

Solving the Water Resource Problems in Iraq

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Abstract

Iraq covers an area of 437072 km² in the northeastern part of the Middle East. Its population now is more than 40 million. It relies mainly on its water resources from the Tigris and Euphrates Rivers and their tributaries. Recently, Iraq has been experiencing a severe water scarcity problem. This is mainly due to climate change, increased hydrological projects in riparian countries, and water resources mismanagement inside Iraq itself. To overcome the problem, a new strategy should be implemented. Such strategy should consider two main courses of action: a) serious negotiations with riparian countries to reach an agreement giving Iraq equitable water shares from the Tigris and Euphrates Rivers and their tributaries. b) Prudent water management practices inside Iraq that consider adopting realistic distribution of water between the governorates, rational policies aiming at increased water use efficiencies within Irrigation networks, increased use of non-conventional sources of water, adjustment of water tariffs and their collection procedures, improving agricultural techniques, introduction of intensive guidance and public awareness programs, and promulgation of new legislations, in addition to creation of human resources development programs.

Keywords

Tigris Rivers, Euphrates Rivers, Iraq

1. Introduction

Iraq is currently going through an unprecedented stifling water crisis caused by an accumulation of misuse of water and neglect, as well as a shortage of water supplies of the Tigris and Euphrates rivers and their tributaries due to climate change on one hand in addition to the hydrological projects established by neighboring countries on the other. Moreover, these projects have led to a dete-

rioration of the available water quality. Scientific studies indicate that the shortage will increase over time during this century, which will cause a real danger threatening the very existence of the nation, the lives of its population, and its environment. All this requires taking serious scientific and practical measures to confront the current and future situation. New policies and legislation must be developed to confront the problem and the Ministry of Water Resources must be restructured to be able to implement the necessary policies and legislation.

Iraq is located on the northeastern part of the Arabian Peninsula, and it covers an area of 437072 km² with a present population of more than 40 million (Figure 1). It relies mainly on the Tigris and Euphrates Rivers and their tributaries in its water resources [1]-[5]. Iraq according to historical records used to receive an annual average of about 30, 21.2 and 24.7 billion cubic meters (BCM) from the Euphrates River, Tigris River, and tributaries of the Tigris respectively. In addition, about 8-10 BCM used to enter Iraq from the Iranian border every year. The water withdrawal was about 42.8 BCM per year and now it is about 70 BCM per year. Most of the water is used for agricultural purposes (it used to be 92% and now it is 85%).

The discharge of these rivers started to decrease from 1970 onward (Figure 2) [6], which may be attributed to climate change, hydrological projects in riparian countries and water mismanagement within Iraq itself [7]-[15].



Figure 1. Location of Iraq.

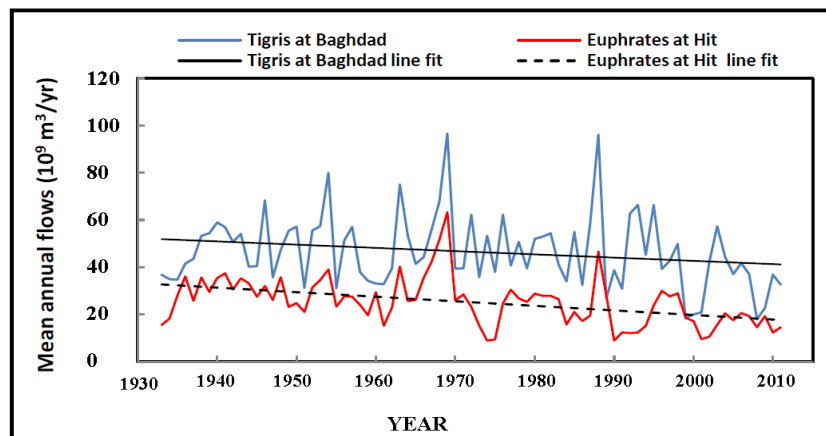


Figure 2. Variation of flow in the Tigris and Euphrates Rivers and their tributaries (modified after [6]).

