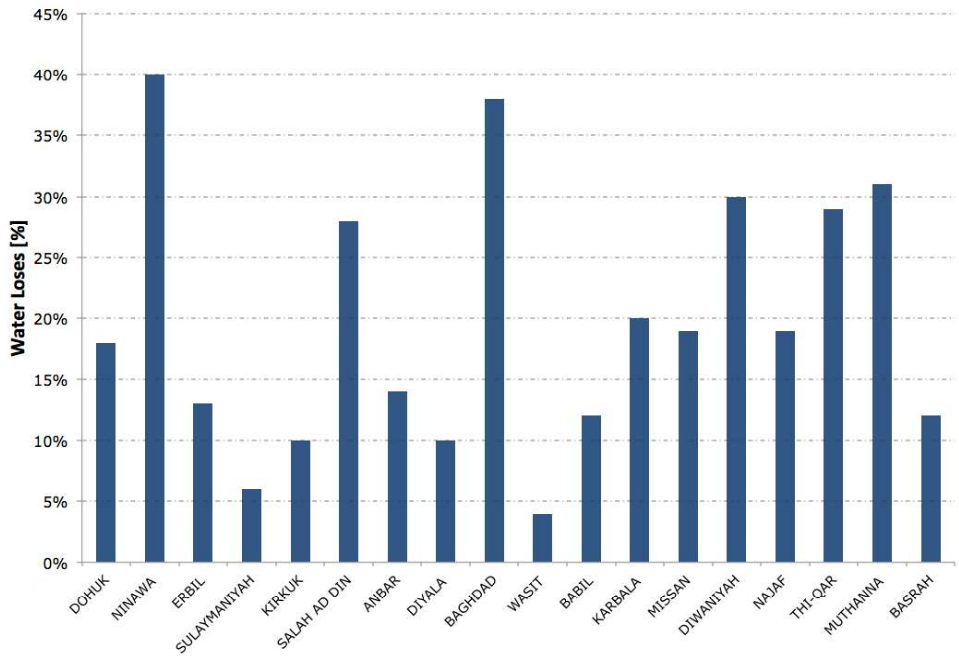


Illustration33/ Figure 3-42: Water losses along the distribution network by governorate

Municipal wastewater treatment

That is approximately32% of Iraq's population is covered by the sewage system, and of the 18% governorateOnly 12 have wastewater treatment facilities.[44]Sanitation systems are only located in urban areas where wastewater treatment facilities are available. Most rural areas do not have access to this service and therefore resort to alternative means of wastewater disposal (such as underground sewage systems or discharging untreated waste into rivers or canals). The figure below shows the spatial distribution of wastewater treatment plants.

Baghdad's sewage network serves approximately78% of the governorate, but for the rest In governorates that have treatment facilities, the sewage network covers less than32% of The area, in some cases, is less than12%. Currently, the total wastewater treatment capacity is Healthy1 million cubic meters annually. The public health impacts of these conditions are dire. The population is exposed to pathogens and other pollutants that enter the water supply, such as untreated sewage, and then into freshwater sources. Between the years0222 and 0210, done At least three cholera outbreaks have been reported in Iraq, in all years between

[44]Environmental Survey in Iraq (0212) by the Ministry of Planning / Central Organization for Statistics and Information Technology (COSIT) (For Statistics), Ministry of Municipalities and Public Works, Ministry of Environment, Baghdad Municipality, Ministry of Planning / Statistics Office / Kurdistan Region, Ministry of Municipalities / Kurdistan Region, Ministry of Environment / Kurdistan Region in cooperation with UNICEF.

Between 2007 and 2010, more than 222,000 cases of typhoid and bacillary dysentery were reported. (dysentery), hepatitisB[45]And in the year0210, died due to a cholera outbreak in the north Iraq at least four people[46].

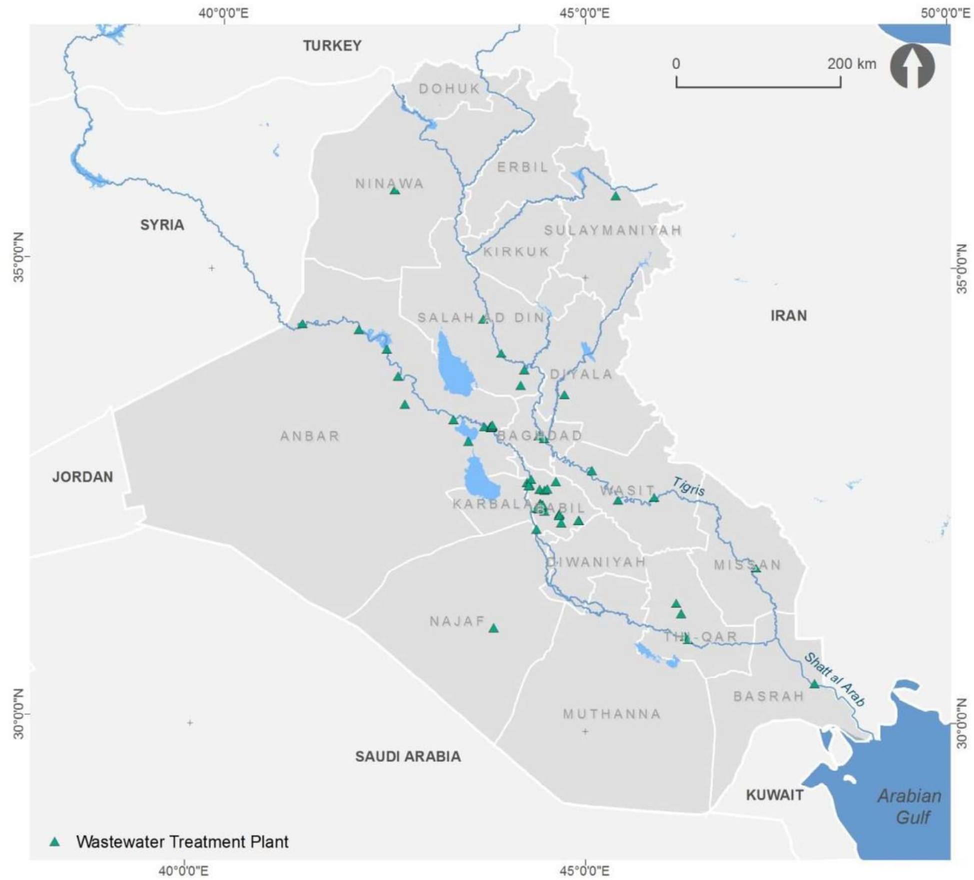


Illustration*34*/ appearance21-3: Wastewater treatment plants in Iraq today

[45]United Nations Educational, Scientific and Cultural Organization, National Framework for Integrated Drought Risk Management for Iraq Report My analysis in January0210.

[46]World Health Organization. 2010 Cholera in Iraq. Year 2010.

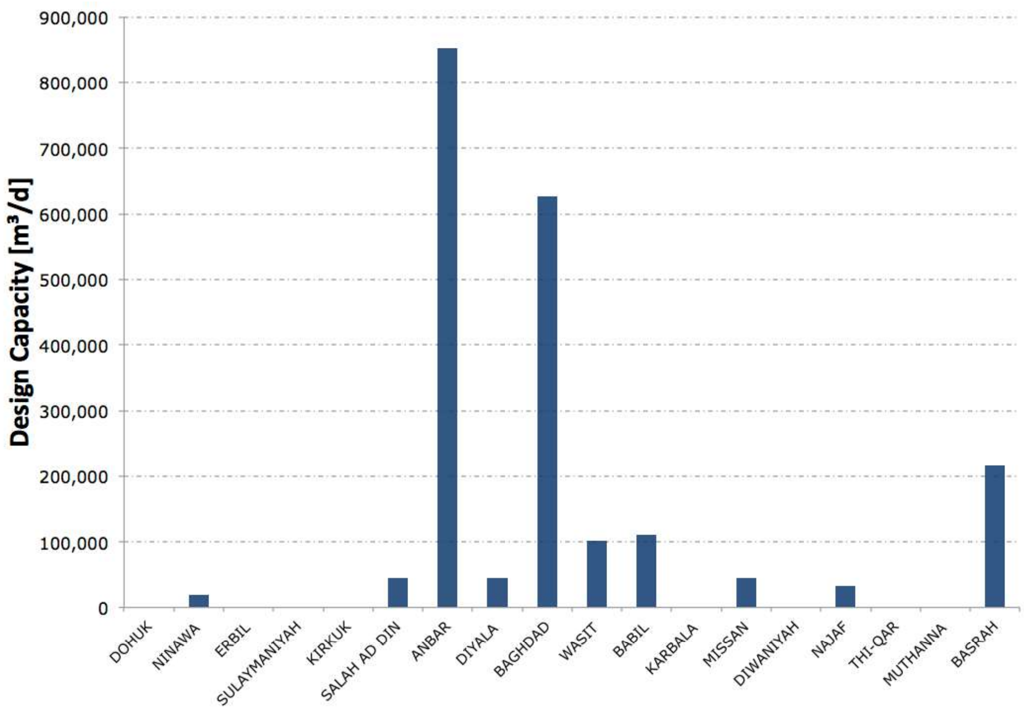


Illustration*35*/ appearance24-3: Design capacity of wastewater treatment plants at the governorate level

industrial water

Iraqi industrial water user groups are divided between oil fields, refineries, thermal power plants, and other facilities with more than25 locations. There are noticeable differences in Water needs, use, and disposal practices among the identified industrial categories, and the projected future needs in these areas. Due to frequent interruptions and unreliability of water supplies, large industries generally do not rely on the public water network. As such, most companies have installed their own water supply systems, and therefore water-related needs must be analyzed separately. It is important to note that secondary industries are included as non-domestic consumption, and this demand is counted within municipal water demand.

oil fields and refineries

Conservative estimates for oil sector development indicate that oil production in Iraq will increase significantly in the next five years, reaching9 million barrels per day by 2020[47]As oil production increases, the demand for water to support this industry will also increase. Taking into account the potential water loss along the water distribution network, the total demand for water for the oil sector will increase.

[47]Booz & Partners Report: Final Report of the Integrated National Energy Strategy Prepared for the Advisory Committee of the Council of Ministers To the Republic of Iraq in June0213

Percentage222%, from 2,000 billion cubic meters of water annually today to 14,120 billion cubic meters cubic meters annually by the year2035[48]The total demand for water for refineries is expected to increase from0.045 billion cubic meters per year today to 2.155 billion cubic meters per year by 2031.

The volume of water required for each barrel of oil

[48]Current water consumption for the oil sector is based on data from the Ministry of Oil, and projected future water consumption for the oil sector. It is calculated based on estimated future oil production published by Booz & Company (June2013)

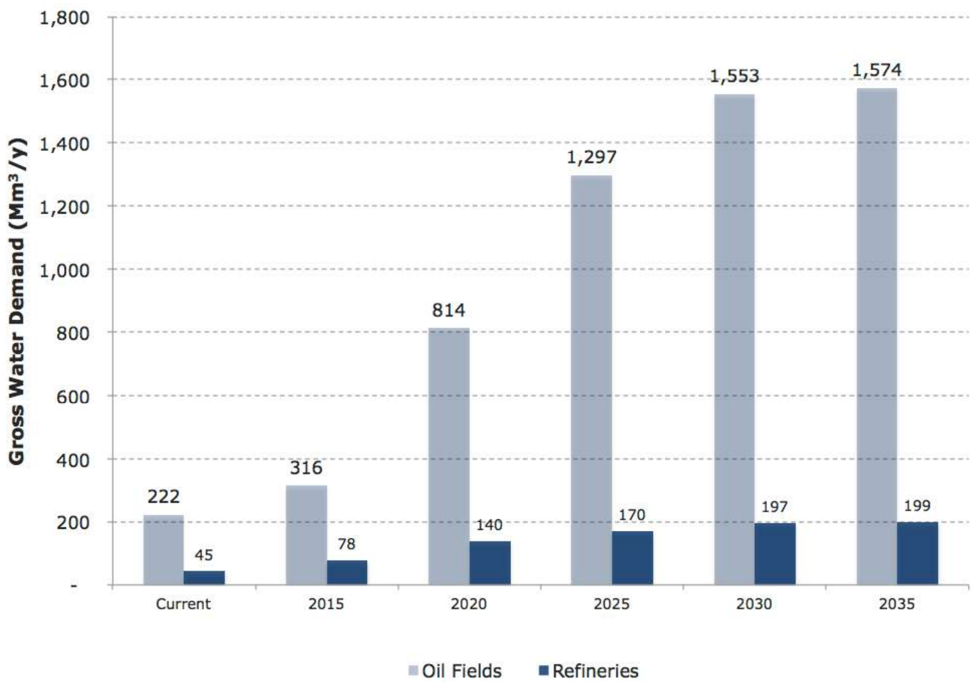


Illustration32/ Figure 3-22: Evolution of total water demand to support oil well and refinery reinjection

thermal power plants

Steam power plants and gas boilers (i.e., thermal power plants) require water for cooling and other processes. Cumulative water consumption for gas-fired facilities is expected to grow from about24111 billion cubic meters annually today to 243.3 billion cubic meters Annually by the year 0231, and the cumulative water consumption of steam-powered facilities will grow from 2423 billion cubic meters per year today to 24212 billion cubic meters per year in 0231.

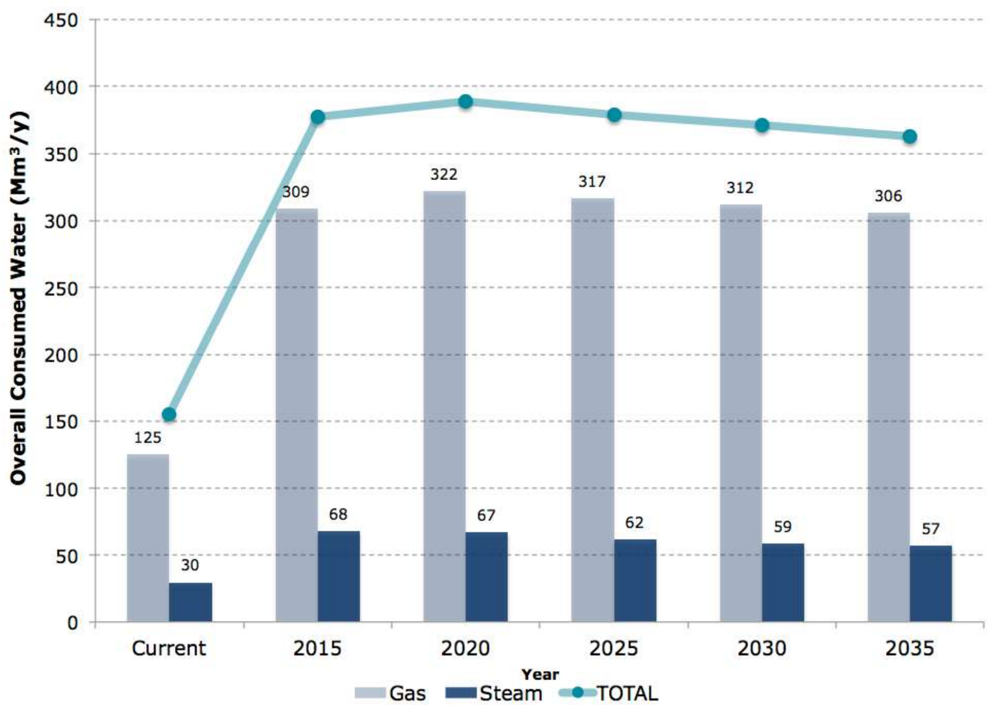


Illustration37/ Figure 3-23: Evolution of the total water demand to support gas and steam thermal power plants

Other industries

There is a demand for other industrial water to meet the water needs of the chemical and petrochemical industries, construction, engineering, food, pharmaceutical, textiles, and other industries. The total water demand for these industries is estimated to be2415 billion cubic meters of water Annually today. It is difficult to predict the growth of these industries, but an annual growth rate of12% to estimate future growth in water demand for these industries. Thus, Assuming that by the year0231, the national demand for water for other industries is estimated to reach to24,155 billion cubic meters annually.

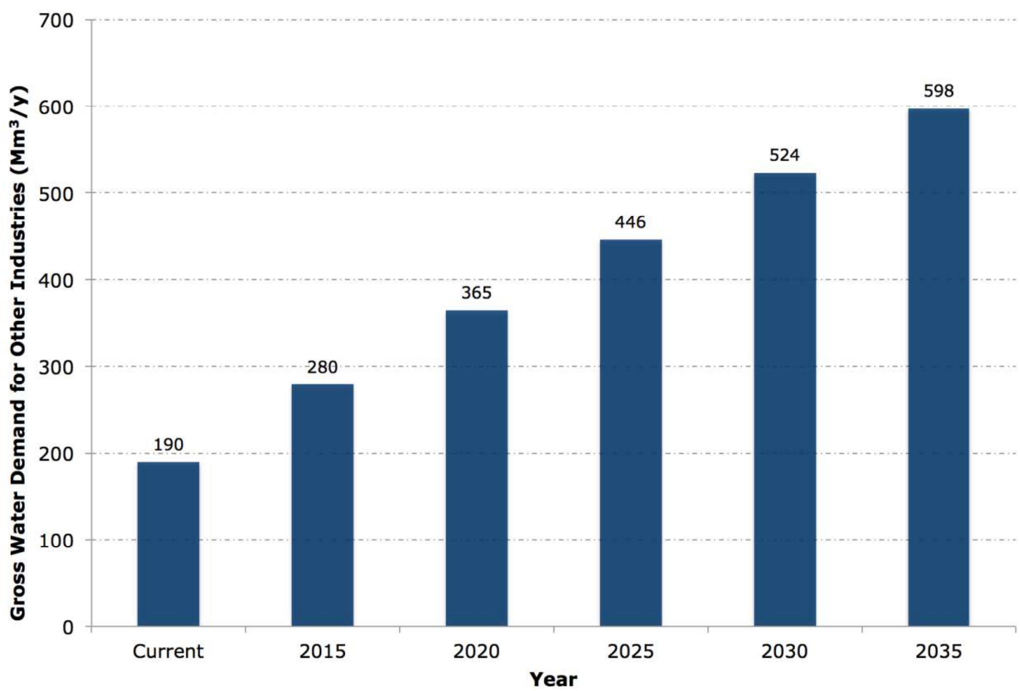


Illustration33/ Figure 3-22: Total water demand expected for other industrial activities

1.2.2.4 Future needs

Since water supply in the municipal and industrial sectors will always be given top priority, the country will face a significant decrease in water availability over the coming years.02 next. Therefore, there is a need To expand water distribution, water treatment, and wastewater treatment facilities, as well as comprehensive demand management and conservation, water and wastewater treatment capacity today is completely insufficient to meet the needs of municipal and industrial users, and a massive expansion of treatment facilities must take place throughout Iraq to both serve today's population and accommodate future generations.

1.2.2.1 Opportunities and Strategies

Water treatment and water distribution network

Expanding the number of water treatment facilities and improving and expanding the water pipeline network that delivers water and serves municipal and industrial water users in Iraq is a top priority. At a minimum, drinking water treatment must meet the drinking water standards stipulated in Specification No.417 of 1520, of the Iraqi Standard Specifications for Drinking Water, which was developed in 2022, Which in some cases are more stringent than the WHO's health-based guidelines for drinking water.

A range of water treatment technologies are suitable for use in Iraq. The need for advanced treatment technologies must be evaluated against several factors, namely the constituents of the source water, potential sources of contamination, and downstream water use. Membrane-based water treatment systems (such as reverse osmosis) are needed when there is an excess of contaminated water that cannot be removed by conventional water treatment facilities (such as dissolved solids). However, the use of this type of treatment is energy-intensive and can worsen TDS concentrations downstream of the treatment plant at low flows, and the brine product is discharged from the treatment facility as a effluent.

By the year0231 Water treatment facilities should be able to supply 40 billion cubic meters. From water to municipalities, to meet the expected demand of these sectors, water distribution networks must be expanded accordingly so that more treated water can be delivered from treatment plants to users. Furthermore, improvements must be made to the water distribution system to ensure that water loss can be reduced along the distribution system. The volume of water required for drinking purposes is expected to increase, as shown in Table 1.1-3, next.

table ٧/5-3: Evolution of demand for treated water to meet demand for municipal water (million m3)3(year)

2035	2030	2025	2020	2015	Current	Time
8,635	7,796	6,960	6,144	5,364	4,632	If Existing Efficiencies Continue
6,399	6,075	5,725	5,359	4,991	4,632	If Improved Efficiencies are Implemented

Comprehensive monitoring of water quality across the country, including at upstream and downstream sites of treatment plants and along water distribution networks, must be implemented to document and monitor progress towards achieving these standards.

Drinking Water Demand Management

Managing demand for drinking water is a critical component of Iraq's comprehensive sustainable water management strategy. Future domestic and non-domestic water demand should be managed in a way that ensures people have sufficient water to support their drinking, cooking, and cleaning needs, as well as those needed to support light commercial activities and home gardening. Average daily water consumption rates for these uses in different demographic locations range from130 liters to0.2 liters per person per day. The United Nations suggests that it should be at least 0.2-12 liters per person per day. Today, it is available for drinking, cooking, and cleaning. The rest accounts for the water demand to support

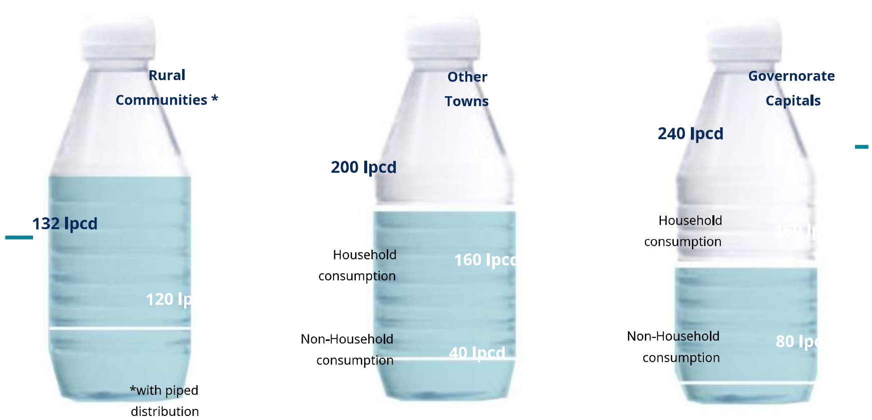
Commercial, industrial and landscape needs to be in line with international standards.[49]These consumption patterns were adopted in the future demand forecasts used in preparing the strategy. .SWLRI

Scaling up treatment facilities, considering that providing water per capita is more than50 liters per person per day should be It should be carefully evaluated on a case-by-case basis, especially when membrane treatments (reverse osmosis) are required, in order to save energy, reduce salinization of water bodies downstream of treatment plants, and ensure that appropriate investments are made in water treatment for the needs of the users of that water.