In this paper, the present hydrological and future situations are discussed, and possible solutions are suggested.

2. Current Problems and Obstacles in the Water Resources Sector

2.1. Historical Background and Current Situation

Iraq has been known for its agricultural lands for thousands of years, and the people of Iraq have used irrigation since ancient times. Archaeological investigations have shown plenty of remains that highlight the importance of water and irrigation practices in agriculture (**Figure 3**, **Figure 4**). Water played an essential role in the lives of the ancient population of the country, and it was so important that they had one God designated for water in their religion (**Figure 5**) [16].



Figure 3. Importance of water and agricultural practices in ancient Iraq (sources: <https://www.gettyimages.com/search/2/image?phrase=mesopotamia+agriculture>; <https://www.alamy.com/stock-photo/mesopotamia-agriculture.html?sortBy=relevant>).

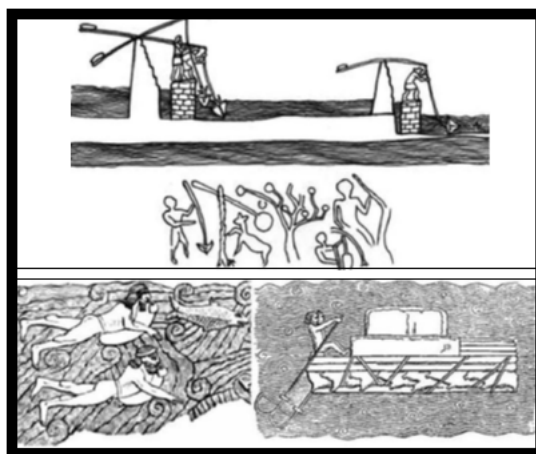


Figure 4. Upper: Bass relief in Sennacherib's palace and Impression of an Akkadian seal (end of the third millennium B.C.). Lower image: Impression of an Akkadian seal. (end of the third millennium B.C.) Lower: Inflated skins used as buoyant elements. Details of stone panels from the palace of Ashurnasirpal II (ca. 910-859 B.C.) [16].



Figure 5. Seals with the representation of the water god Enki—Ea. Upper image: Old Babylonian seal (ca. 1700 B.C.) showing the god with water flowing from his shoulders. Lower image: Akkadian cylinder seal (ca. 2300 B.C.) shows the god seated on a stool and holding up a jar from which waterspouts and falls [16].

The paradox which is evident in water use practices in Iraq today is clearly indicated in retaining the same methods used in ancient times. While development in this sector included the construction of dams, regulators, pumping stations, and irrigation and drainage networks, not much attention was paid to improving water conveyance methods and field irrigation practices to the required level. This did not help in reducing water losses which account for about 60% of the available water. In addition, the state did not attempt to guide the farmers in preserving this important resource, which led to more waste and damage to agricultural lands.

From the above, we find that the agricultural lands that were reclaimed in the sixties and seventies were not utilized to their full potential. In fact, most of them need rehabilitation again, and no effort has been made to reduce water losses by establishing closed water transfer systems or encouraging modern irrigation systems to raise irrigation efficiency and rationalize water consumption [17] [18].

Regarding legislations related to water resources, the new (2005) Iraq constitution was ambiguous about water resources, as Articles (110 - eighth), and (114 - seventh) have classified water resources into; external waters which are the responsibility of the central government and internal waters that are under the jurisdiction of local authorities [19]. Following this the Ministry of Water Resources Law No. (50) of (2008) entrusted the task of managing external and internal water resources to this ministry contradicting Article (114 - seventh) of the Constitution [20]. In addition, law no. (21), on governorates not organized into an autonomous region promulgated in 2008 did not address water resources other than the vague text in the second section of the “Powers of Local Coun-

cils”—(Article 8-Paragraph. nine), which stipulated the following:

“Monitoring the organization of public lands exploitation within the geographical area of the district and working to develop agriculture and irrigation” [21].