DAILY MUNICIPAL WATER PRODUCTION NEEDS

Average daily demand (lpcd)	
	Governorate capital
160	Household consumption
80	Non-household consumption
240	Total
	Other towns
160	Household consumption
40	Non-household consumption
200	Total
	Rural communities with piped distribution
120	Household consumption
12	Non-household consumption
132	Total

table8/2-3: Water demand per capita for municipal water



[49]This assumption is in line with what was formulated in the “Medium-Term Expenditure Framework (MTEF) Cost Study Report” for the Modernization Programme. Public Sector in Iraq - Water and Sanitation Sector "Submitted to UNICEF and the United NationsIn 2011 HABIAT

Reducing physical and administrative water losses

Reducing physical and administrative water losses (e.g., non-revenue water) along water distribution networks is a very important step towards managing water demand in Iraq. Today, losses range between0.2 to 12% due to leakage or old pipes. A decrease is suggested. Continuous losses through replacing or rehabilitating existing pipeline networks. Reducing losses by12% in major cities in the governorates, and 21% in other urban areas, And in percentage52% in rural areas by 2031. Meters and other technology must be installed. To monitor consumption along pipelines to identify areas where water is being consumed and track unauthorized withdrawals.

Wastewater treatment and sewerage networks

Expanding sewage networks and connecting them to wastewater treatment plants is crucial to maintaining public health and preserving the quality of the Iraqi environment. The focus in the near future is on expanding wastewater collection and treatment capacity throughout the country, as by the year0231, 0.225 billion cubic meters of wastewater can be treated Sanitary wastewater is treated in central treatment plants and returned to rivers. This includes municipal and industrial water supply systems. Central treatment in large treatment plants is feasible in many urban and rural areas, but treatment will continue to play a role in remote rural areas or environmentally sensitive areas such as the Mesopotamian marshes.

table9/7-3: Expected water treatment capacity from the present time to the year 2135 (million cubic meters/year)

2035	2030	2025	2020	2015	Current
2,078	1,710	1,357	1,045	776	548

Water reuse and recycling

Reusing and recycling water previously used for municipal or industrial processes in Iraq will be possible in the future, provided that dedicated water collection systems and appropriate water treatment technologies are implemented to render the water suitable for future use. Water reuse and recycling helps expand the use of existing water resources and prevents water pollution by preventing the discharge of effluents into freshwater bodies. Collected and treated domestic wastewater can be reused, and fertilizers extracted from treated wastewater sludge can be diverted to the agricultural sector to improve farmland productivity and prevent desertification. Industrial water reuse and recycling is achieved through the installation of closed-loop water systems within industrial facilities and/or the implementation of on-site local water treatment. It is also possible to significantly reduce future water demand in the industrial sector. It is estimated that by general0231 The local level of industrial water reuse will reach 0.1% in that Industries that reuse water today.

Also, decentralized water reuse strategies can be implemented at the individual level in Iraq, especially in rural areas, by applying plant-based purification technology.

.) Followed by on-site reuse of treated wastewater for agricultural irrigation. In addition, the use of rainwater harvesting systems and water storage in tanks will provide an opportunity to harvest local rainwater. An example of this is the "greywater" collection strategy that can be adopted to provide more water for domestic uses such as washing, garden irrigation, etc. phytodepuration.

Water desalination

A large desalination plant is currently under final planning to supply water to the oil fields in southern Iraq. Desalination plants may also be necessary to treat municipal water, depending on the quality of the inflowing water. Within the investment strategy, desalination plants represent0.2% of Budget of water treatment plants in the country.

3.1.8 Surface water quality

1.2.1.2 Facts and needs

The anticipated deterioration of water quality in Iraq will devastate numerous sectors, including the environment, public health, agriculture, and economic development. Pollutants enter freshwater from agricultural, industrial, and municipal sources and include total dissolved solids (TDS) (represented by salinity), organic and inorganic materials, and pathogens. Human activities, in addition to being natural conditions related to the geological and environmental characteristics of Iraq's internal and external environment, also impact the quality of surface and groundwater in Iraq.

Currently, Iraq is struggling with two types of water quality issues in its surface waters. One is the salinity of water, and the other is the concentration of pollutants in water associated with municipal, industrial, and agricultural activities that enter the return flow to freshwater sources. Agricultural development throughout the Tigris and Euphrates watershed, both within and outside Iraq, is causing a steady increase in the salinity of the Tigris and Euphrates, and other major rivers in Iraq. Economic development and population growth are both contributing to increased levels of various pollutants in freshwater. The deterioration in water quality is exacerbated by droughts and is a major factor contributing to the desertification of Iraq's agricultural lands.

salinity

Salinity concentrations in Iraq's rivers are increasing as they move south. This trend will worsen over time if development in upstream countries outside Iraq continues unchecked and if water management in Iraq remains unchanged. Salinity along the Euphrates River is higher than along the Tigris River and its tributaries due to land management practices, agricultural irrigation, and drainage within the Euphrates watershed.

The Shatt al-Arab suffers from high salinity due to the confluence of rivers and drainage channels with high salinity, low water flow volume, and the influence of tides from the Gulf, which affect areas below Basra. Total dissolved solids quantities increase by up to four times along the Euphrates between Husaybah and Nasiriyah and up to six times along the Tigris between Mosul Dam and Al-Qurna, with an average monthly water quality data available from the Ministry of Environment for the period from0220 to 0211.

table *10*/3-3: Summary of water quality data under current conditions

Tds [Mg/L]	Monitoring Site		River
606	Husayba	Upstream	Euphrates
2254	Nasiriya	Downstream	
268	Upstream Mosul Lake	Upstream	Tigris
1512	Qur'an	Downstream	

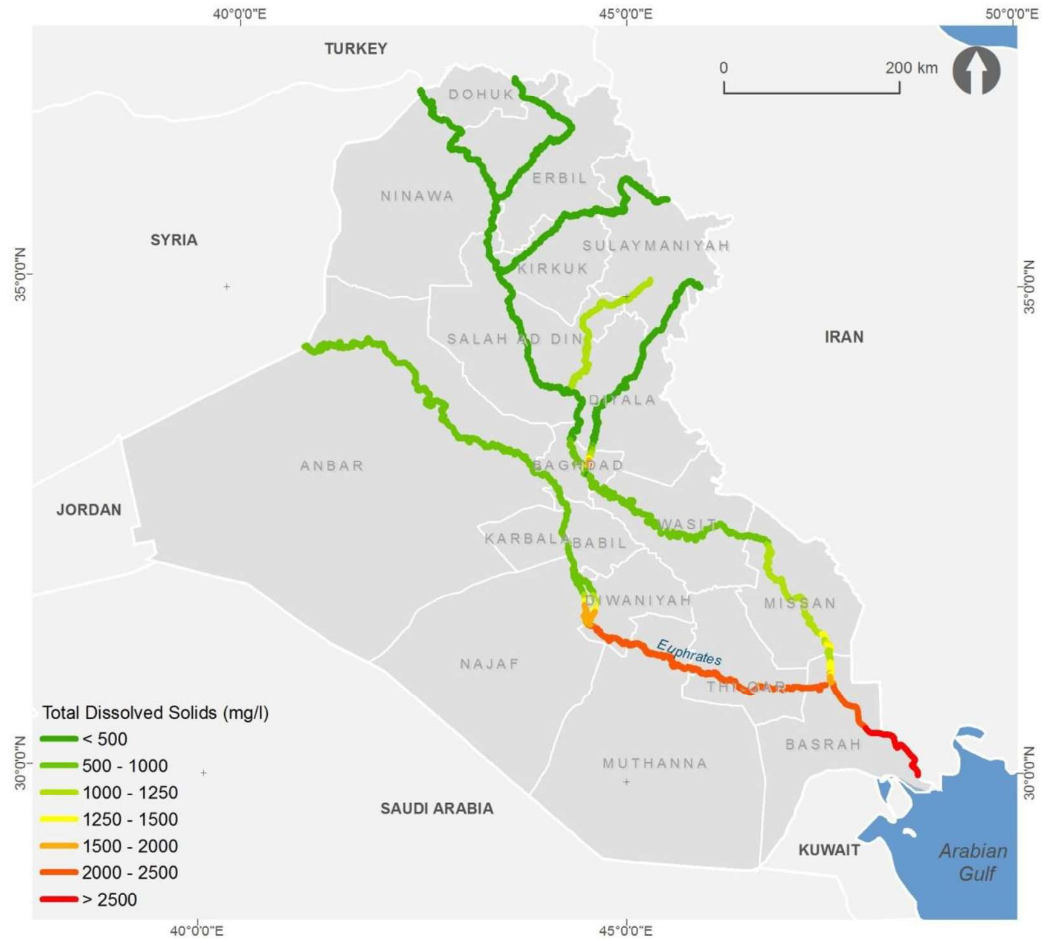


Illustration*39*/ appearance11-1: Salinity curve along the main river systems in Iraq (prepared from monitoring data at the Ministry of Environment)

Most soil salinization in central and southern Iraq occurs as a result of the use of irrigation water with high salt content. Limited drainage mechanisms and high evaporation rates have led to salt accumulation in irrigated agricultural lands.

Other pollutants

Waterborne diseases are widespread in Iraq due to contaminated drinking water sources. Reports from the Iraqi Ministry of Environment for 2017 indicate that0225 Bacteriological contamination of water sources Water varies between governorates, ranging between0.41% to 32%, with an average of 0.1%, which is It exceeds both the national drinking water standards in Iraq and the World Health Organization's drinking water guidelines. Data on other contaminants, including organic and inorganic materials, pathogens, and bacteria, is limited in Iraq, making it difficult to fully describe the sources and extent of contamination or any anticipated changes that may occur in the future.

Water quality standards

There are specific standards for water quality in effect in Iraq today. The provisions for liquid waste stipulated in Iraqi Law No.01 of 15.2 and No. 0 of 0221, whereby the limits were set Pollutants are released into the main water sources, main sewers, and tributaries to the main water sources and marshes. However, the regulations do not impose any specific restrictions, even for discharges into freshwater bodies. Furthermore, the limits on discharges into the sewer system are restricted, and even industrial discharges are discharged without any pretreatment. This is a significant problem because uncontrolled industrial discharges, especially those containing toxic materials, undoubtedly expose downstream users to poor-quality water. In addition, most municipal water treatment technologies currently available in Iraq consist of biological processes that do not remove all industrial pollutants, such as heavy metals.

Suitability of surface water

To describe the suitability of surface water in Iraq for various applications, two water quality indices (WQIs) were developed (further details are provided in Appendix 2.B). One assesses the suitability of water for human consumption, and the other assesses the suitability of water for irrigation. Each WQI combines multiple physical parameters from a water model to represent the suitability of water use for a particular application, allowing for rapid interpretation of monitoring data. To calculate the WQI for human use, a set of nine physical water parameters (i.e., pH, total dissolved solids, total water hardness, and concentrations of calcium, magnesium, chloride, nitrate, sulfate, and phosphate) were used. These parameters were used to classify water quality from excellent to unsuitable for human consumption.[50] The WQI indicates that water quality in Iraqi rivers ranges from good to poor along many lengths of the Tigris and Euphrates, but poor (or worse) water quality is prevalent along the Azim, along the Euphrates south of Najaf, and on the Tigris in front of the city of Qurna.

[50] Twari and Mishra (1551) Preliminary assignment for the supplement to the water quality of major Indian rivers, Indian Journal of Environmental Protection, 1)0), .02-025

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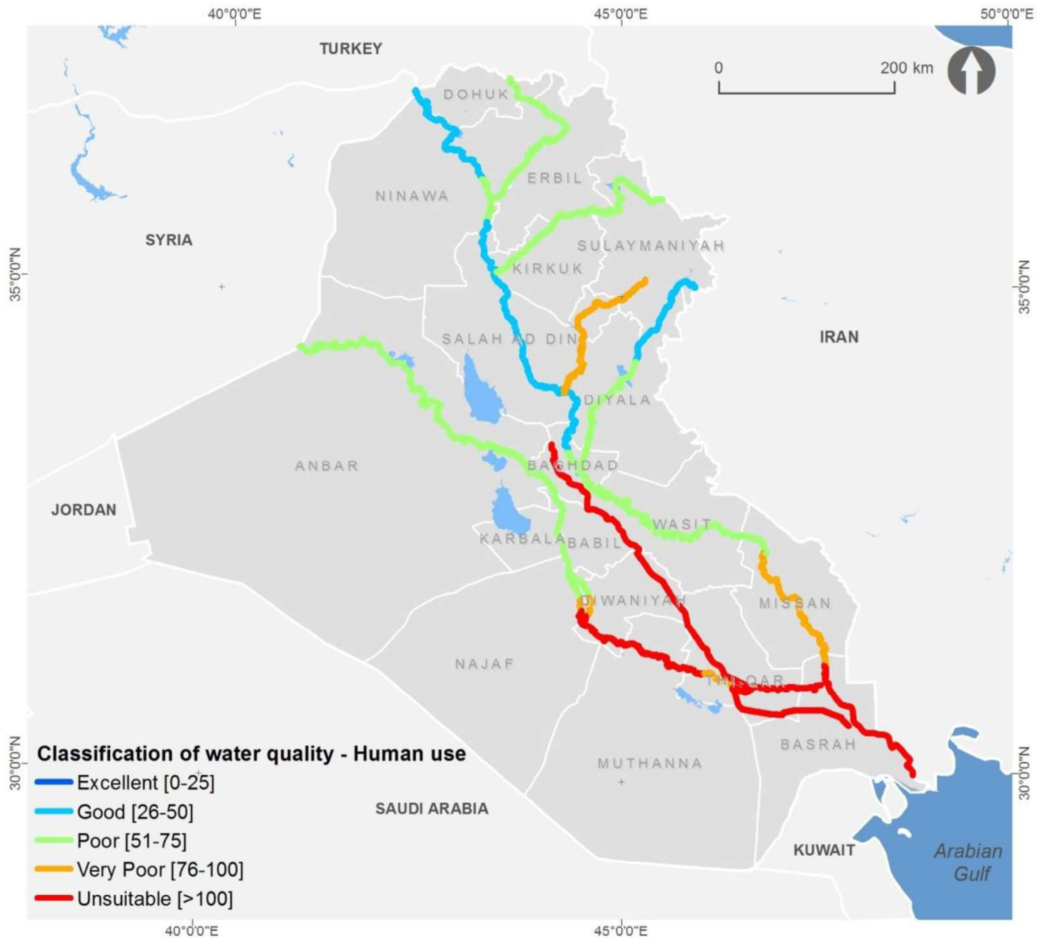

Illustration*40*/ appearance22-3: Classification of water according to the water quality index (*WQI*) for human consumption

The Water Quality Index (WQI) for irrigation water was also calculated based on studies conducted by the Food and Agriculture Organization (FAO) as well as groundwater studies conducted in Iraq. The WQI for irrigation is based on measurements of electrical conductivity, sodium, chloride, sulfate, soil sodium absorption ratio (SAR), and nitrate. The suitability of surface water in Iraq for irrigation decreases downstream, reaching significantly restricted levels above the Samawi area along the Euphrates River and around the Ali al-Gharbi area on the Tigris. The general downstream water is unsuitable along the canal.

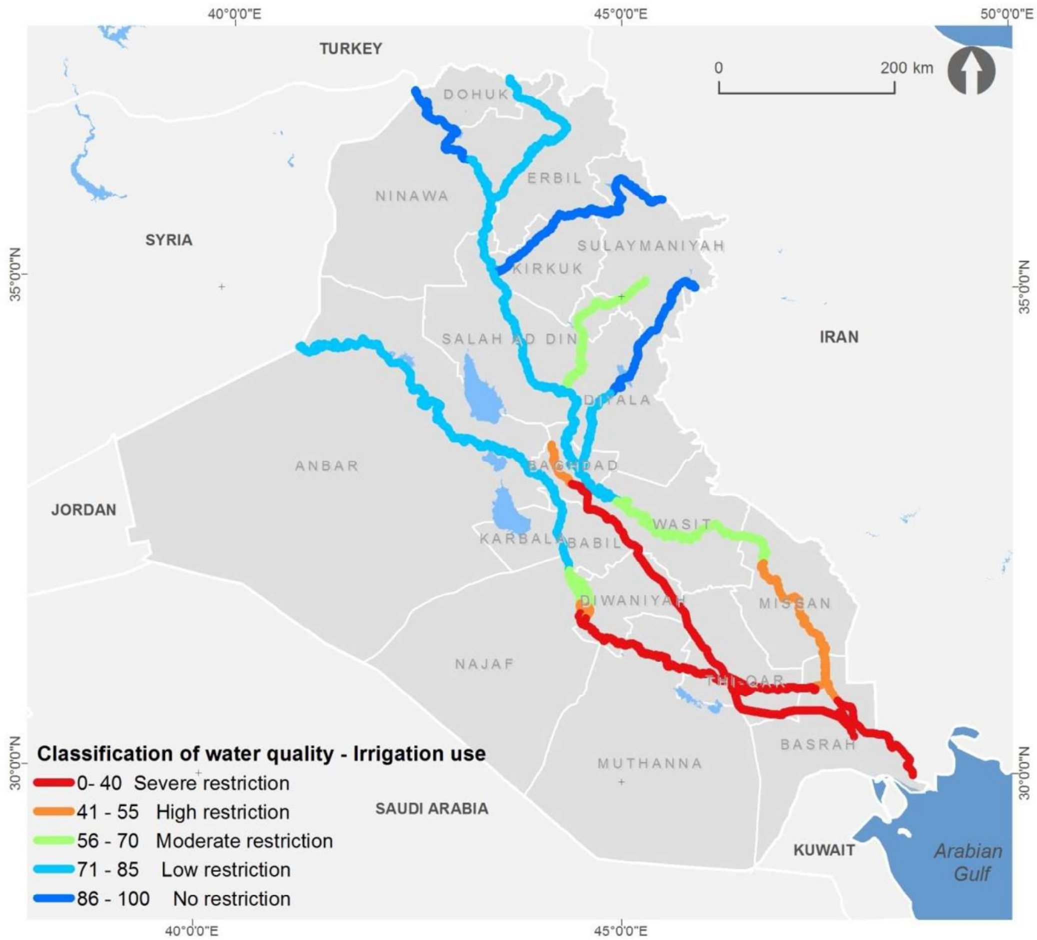

Illustration24/ Figure 3-27: Water classification according to the water quality index (*WQI*) for agricultural uses

1.2.1.4 Future needs

If current water management practices continue, the water quality of Iraq's river system will continue to decline. To prevent future deterioration and improve water quality, there is a need to:

0. Comprehensive global preventive and management measures for the efficient use of agricultural and municipal water.

   and industrial;

4. Comprehensive standards for the quantity and quality of surface and groundwater

4. Comprehensive quantitative and qualitative standards for discharges into water bodies and soil.

4. Referring to appropriate wastewater treatment technologies with efficient energy consumption and resources,

   in addition to opportunities to recover energy and resources to achieve optimal sustainability of the system.

2. Design and plan the infrastructure based on current and future planned conditions.

1. Collecting data and tools to monitor the flow and quality of water flowing into Iraqi rivers from municipal, industrial, and agricultural water users, and information tools that facilitate the visualization and processing of collected data.

1.2.1.1 Opportunities and Strategies

Monitoring and data collection

A comprehensive water quality monitoring program is essential to understanding the locations and sources of contamination within Iraq's surface water network. Such a program should include measurement protocols to record the chemical, physical, and biological conditions within the surface water; the volumetric flow rate of the river at the time of the measurements; and the date and time of the measurements. A list of parameters that should be recorded is shown below. Sampling sites should include areas upstream and downstream of major diversions, confluence points, urban centers, major industrial facilities, and water and wastewater treatment facilities. Sampling should be conducted daily.

The current distribution of water quality monitoring stations along the Tigris, Euphrates and Shatt al-Arab rivers is comprehensive, while the distribution of monitoring stations along the Greater Zab, Lesser Zab, Greater Zab and Diyala rivers needs to be improved, as water quality measurements are not currently taken along these tributaries.

table 11/2-3: List of chemical, physical and biological measurements that must be recorded during the process of measuring the quality of water samples.

Irrigation purpose	Municipalities purpose	Parameters	Type
- -	- -	pH	Chemical & Physics Properties
- -	- -	EC	
- -	- -	TDS	
- -	- -	essTotal hardness	
- -	- -	3NO	
x	- -	3HCO	
x	- -	3CO	
x	- -	4SO	
- -	- -	Cl	
x	- -	K	
- -	- -	Na	
- -	- -	Ni	
- -	- -	Ca	
x	- -	COD	
- -	- -	Fe	
- -	- -	Be	
- -	- -	Pb	
- -	- -	Zn	
- -	- -	CD	
- -	- -	Cu	
- -	- -	Cr	
x	- -	BOD	
x	- -	Ur	
- -	- -	E-COLI	Biological

Irrigation purpose	Municipalities purpose	Parameters	Type
- -	- -	rmTotal colifo	

Salinity control

Of paramount importance in controlling salinity along rivers in Iraq is changing the way agricultural drainage is managed. From now until0231 Irrigation projects must be linked Simultaneously, drainage channels that convey agricultural return flows, and completely isolate polluted agricultural runoff from Iraq's freshwater resources, are expected to significantly improve water quality in Iraq.

An additional measure to improve the salinity of surface water in Iraq is to stop using Lake Tharthar as a reservoir. Evaporation rates from this lake are high, and its salinity is steadily increasing, negatively impacting the quality of downstream water.

Use of appropriate technology to treat wastewater

The application of appropriate wastewater treatment technologies to prevent municipal and industrial pollutants from entering Iraq's rivers must be evaluated on a site-by-site basis. The choice of wastewater treatment technology can be determined by the characteristics of the water to be treated, which typically depends on the size of the community. Discharge from small rural communities has less impact on receiving water bodies than discharge from urban areas, and in rural communities, it can be difficult to recruit and train technical personnel to operate complex treatment plants. Therefore, it is important to adapt to the required level of technology. Simple wastewater treatment facilities are suitable for small villages of up to 1,111 inhabitants. Primary treatment (i.e., screening and separation of sand and floatables) is followed by primary sedimentation (to separate primary sludge), aeration, and final filtration (secondary treatment). This can be followed by unconventional technologies such as ponds, wetland construction, or phytodepuration systems. To be effective, unconventional treatment technologies require large areas of land and are relatively simple to maintain. In the long term, phytodepuration areas can add great value to the environment and the local community by creating habitats for animals, increasing biodiversity and possibly serving recreational areas.