2.2. Declining Water Resources

Iraq’s water resources have been decreasing significantly since the seventies of the last century, due to three important reasons [1]-[15]:

a. The phenomenon of climate change; Studies on this subject have confirmed that the Middle East is one of the regions most affected by this phenomenon, and, that rainwater, river water, and groundwater will decrease with time [10]-[15] [22]-[29]. All published research and papers despite the technique or the model used suggest that rainfall is expected to decrease in the Tigris and Euphrates basin within this century. The decrease ranges from 15% - 25%. This will cause a decrease in the flow of rivers within the basin by 29% - 73%. In such a condition, there will be grave depletion of groundwater resources due to heavy dependency and reduced replenishment.

b. Projects built on the Tigris and Euphrates rivers and their tributaries in neighboring countries (Figure 6). Neighboring countries began constructing dams and establishing water projects at the beginning of the seventies.

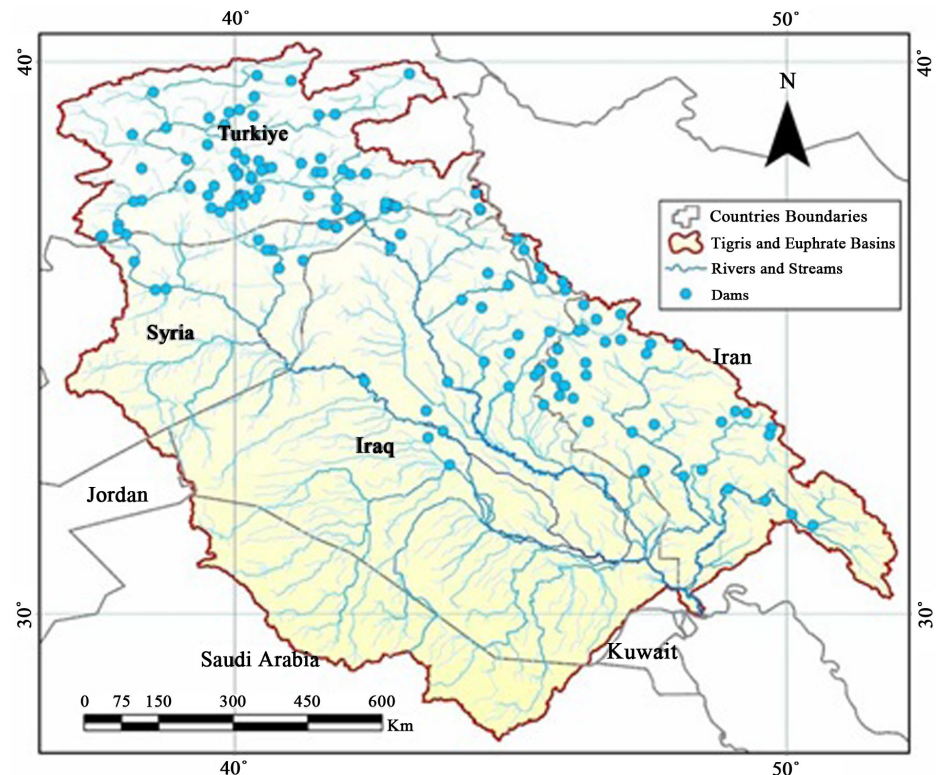


Figure 6. Dams on the Tigris and Euphrates.

The largest example of this is the Southeast Anatolia Project (GAP) in Turkey,

which includes 22 dams and 19 hydroelectric generating stations for its first stage, which led to a reduction in the river's discharges by about: 90% for the Euphrates River and 50% for the Tigris River [7] [8] [10] [11] [28] [29]. The final stage of this project is to construct 90 dams and 60 power stations [28] [29]. In addition, irrigation return water has led to impairing the water quality of these rivers. Similarly, dams built in Iran which reach 40 dams [28] have also affected Iraq's water resources whereby Karun, Karkheh, Vand, and Sirwan dams have diverted considerable parts of the Tigris River tributaries flows, while other 18 border rivers were cut completely. As an example of the discharge of these rivers, Karun and Karkha Rivers that were diverted inside the Iranian borders, contribute 24.5 and 5.8 billion cubic meters (BCM) annually, respectively to Shatt Al-Arab River [6]. These caused an increase in the salinity within the lower reaches of the Tigris River and Shatt Al-Arab River.

Despite all these practices, the Iraqi Government and its Ministry of Water Resources have not made any significant diplomatic effort with these countries to agree with fair water quotas.

c. Water management strategy inside Iraq:

In April 2010 the Ministry of Water Resources signed a contract with a consortium of an Italian company (MED-Ingengneria s.rl and Studio Gali Ingengneria) and some other companies (Concord, Exponent Inc, Sandia National Laboratories) and US Army corps of Engineers) to set the Strategy for Water & Land Resources in Iraq [30]. In this context, there are a number of negative inputs and outputs in this strategy. As an example, Alazzawi [31], noted the following points:

- The quantity of water that enters Iraq from the Euphrates River will be 4.473 BCM and not as the strategy stated to be 9.41 BCM.
- There is no agreement between Iraq and Turkey to supply Iraq with 9 BCM from the Euphrates River.
- It also stated that the quantity of water generated inside Iraq is assumed to be 45.4 BCM and this is unrealistic.
- Not all the Iranian dams were considered.
- The volume of water entering Iraq from riparian countries and inside Iraq reaches 54BCM while the expected number is 32 BCM.
- In 2035, the decrease in the volume of water entering Iraq is expected to be 24.2% but Iraq can increase its agricultural land by 17% and increase the agricultural density by 45%. These are not realistic.

In addition to the above, the strategy did not consider the following points:

- Lack of scenarios considering climate change and upstream developments.
- Non-conventional water supplies and groundwater recharge were given minimal consideration.
- Lack of planning for the distribution of water resources among governorates and regions.
- No consideration was given to public awareness programs (specifically targeted at farmers and the general population).

-No consideration was given the modification to the current water resource management laws and guidelines so that it considers the present and future conditions.

- Storage capacity of dams was taken as its designed and no consideration was given to the fact that these numbers are reduced due to sedimentation where some of these dams were operating since 1959.

In any case, the prevailing conditions that exist now in Iraq about water resources is an indicator of the failure of this strategy.

2.3. Deteriorating Water Quality

Studies including one of the ESCWA studies [32]-[40] have shown that the Euphrates River water at the Iraqi-Syrian border contains quantities of dissolved salts greater than what is permitted for drinking and agricultural purposes (Figure 7). The salinity increases southward to reach high levels in Nasiriyah. As for the Tigris River, the same study indicates that the percentage of dissolved salts becomes unacceptable for drinking and agriculture south of Baghdad.