On the other hand, larger communities must be served by more conventional wastewater treatment plants. In particular, communities with more than 11,000 residents must have facilities capable of removing nutrients and contaminants from the water, while also managing energy requirements, chemicals, and sludge production. Under suitable conditions, facilities can achieve year-round energy balance, producing the same amount of energy required for treatment. This may only be possible by adopting modern wastewater treatment technologies and ensuring that the wastewater collection network does not combine wastewater from multiple sources.

In large facilities, wetlands and phytodepuration systems can be adopted as a tertiary treatment: they can be managed as natural parks, serve as recreation areas, ecological reserves, and can become ecotourism attractions.

Water Quality Management along the Shatt al-Arab

A recent water quality assessment was conducted for the design of the Shatt al-Arab Irrigation Project (independent of the SWLRI project). The conclusions of both the Pol Service Feasibility Report (1981 Pol) and the New Eden Project Report 1981 confirmed that: To prevent seawater intrusion in Basra, the flow rate should be 21 m^3/s along the Shatt al-Arab.[51]While increases in salinity have been recorded in recent years in Basra, the reason for this increase is the decrease in flow along the Tigris and its tributaries and the increased salinity concentration within these flows. Thus, the salinization in the Basra region is not related to seawater intrusion from the Gulf. This means that securing a minimum flow of 21 m^3/s south of Basra city in the future eliminates the need to build a dam, both now and in anticipated future conditions.

However, if the minimum flow of 21 cubic meters per second along the Shatt al-Arab cannot be guaranteed, a dam is the only solution to prevent saltwater from penetrating Basra and moving upstream, and to prevent tidal effects along the river. The best location to place the dam to stop the salt intrusion would be directly upstream of the proposed port at Al-Faw. Such a location has been proposed for more than half a century and would provide the greatest amount of freshwater across the entire Shatt al-Arab.[52]To fully benefit from this location, the dam must be built as a joint project with Iran. The 2002 Iran-Iraq Agreement provides justification for implementing such a joint project.[53]However, since the construction of a dam at Al-Faw might require negotiations with Iran, the construction of a dam at Abu Flus was considered as an alternative solution.

The construction of the East Tigris Main Drain will divert sewage from the Shatt al-Arab and Suwayb when water quality is uncertain. A drainage and sewage network is also needed in Basra to ensure that untreated water is not allowed to enter the Shatt al-Arab. Similarly, industrial wastewater must be treated on-site before being discharged into the river.

[51] Mid Engineering, SGI and Concode. Design studies for the Shatt al-Arab Irrigation Project. A report prepared for the Iraqi Ministry of Water Resources 2013.

[52] Knapper-Tibetts-Abet McCarty,1510. Tigris-Euphrates Water Supply System Development Report. Also known as the 1510 TAMS Report.

[53] Treaty on the Borders of the Country and Relations with the Neighbors between Iran and Iraq established on the basis of the Agreement on the Use of Watercourses The treaty was signed in Tehran in13/./1521 and implemented on 00/./.152 by exchanging certified documents based on Article 5

3.1.9 Groundwater

1.2.1.2 Facts and needs

There are five main hydrological zones and02 Sub-regions (for more For details, see also the “Water Security Map –21" attached) that can be identified in Iraq Based on the physiographic, geological, topographic, tectonic, and structural characteristics of the subsurface conditions. The map below illustrates the shape of05-3, these areas.

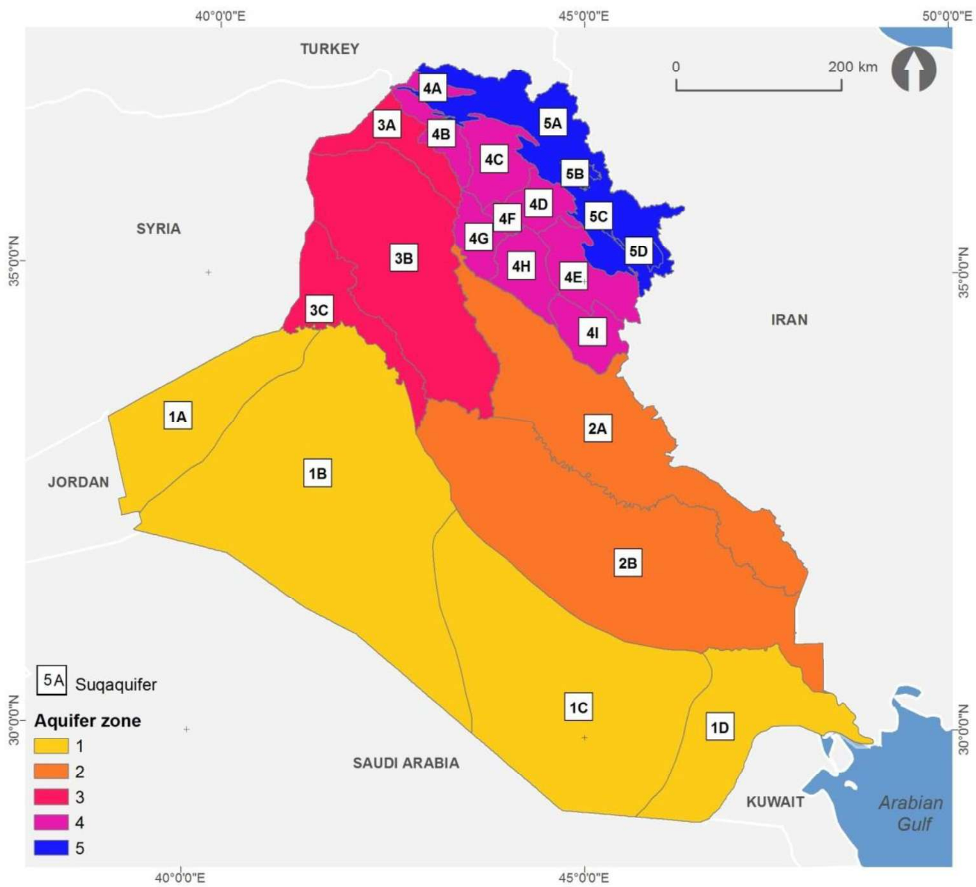

Illustration*42*/ appearance23-3: Hydrogeological map and identification of sub-groundwater layers

The average annual nomination in Iraq is114,205 billion cubic meters annually, based on the system Physicist and geologist, the best available estimate of sustainable groundwater is14003 billion meters cubic meters per year, about32% of the average annual infiltration. Groundwater storage is very sensitive. Due to the consumption and availability of surface water, any changes in well withdrawals can affect discharge along the river, and any changes in stream flow can affect the volume of available groundwater. International studies of various aquifers have shown that water levels

Renewable groundwater ranges between12% to 22% of annual filtration, so the estimates are For Iraq it is within reason.

Groundwater quality in Iraq varies regionally. Accessible, high-quality, and productive groundwater is found in the northeast of the country. In this region, rainfall is high, so the concentration of dissolved solids in groundwater is typically very low. Groundwater salinity is highest in the central, low-lying areas of the Mesopotamian Plain and the Jazira region. Groundwater in the Mesopotamian Plain is generally very saline. In arid and semi-arid areas such as Iraq, the chemical composition of groundwater in shallow subsurface layers depends on the quality of the recharge water and the depth of the groundwater. Generally, sodium and chloride contents increase with depth, while in deeper areas, sodium, calcium, and chloride brines predominate. These vertical changes in the chemical composition of groundwater are associated with increased salinity relative to overall depth (for more details on confined aquifers, see the "Water Security Map").2" attached, and around water points Unconfined groundwater, see the “Water Security” map.22" also attached.

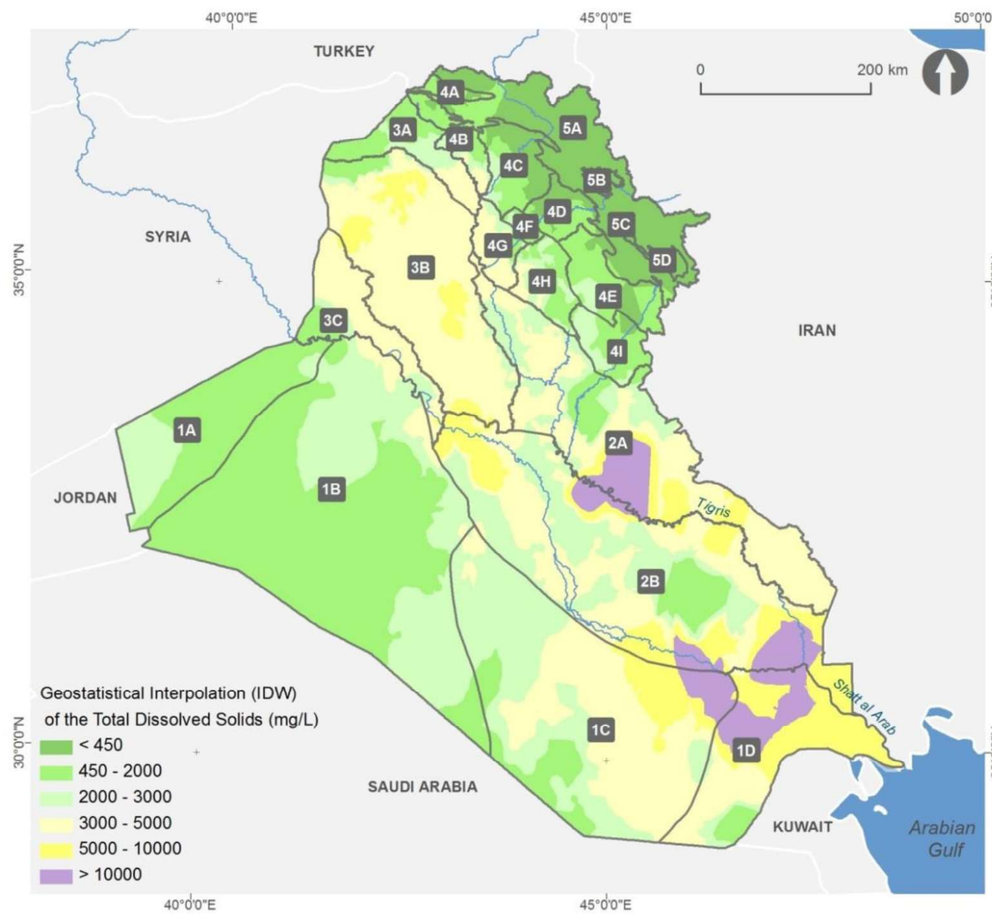

Illustration23/Figure 3-22: Salinity (mg/L) of unconfined aquifers

Groundwater suitability

Drinking water quality can be classified based on two sets of criteria: typical criteria, such as total hardness, electrical conductivity, chlorine, sulfates, and nitrates; and undesirable criteria, such as ammonium, iron, and manganese. Based on the constituents within the water, there are three categories: Class A, water suitable for drinking without any treatment; Class B, potable but with some restrictions for agricultural and industrial uses; and Class C, which is not suitable for drinking.

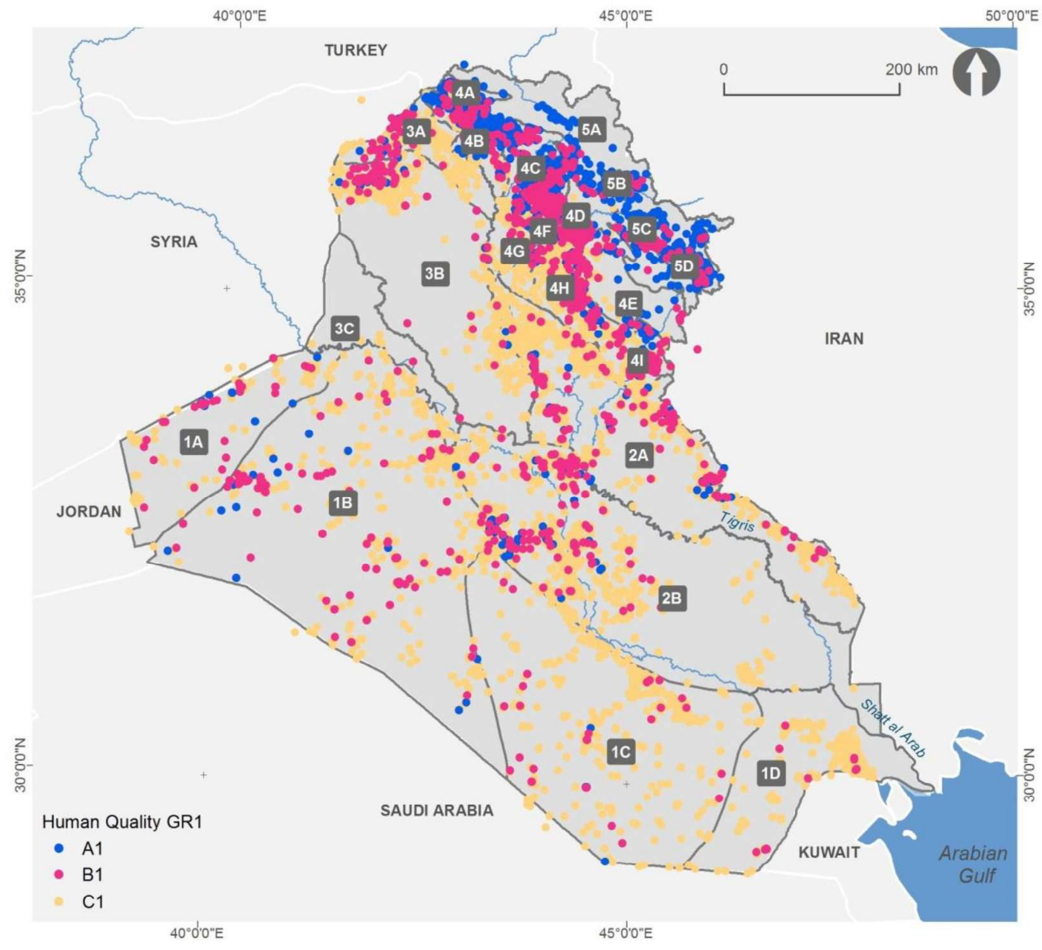

Illustration*44*/ appearance31-3: Classification of groundwater according to its suitability

A specific classification of agricultural suitability can be made by different criteria following the criteria of FAO and many authors (e.g. AM Jawad, 2010): epm, Cl (ppm), Na%, EC (μmohs/cm).$_4$Using the GIS hierarchy method with geostatistics analysis of GIS. SAR(unitless), SO

Analytical Hydrology (AHP) was used to calculate the weights of the coefficients. A map was prepared to determine the suitability of confined and unconfined reservoirs for irrigation within Iraq.

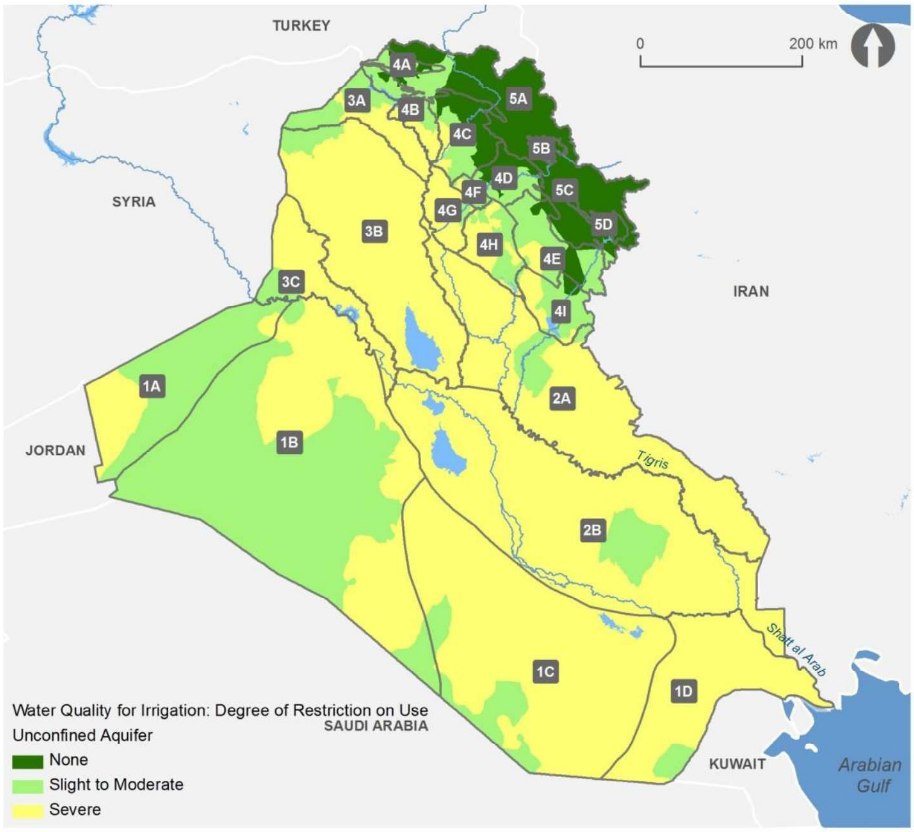

Illustration25/ Figure 3-34: Classification of groundwater according to its suitability for agriculture in different main and sub-hydrological zones[54]

Current use of groundwater

In Iraq, groundwater is used primarily in the agricultural, industrial, and municipal sectors. Total02 groundwater-based projects to support irrigation as well as irrigation projects The other is in Western Sahara. There are more than550,222 wells located throughout the country, supplying Households, cities, and industries require water, although detailed information on consumption rates is not available. Based on agricultural land use patterns, well records, and groundwater modeling, approximately341 billion cubic meters of groundwater are currently consumed annually in Iraq.

[54]See also the "Water Security Map 25" for more details on water quality for irrigation, and the degree of restriction on use in reservoirs. Confined groundwater, and the "water security" map –25" for unconfined groundwater reservoirs.

1.2.1.4 Future needs

Sustainable use of groundwater and groundwater quality management strategies are essential to ensure that14,003 billion cubic meters of renewable groundwater annually will be used sustainably in the future.

1.2.1.1 Opportunities and Strategies

By the year0231, groundwater development is expected to reach 14,003 billion cubic meters annually, This is the estimated maximum sustainable groundwater withdrawal for the country. This represents545% of Freshwater resources available in Iraq at the time. Achieving optimal extraction of this volume requires coordinated network expansion and support for pumping infrastructure to deliver groundwater to users.

Groundwater development

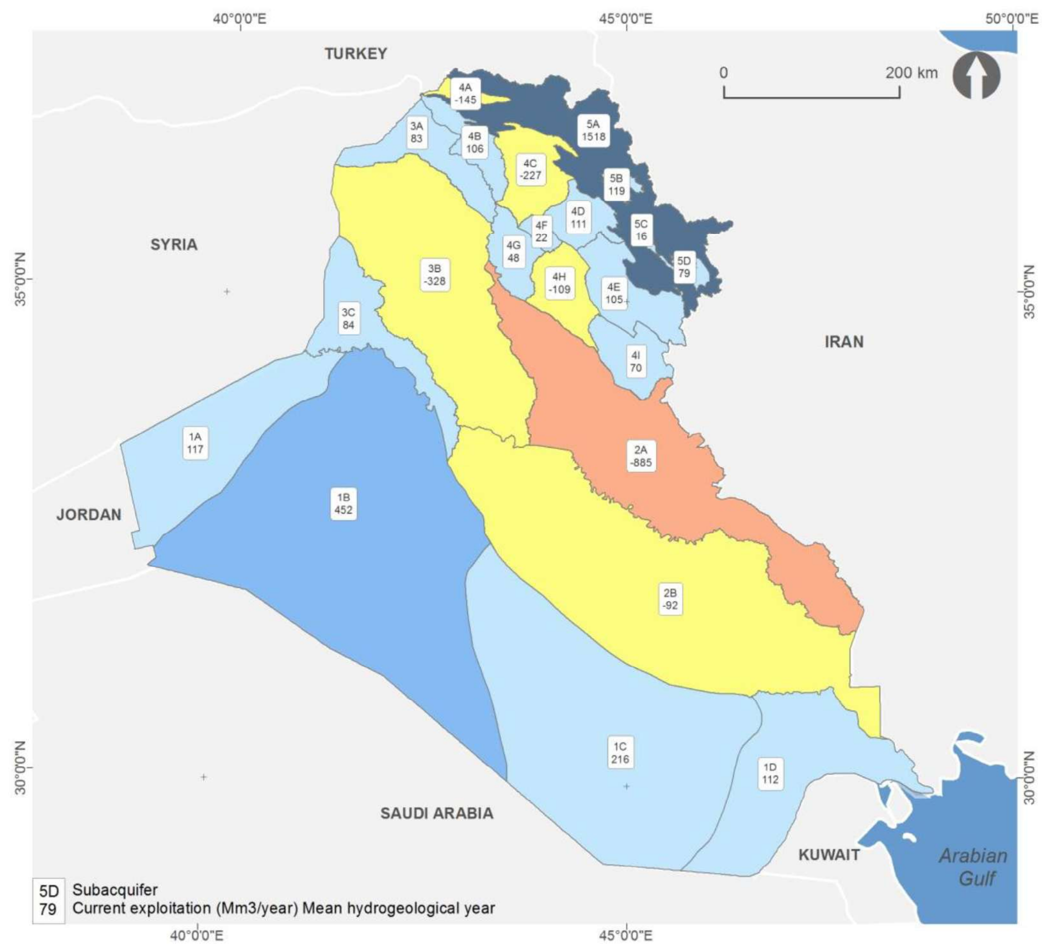

Illustration46/ appearance32-3: The current level of overexploitation of various groundwater aquifers in Iraq

The total maximum sustainable annual groundwater withdrawal volume is divided among five aquifers in Iraq, as shown in the table below. Based on current indicators of groundwater withdrawal for municipal, industrial, and agricultural uses (both within the boundaries and beyond the boundaries for official irrigation projects), the amount of potential new groundwater withdrawals is approximately14020 billion meters Cubic meters annually across the five reservoirs. The evaluation can also be scaled to a single aquifer (see table). 12-3, next).