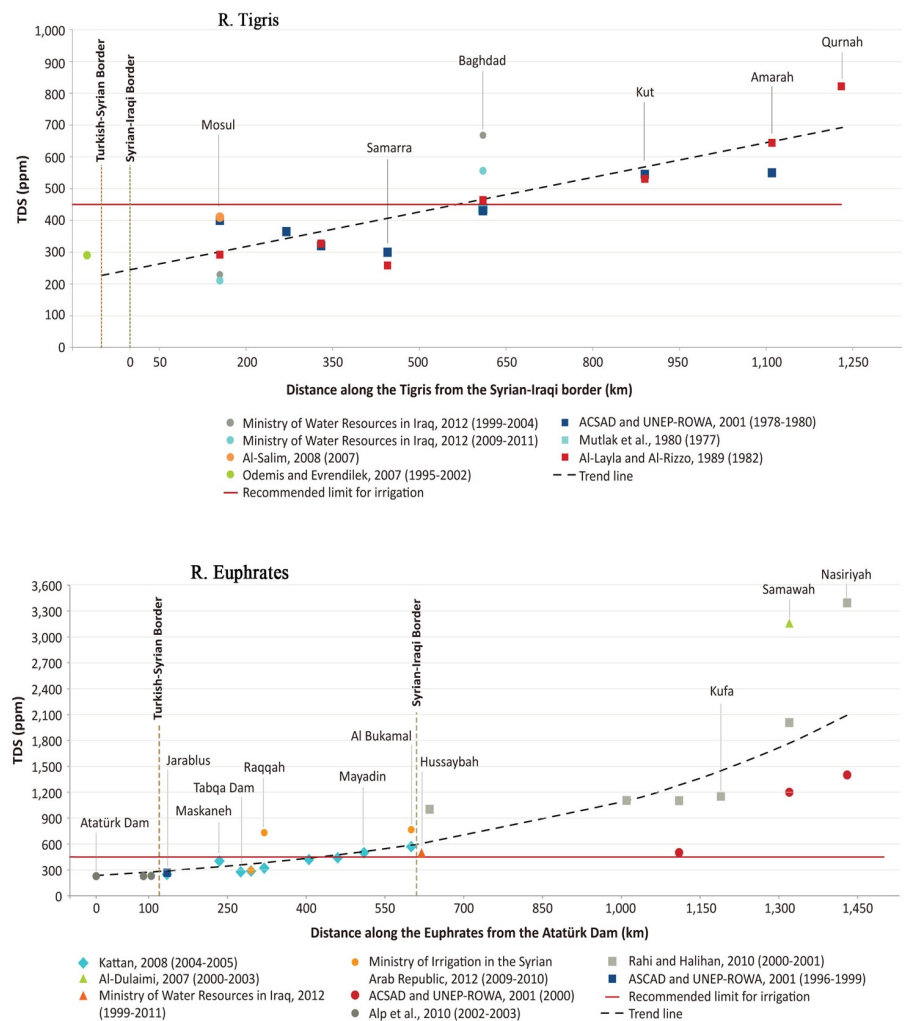


Figure 7. Water quality in the Tigris and Euphrates rivers [32].

Causes of water pollution are primarily the polluted water received from agricultural projects outside the borders of Iraq and the pollutants dumped into the rivers within its borders. These include very large quantities of wastewater that reach these rivers without treatment, untreated wastewater from factories, while existing wastewater treatment plants which only serve 25% of Iraq's population are not operating at full capacity. In the cities, the sewage networks have become worn out, causing this water to leak into the groundwater and ultimately into the rivers. In addition, polluted water from hospitals is pumped directly into the rivers without proper treatment.

2.4. Efficient Management of Water Resources for Irrigation Purposes

Evidence indicates that the efficiency of irrigation water management is very low in Iraq and does not keep pace with population growth which is accompanied by a shortage of water resources at the same time [9]. This is mainly due to a lack of irrigation networks maintenance or its absence at times, in addition to inefficient water distribution systems. It follows that no more than 30% of the available water reaches the fields. Vandalism and modifications of field outlets for the purpose of manipulating water quotas by farmers play one more reason for this decline. This reflects a clear weakness in management procedures and application of law leading to users at the inlets of canals acquiring quotas greater than theirs, while leaving the rest of the users suffering from water scarcity. One more factor causing this unhealthy situation is the uneven distribution of water due to improper leveling of the irrigated lands, which leads to some parts getting more than the allocated water share and others not getting the water needed.

It has been noticed also that there is a gap between supply and demand [41]-[43]. The water required is about 75 - 81 BCM [41], and the agricultural sector consumed 22 BCM in 2003/4 equivalent to 44 BCM of derived water assuming the irrigation efficiency is 50% while the real efficiency might be in the range of 25% - 35% [41]. The demand reaches 5 BCM for the sanitation sector and due to the fact, the infrastructure system is out of service, losses have increased. The total water demand reaches 73 BCM excluding restoring the marshes and the available is about 59 - 75 BCM. In case there is no change in the situation then water supplies to Iraq will drop to about 17.61 BCM by 2025 [43] and the demand will be 66.85 BCM [44] or 77 BCM [45].