It is clear from this analysis that some reservoirs are overused (see figure).3-30, previous). Given the complexity of water hydrology, it is recommended that more studies be conducted. Detailed information on where excessive use occurs when planning future withdrawals.

table *12*/41-3: Summary of sustainable groundwater volume and current withdrawals by aquifer

Current condition of groundwater exploitation (BCM/y)

Residual Exploitation	Current Withdrawal AG	Current Withdrawal M&I	Sustainable Withdrawal	Renewable Resource	Precipitation	Aquifer
0.700	0.326	0.000	1.026	3,079	29.203	1
1.220-	1,930	0.003	0.713	2.138	17,468	2
0.234-	0.655	0.019	0.440	1.320	12,050	3
0.493	0.585	0.111	1,189	3,566	13,035	4
1.733	0.004	0.138	1.875	5.626	17,781	5
1.472	**3,499**	**0.272**	**5.243**	**15,729**	**89,537**	**TOTAL**

Currently, Iraq must seek to identify illegal uses of groundwater and illegal well drilling, and halt the current trend of over-exploitation of this natural resource. This over-exploitation currently occurs mostly on irrigated lands located outside the irrigation projects that this strategy proposes to develop in the future.

If the difference between sustainable and current withdrawals is related to expansion into sub-reservoir systems, the remaining exploitation rate can be analyzed. According to this criterion, the most prominent area is the high-folding reservoir layer (Then there are several sub-reservoir systems that have resources (High Folded aquifer). Groundwater remains to be extracted, but with a low rate of exploitation. These aquifers include the Western Desert, the southern and northern parts of the Gezira region, and a large part of the foothills. Details of this analysis are given in the hydrogeological study of the sub-reservoir systems.B. Listed in Annex 3 SWLRI

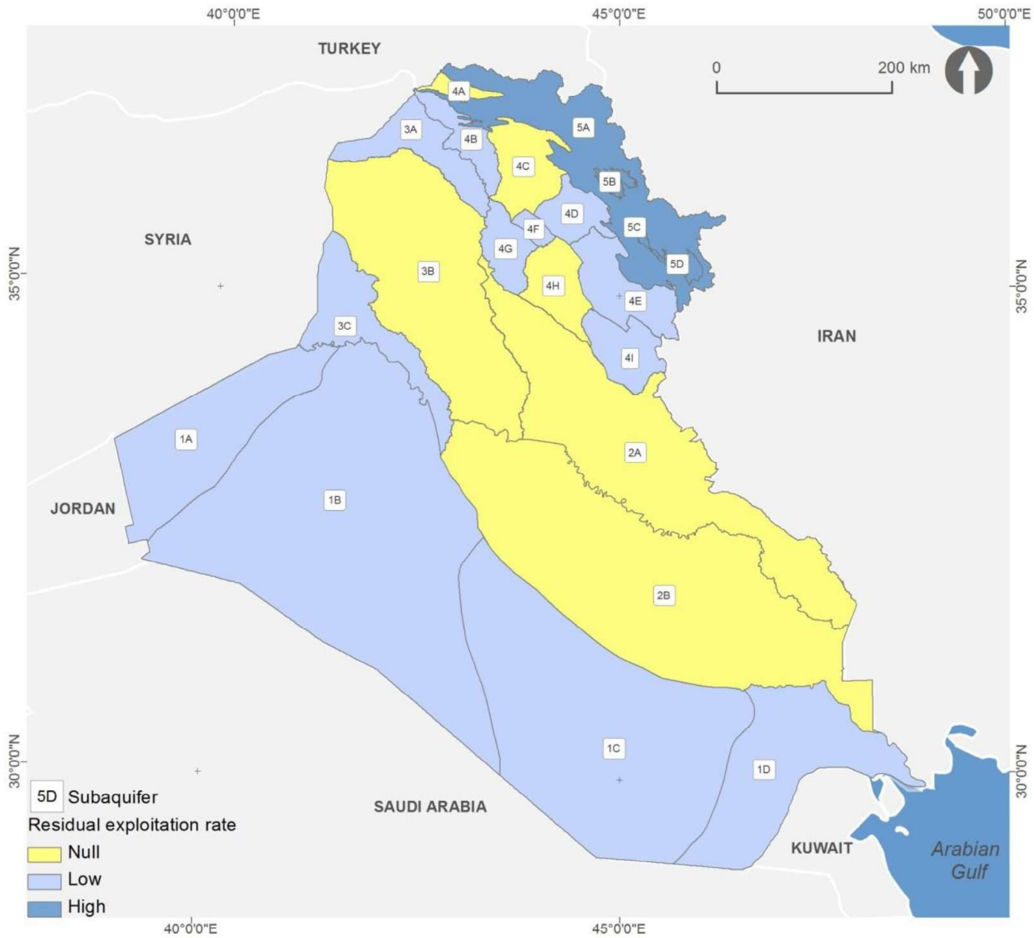

Illustration47/appearance33-3: Remaining rate of over-exploitation of groundwater in sub-reservoir systems

A groundwater abstraction sustainability assessment should be conducted to identify the relevant aquifers and compare the acceptable additional abstractions with the required water demand. This analysis should consider the aquifers as a "stand-alone" component of the Iraqi groundwater system (groundwater recharge and abstraction are compared "statistically"). In fact, each aquifer is hydraulically linked to one or more aquifers, and therefore both inflows and outflows involving the aquifers must be considered to obtain a comprehensive assessment of the entire water cycle.

Finally, it should be noted that groundwater naturally drains through the surface network, particularly along the Tigris River tributaries in northeastern Iraq. Therefore, artificial groundwater withdrawals could affect water exchange. As a result, discharge along these rivers may decrease.

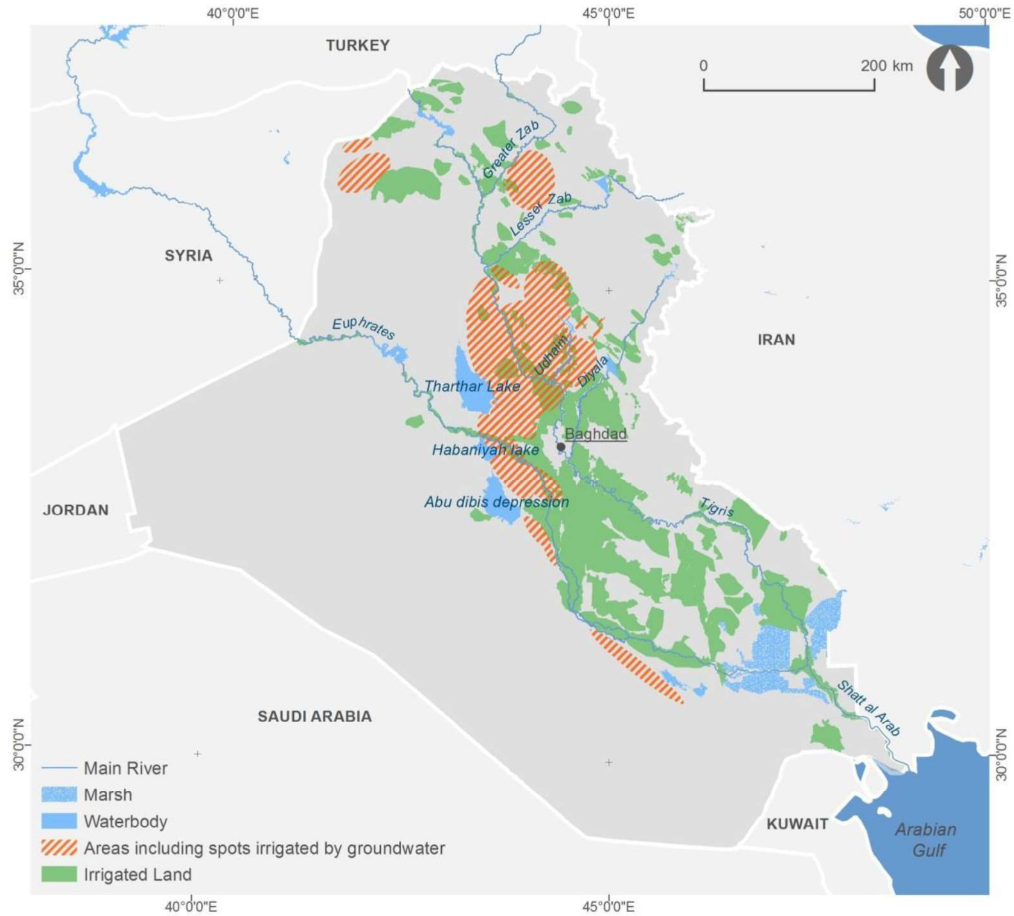

Illustration48/ appearance32-3: Reference to some areas irrigated by groundwater.

groundwater quality

In addition to the volume of available groundwater, it is also necessary to assess the quality of the groundwater to determine the purpose for which a particular groundwater resource can be used. Generally, the highest levels of groundwater quality are found in the northern parts of Iraq and the lowest in the south. This strategy suggests that groundwater with a TDS less than212 mg/L should be given priority for drinking.

Control of aquifer recharge (MAR) and rainwater harvesting

The central part of the Jazirah region, the Mesopotamian region from Lake Tharthar to the Shatt al-Arab, the Mandali-Tayyib region, and the sub-aquifers of the foothills are being overexploited. For these areas, the current water withdrawal rate must be gradually reduced and/or artificial recharge interventions must be anticipated.

However, prior to these procedures, a hydrogeological study of the aquifer should be conducted. In fact, the correct definition of an aquifer is based on determining the nature of its main components: the solid matrix (determined by geological and petrographic analysis, grain size classification, and porosity), the quantity and quality of water, the movement and main pathways of water in the porous medium (characterized by the aquifer's permeability, groundwater pressure level, and percolation rate), and finally, the amount of natural recharge from rainfall data, the hydrological regime, and the surface water channel system associated with groundwater.

Among the information needed for the general preliminary study of the groundwater aquifer system is the following:

- Meteorological, hydrological, topographic and land use data;
- Morphological, pedological, geological and petrographic features;
- Hydrogeological factors (effective porosity, horizontal and vertical conductivity, reservoir thickness and permeability);
- Pressure levels across the aquifer (during flood and drought seasons);
- Surface hydrological data (river network, flow regime and flow rates);
- Water resource uses or location and total volume of discharges and withdrawals.
- Interaction with surface water resources (intersections between groundwater and the river network, and average annual flow volumes feeding the aquifer).

For Iraq, the area between the Khazir and Greater Zab rivers, upstream of the confluence, is characterized by high permeability, and therefore groundwater recharge measures could be beneficial for the currently overexploited portion of the mountainside aquifer. Furthermore, the Khazir and Greater Zab, in particular, have associated drainage systems and could thus serve as a water source for controlling the aquifer recharge (MAR), which occurs primarily outside the irrigation period.

In contrast, the overexploitation of the sub-aquifer on the mountainside (the hill) behind Kirkuk, which is fed by the Rukhaneh River, is a low-permeability aquifer. The sharp decline in permeability and the scarcity of surface water make artificial recharge from the central Jazira region extremely difficult to compensate for the current water deficit. Given the infiltration capacity and water availability, it appears futile to address the significant imbalance between sustainable and current water withdrawals: groundwater exploitation in this area must be gradually reduced.