In addition to the above, the imposed tariffs for irrigation water use are very nominal. This encourages users to underestimate the value of water which in fact is costing the state considerable amounts, and only means that reconsideration of these tariffs and their methods of collection should follow rational norms used in other countries of the world. Here it is necessary to stress the need to increase user awareness to rationalize water consumption.

2.5. Organizational Structures in the Water Resources Sector

(MOWR) or the Ministry of Water Resources is the responsible authority for

managing, preserving, maximizing water resources in Iraq in addition to monitoring their proper exploitation while there are also other ministries that are only water users. The Ministry of Agriculture is considered the main beneficiary and largest consumer of water, since water quantities required for agricultural purposes are estimated at approximately 85% of the total water consumed. This ministry is responsible for reducing wastage of water and rationalizing its use to overcome the scarcity problems and limiting land salinization, in addition to the necessity of managing the drainage process properly in reclaimed lands as well.

Similarly, the Ministry of Municipalities and Public Works is the responsible body for providing drinking water and treatment of sewage effluents and bringing their quality to the required international standards before pumping them back to the rivers to avoid their pollution. Other ministries that use water include the Ministry of Industry and the Ministry of Electricity on whose shoulders lays the responsibility of monitoring and treating the water they use before pumping it back to the rivers to prevent their pollution. Moreover, the Ministry of oil and its refineries have the obligation of doing the same as far as water used and/or waste. It remains for the Ministry of Environment to act as the guardian over the natural water resources quality and to cooperate with all water uses, whether in the public or private sectors, to preserve high standards of this quality.

It can be concluded that there must be strong coordination between the Ministry of Water Resources and the rest of the ministries in addition to all users in the private sector so that all those users bear the responsibility for preserving water quantity and quality.

The magnitude of the problems involved in this sector indicates the need for establishing one higher water council to better organize the relationships between all parties involved and solving conflicting issues. At the same time reorganization of (MOE) itself seems to be an absolute necessity at this time when water scarcity is being aggravated year after year.

3. Development Requirements

3.1. Iraq's Water Supply

Geographically, Iraq is located at the lower part of the Tigris and Euphrates River basins, and accordingly, the activities carried out by the riparian countries have a significant negative impact on the country in terms of the quantities and quality of incoming water [30]-[38]. The projects established in the riparian countries are well-known and much has been published about them. The construction of dams in these countries causes increasing water losses due to increased evaporation from their reservoirs, while the new extensive irrigation projects consume high percentage of the flows, as well as causing the deterioration of the quality of rivers waters since their drainage increases salinity in these rivers. The upstream riparian countries, Turkey, and Iran do not seem to pay serious attention to the problems they are causing for Iraq since they are located at

the upper side of the river's basins, especially so with the absence of binding agreement which regulates the common use of water between all parties involved and promote fair sharing of its resources. The present situation as far as Iraq is concerned dictates that its government make diligent efforts to conclude such an agreement. In our vision this agreement must be far-reaching and comprehensive and should include economic and commercial incentives for these two countries for better water resources sharing, otherwise they will not be interested in concluding any agreement with Iraq on the water issue alone. Experience of long negotiations between Iraq and these countries has proven this.

3.2. Distribution of Water Shares between the Governorates and the Kurdistan Region

The 2005 Iraqi Constitution stipulates that governorates are managed by local governments in addition to the autonomous Kurdistan region. Decentralized administration has caused many questions to arise about how to manage water resources between the governorates themselves and between the Kurdistan region and the rest of Iraq which requires immediate and serious work to establish the necessary frameworks for how to use this water. Determining water quotas for all parties involved is a vital issue, as in the absence of such frameworks has caused and will cause disagreements, conflicts, and problems.

3.3. Water Rationalization Policies and Increased Use Efficiency

3.3.1. Irrigation Networks

It is necessary to review seriously the present conditions of existing irrigation projects in terms of their needs for rehabilitation and maintenance so that they are restored to their designed state and improved. In these efforts closed water systems have to replace the present networks as far as possible to reduce water losses, re-level the land in agricultural units, replace field outlets so that they cannot be manipulated and better control water quantities, and expand the use of sprinkler and drip irrigation systems especially in orchards and vegetable farms. Water tariffs shall be increased to reflect the true economic value of water and limit wastage on one hand while providing the required capital for maintenance.

3.3.2. Non-Conventional Sources of Water

It is necessary to use methods of water harvesting and artificial recharge of groundwater. Research conducted in this field so far has proven that these methods can be used well in Iraq in areas where the conditions for implementing these projects are met [9]. Reusing wastewater for agricultural purposes can also save large quantities of water for irrigation. In addition to the above, there is a possibility of desalinating salty groundwater and drainage water and using it for agricultural purposes.

Such projects can provide large amounts of water for agricultural and industrial purposes, thus saving large amounts of water for human consumption.

3.3.3. Water Pricing

Many countries follow an increasing scale for water pricing, so the price of water increases as consumption increases [9]. In this regard, the current pricing of irrigation water must be fundamentally reconsidered, as is the case in many countries of the world. Ways of collecting these tariffs shall have to be reviewed and changed to avoid manipulation and corruption presently existing.

3.3.4. Agricultural Techniques

It is necessary for agricultural authorities to modernize irrigation techniques used at the moment to reduce water consumption [1]-[5] [7]-[9], in addition to developing cultivation plans that include the use of agricultural cycles that consume less water, choosing suitable varieties for such applications, and increasing agricultural intensity to make use of most of the soil moisture and raise the economic value of production, use of appropriate fertilizers and pesticides to have better yields.

3.3.5. Maintenance of Water Distribution Networks

The efficiency of the present water distribution networks is very poor (32%) [41]. Prior to the Gulf War in 1991, the water and sanitation services in Iraq were fairly robust. Access to potable water was 95 percent in urban areas with an average supply of about 330 liters per person per day in Baghdad and about 250 liters per person per day in other cities. Rural water coverage was 75 percent with an average supply of about 180 liters per person per day. Access to sanitary services was 75 percent in urban areas (25 percent connected to sewerage systems and 50 percent with on-site septic tanks) and 40 percent in rural areas [40]. Now, the situation deteriorated in both quality and quantity and 33% of the population does not have access to safe water and sanitation [42] [46]. According to Multiple Indicator Cluster Survey [44] about 79% (92% in urban and 57% in rural areas) of the population has access to drinking water. The presently available information indicates that 21% have no access to drinking water, and 16% have daily problems while 7% have weekly problems, 15% have less than weekly problems and only 41% have a reliable source [42]. According to the Iraqi Ministry of Municipalities and Public Work-IMMPW [47], the water demand is about 11 million cubic meters per day while the supply is half that amount.

The present distribution networks should be modernized to minimize the losses and as mentioned earlier, the irrigation and water demand networks are to be lined and covered.

3.4. Public Guidance and Awareness

Most countries of the world follow awareness and guidance programs for citizens in general on the importance of water and how to rationalize consumption [1]-[5] [7]-[9]. Such programs are usually started in primary schools with the participation of all audio-visual media to guide citizens to the best ways of rationalizing water consumption and preserving it.

3.5. Human Resources Development

To implement new irrigation techniques, training courses are to be given to farmers, engineers, and technical staff on these techniques so that they can use and employ them efficiently [7]-[9].