Once the described analysis has been performed, specific aspects of artificial nutrition must be evaluated and the most appropriate and effective measure should be used.

In order to verify and ensure the effectiveness of artificial feeding, choosing the best location for its application is paramount. The site must have the best possible conditions. Depending on the type of technology used, it is necessary to consider the following, for example:

- Areas with good infiltration capacity;
- Areas close to one or more bodies of water with a good volume of water available to feed the aquifer;
- Sufficiently flat areas with space to intervene;
- Areas with unsaturated porosity layers of at least ten meters, but where the groundwater level is not very deep;
- Preference should be given to areas suitable for receiving large volumes of water for feeding, such as retention basins or quarries.

Classification based on the inflectional methodology can be divided into direct and indirect methods.

There are direct surface methods such as flooding, infiltration basins or tanks, flow enhancement, canals, and over-irrigation, but also direct subsurface techniques including well injection from feeder wells, drilling of feeder wells, and natural boreholes. Finally, it is possible to combine surface and subsurface techniques (infiltration basins or tanks, vertical boreholes, or wells) and indirect techniques such as recharge resulting from modification of the surface water source or aquifer.

Finally, it is important to note that there are groundwater dams that obstruct or impede the natural flow of groundwater and the replenishment of underground water reserves. There are two main types of groundwater dams: semi-surface dams and sand storage dams. An underground or semi-surface dam is built underground and prevents the natural flow of groundwater to avoid high water losses from evaporation. A sand storage dam traps water in the sediment naturally accumulated by the dam itself.

Groundwater dams appear to be particularly suitable in the Western Desert of Iraq, as they are generally implemented in rural areas with semi-arid climates to store seasonally available water for use during dry periods for livestock, minor irrigation, and domestic use.

General Recommendation for the Strategic Exploitation of Groundwater

Since the SWLRI groundwater study was conducted on a regional scale, more detailed local studies and investigations regarding both groundwater quantity and quality and monitoring of specific site conditions are strongly recommended. This should be undertaken prior to any future groundwater abstraction development.

3.1.10 Navigation and water transport

1.2.21.2 Facts and needs

Iraq's main waterways are the Tigris, Euphrates, and Shatt al-Arab rivers, which stretch the entire length of the country from northwest to southeast. Along with the marshes, the major rivers have historically been used for navigation and the transport of goods and people. However, the waterways have not been used extensively in recent years. The volume of goods transported by the river decreased significantly between 1975 and 1980. 1511 and 1522 as mentioned in the Russian plan (1550). In the half The second half of the last century, when navigation was restricted to the Shatt al-Arab River, the Tigris River via the Baghdad-Qurna extension, and the Euphrates River along limited stretches.

Periods of low flow have always posed difficulties in ensuring safe navigation on rivers. Navigation on the Euphrates was limited to isolated stretches due to improperly designed boat slipways and the large variations in water depth. Despite these difficult conditions, several navigation locks were implemented during the Russian Master Plan, and proposals were made to improve navigation in general. A minimum flow system was designed for rivers that were estimated to be much higher than the expected flows. 0231.

In the year1551, a study was completed to investigate the navigational possibilities along the Euphrates River, including: This assessment included hydrological, declining water availability, and the function of dam construction and storage. Additionally, hydraulics were studied to understand the minimum water level required to ensure navigational requirements, river erosion problems following dam construction that reduced sediment transport downstream, and the types of boats and materials transported. Plans resulted in the construction of several navigation locks along major rivers, but inland navigation development has declined in recent decades due to projected declines in water availability and as other transportation options (i.e., rail and highway trucking) have become more economical and preferable.

Current situation

Currently, navigation along Iraq's waterways is not considered a clear viable option, except in special cases, such as local navigation and along the Shatt al-Arab. On the Shatt al-Arab River, between the ports of Abu Shahr and Al-Faw on the Gulf, navigation by marine vessels is possible, and at Abu Shahr, small cargo vessels can navigate the waters. Dredging and widening the channel will be required to support the navigation of larger vessels near Abu Shahr. Because of the Shatt al-Arab's geographical and strategic location, oil companies have studied the feasibility of using the entire length of the Shatt al-Arab, from the Gulf to Al-Qurna, as a transport corridor. A sophisticated plan has been proposed for the new port of Al-Faw, which could become one of the most important ports in the Gulf as a whole. In addition to the ports along the Shatt al-Arab, Umm Qasr is the second entry point into the Gulf used by the oil industry.

A major limiting factor for navigation is passage under the newly constructed bridges along the Tigris River between Kut and Al-Qurna. The space between the water surface and the footbridges is insufficient for the passage of cargo vessels. Navigation along the main estuary has been proposed for years, including navigation locks in Nasiriyah, but much of the proposed infrastructure to support navigation has not been constructed.

1.2.21.4 Future needs

Due to the need to allocate water to multiple sectors and projected declines in water availability, large-scale navigation investment along Iraq's waterways is a low priority. The most important areas for navigation-related investment are along the Shatt al-Arab to support shipping activities from the Gulf.

Navigation on the Tigris and Euphrates rivers should be reassessed in future updates of this strategy, particularly if more favorable water allocation agreements with neighboring countries emerge. In the meantime, this strategy recommends that any new water control facilities located along the major Tigris and Euphrates rivers should be designed to include a lock (navigation key) capable of passing vessels of the same size as any existing upstream facility. This is to prevent new facilities from restricting future navigation of the rivers should Iraq increase its water availability through a negotiated agreement with neighboring countries.

1.2.21.1 Opportunities and Strategies

Navigation across the Shatt al-Arab

The dischargeA minimum of 21 cubic meters per second must reach the Shatt al-Arab to ensure that the salt front from the Gulf does not reach Basra. If the strategy is not fully implemented, this amount of water must be guaranteed at all times from the Tigris River. On the other hand, if the strategy is implemented immediately, a greater flow of12 cubic meters per second will flow into the Shatt al-Arab. Given the contribution of the Tigris River and the outflows from the Hawizeh Marsh, this strategy shows that the inflow of more than122 m³/s can guarantee 12% of the time

Along the Shatt al-Arab. This is equal to the size of34,351 billion cubic meters/year (see Figure 3-31). It should be noted that the quality of water coming from the Hawizeh Marshes may not always be suitable. For the Shatt al-Arab, a good water quality monitoring and management system must be implemented to fully exploit any excess water coming from the marshes. Even a flow rate of 21 cubic meters per second will provide sufficient water depth to support the passage of some cargo ships. Regular dredging of the Shatt al-Arab must be carried out to ensure that ships crossing the river from the Gulf can reach the inland areas.

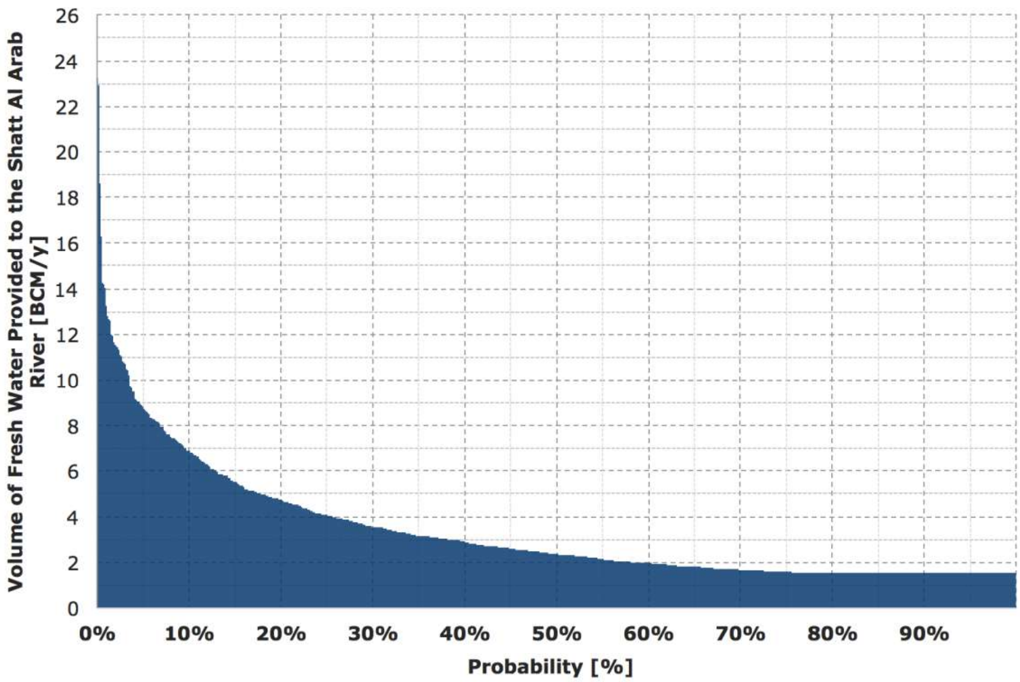

Illustration22/ Figure 3-35: Volume and duration curve showing the amount of water flowing into the Shatt al-Arab

Use of the public drain

Historical proposals to use the general outlet as a navigation channel along its length cannot be widely supported because there is a plan to reuse discharges from the general outlet to support water supplies for green belts, for reinjection into oil wells, and also to preserve the Mesopotamian marshes. In particular, reusing drainage water to support the Hammar Marshes will only be possible if there is adequate water quality monitoring at the site where the drain water is pumped into the marsh. Pumping must be stopped when the salinity of the general outlet exceeds0222 mg/L.

3.1.11 sedimentation

1.2.22.2 Facts and needs

Sedimentation of major river facilities significantly impacts water management throughout the country. This strategy estimates that more than .134 million cubic meters of sediment accumulated in advance. Main dams.

table*13*/44-3 Evaluation of sediments at the tops of existing dams (cubic meters)

Sediment Volume [m3]	Length upstream [m]	Name of Barrage
627,806	300	Dibbis
2,482,118	2,330	Hindiya
137,716	550	Kufa
160,262	700	Abbasiya
1,369,833	1,400	Samarra
3,331,816	1,300	Kut
777,617	800	Ramadi
4,748,325	1,300	Falluja
13,635,493		

These results are based on information collected over the past five years by the Ministry of Water Resources and the consultant, and were calculated using all available data. Although they provide a good representation of the situation, the aggregate data are insufficient for a comprehensive assessment of the sedimentation issue (particularly for the Fallujah and Samarra dams).

1.2.22.4 Opportunities and Strategies

It is essential for the Ministry of Water Resources to conduct a more detailed investigation of sedimentation issues and improve the level of analysis of sediment transport along rivers, especially near key water control facilities. Some sites, such as the Fallujah and Samarra dams, are complex and require the implementation of a physical model to study sediment removal and hydrodynamic conditions. Appropriate numerical models should also be developed to study sediment transport dynamics at other strategic locations in Iraq. All details, tender documents, and design principles were developed in 2017.0225 by The World Bank on behalf of the Ministry of Water Resources.

It is recommended that there be a call for “consultants” to conduct a specialized study on sediment removal issues.[55]The Ministry of Water Resources has already conducted a preliminary assessment of the measures required before proceeding with the removal and disposal of drifting river sediments. A comprehensive environmental characterization of the sediments must be conducted in accordance with international standards to assess the suitability of their disposal and potential reuse.

[55]The technical specifications for selecting consultants and implementing the study are all included in the request for proposal within the World Bank’s standards. (December 0225 and references May 0212), under the working title “Development of sediment transport analysis in dams through modeling support”