3.6. Requirement of New Legislation

Given that the constitution issued in 2005 did not address the issue of water in detail, and there is a contradiction between the constitution and the Ministry of Water Resources law, the national or federal water must be redefined as a national wealth whose ownership is shared by all Iraqis, whether in the Kurdistan region or in all the governorates, and that everyone must exploit it properly and preserve and maintain its best quality. Moreover, no unilateral action shall be allowed to be taken by any of these parties without the mutual consent and approval of all. The need therefore arises for the promulgation of a Federal Water Law, and all existing laws dealing with the water sector must be reviewed and new laws be issued that are consistent with the required changes [1]-[5] [7]-[9].

In this context to overcome the water shortage problem a long-term strategy is to be adopted. In such strategy the Iraqi Government should adopt two main lines as:

1) Negotiations with riparian countries: this should include the economic and security factors because the economy of the riparian countries highly depends on what Iraq imports from these countries. In addition, there are groups hostile to the authority of riparian countries present in Iraq and this is a very important issue for these countries. Therefore, the negotiations should include economy, security and water. In such case, Iraq might get what it requires for its water share.

2) Internal management planning should take into consideration all what is stated in section (6) above.

4. Expectations

Despite the large number of International and national organizations reports and what the news media has written on the future of Iraq in view of the water crises, no serious action has been taken so far. Examples taken from the reviewed literature [48]-[79] can be cited as follow:

-In 2006, the Undersecretary of the Ministry of Agriculture, Dr. Sobhi Al-Jumaili pointed out that 90% of the area of Iraq is inflicted by desertification to varying degrees due to bad human actions, wrong exploitation of the natural resources which causes salinization, water logging and damage to the soil.

-In 2011, the Director of the Environmental Awareness Department at the Ministry of Environment, Eng. Thaer Shafiq, confirmed that desertification had covered 70 percent of irrigated agricultural lands and about 72 percent of rainfed agricultural lands because of water scarcity due to climate change, and mismanagement in the water sector and constituting a threat factor to food security in

the country.

-According to a report by the Iraqi Ministry of Planning, the arable lands in Iraq amount to 28 million dunums, but the area used for agriculture did not exceed 11.5 million dunums of the total area. The Ministry of Water Resources decreased that area by 50% a few years ago due to water scarcity.

-United Nations statistics estimate that Iraq loses about 100,000 dunums of arable land annually, because of climate change that has occurred globally, including Iraq. Moreover, the overuse of soil, using the same agricultural methods and practices and irrigation system that causes soil salinization.

-In one of the UN reports, it was stated that in case the situation remains like what it is in Iraq and in case that Turkey, Iran and Syria implement all their hydrological projects, then The Tigris and Euphrates Rivers and their tributaries will be almost dry inside Iraq in the near future.

-According to International organizations reports:

21,314 people from 9 governorates in middle and south Iraq have left their homes due to water scarcity and bad water quality. During 2012, as an example, 20,000 farmers left their lands. According to UNESCO reports, 100,000 people in Kurdistan region left their villages due to water scarcity.

-Norwegian Refugee Council (an independent organization) indicated that more than 7 million citizens in Iraq are threatened by the loss of access to the Euphrates water.

-According to the Iraqi former president Dr. Barham Saleh he stated that 7 million will suffer from water scarcity and try to immigrate.

-UNICEF confirmed that “more than two million children and their families in Iraq will face a large household water deficit in 2030, if the required measures are not taken.”

-US National Intelligence Council recently said that:

11 countries around the world, including Iraq, will be vulnerable to geopolitical instability for reasons related to climate change, which will worsen more after. These countries are likely to face a large series of extreme climate events that pose threats to energy, food, water security and health.

5. Conclusion

Iraq at present is experiencing a water scarcity problem, which is due to climate change, hydrological projects in riparian countries as well and water mismanagement practices inside the country. This implies the necessity to design and apply prudent long-term water management plans. These plans should consider solving ongoing problems and future expected problems. It is believed that these plans should reconsider new policies and legislation to confront the problems. Further to this, the Ministry of Water Resources must be restructured to be able to implement the necessary policies and legislation. In addition, negotiations with riparian countries should include economic and security factors.

Conflicts of Interest

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

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