Toward Prudent management of Water Resources in Iraq

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ABSTRACT

In 1977 the Turkish Government started to utilize the water of Tigris and Euphrates Rivers through South-eastern Anatolia Project (GAP). The project includes 22 dams and 19 hydraulic power plants which are to irrigate 17 10^3 km^2 of land with a total storage capacity of 100 km^3 which is three times more than the overall capacity of Iraq and Syrian reservoirs Prior to 1990, Syria used to receive 21 km^3/year of the Euphrates water which dropped to 12km^3 in 2000 onward and for Iraq it dropped from 29 km^3 before 1990 to 4,4km^3 (90% reduction) now. This reduced agricultural land in both countries from 650 10^3 to 240 10^3 hectares. Iraq used to receive 20.9 km^3/year of water from the Tigris River and once Ilisu dam is constructed, this is likely to drop to 9.7 km^3 which means that 47% of the river flow will be depleted. This means that 696 10^3 hectares of agricultural land will be abandoned due to water scarcity. The reduction of flow in the Tigris and Euphrates Rivers in Iraq is considered to be national crises and will have severe negative consequences on health and on environmental, industrial and economic development. It is believed that the Iraqi Government should take solid and fast measures to ensure prudent management of its water resources and to secure the life of huge sector of its society and protect the environment.

***Keywords*: River Tigris, River Euphrates, GAP project, Mesopotamia, Iraq.**

1. Introduction

Scarcity of water resources in the Middle East represents an extremely important factor in the stability of the region and an integral element in its economical development and prosperity (Naff, 1993; Al-Ansari, 1998; Al-Ansari 2005). Future predictions suggest more severe shortages (Bazzaz, 1993; Al-Ansari et al, 1999).

Iraq was considered till 1970s as an exception relative to its neighboring countries due to the presence of Tigris and Euphrates rivers. Construction of dams by Syria and Turkey on the Euphrates and Tigris Rivers after that have highlighted a further concerns over future water quotas and its alarming implications upon the national security and strategies. Current conflict originates from disagreement over surface water rights and quotas. This problem has originated, in part, as a result of over ambitious development programs exercised by Turkey (in particular) in the region to attain self-sufficiency in agricultural products, generate electricity and achieve further political goals.

Most of these undertakings have failed to recognize its implications upon existing water resources (depletion, deterioration and its adverse environmental implications on land use). These programs, accentuated by population explosion, have driven Iraq into a national crisis.

The total area of Iraq is 438, 3 10^3 km^2 of which 924 km^2 (0, 2%) is inland water. It is surrounded by Iran from the east, Turkey to the north, Syria and Jordan to the west, Saudi Arabia and Kuwait to the south and the Gulf to the southeast as shown in Figure. 1.

The population is about 20.4 10^6 (1995) with a growth rate of 3.6% (1980-1990). This rate has dropped since 1989 due to severe economic hardship. About 25% of the inhabitants are living in rural areas. The population density ranges from 5 to 170 inhabitants/ km^2. The lower number is in western desert and the higher in the central part of the country.

Fig.1. Map of Iraq

The country is shaped like a basin, topographically containing the great Mesopotamian plan of the Tigris and Euphrates rivers. The climate is mainly of the continental, subtropical semi-arid type with the north and northeastern mountainous regions having a Mediterranean climate.

The temperature during summer is usually over 43^0 C during July and August and drops down to 16^0C and 20C during the day and night respectively in winter time. The average annual rainfall is 154 mm, but it ranges from less than 100mm over 60% of the country in the south up to 1200mm in the northeast. The rainy season is restricted to between October to April (Al-Ansari et al, 1981).

Rivers Tigris and Euphrates form the main water resources of Iraq. They join together in the south forming what is referred to as Shat Alarab which drains toward the Gulf (Fig. 1).The average annual flow of the Euphrates is estimated to about 30 km^3/year (951 m^3/sec) which might fluctuate from 10 to 40 km^3/year (317 to 1268 m^3/sec). The average annual flow of the Tigris River is 21.2 km^3/year (672 m^3/sec) when it enters Iraq. Its tributaries contribute with 24.78 km^3/year (786 m^3/sec) of water and there are about 7 km^3/year (222 m^3/sec) of water brought by small wadies from Iran which drains directly toward the marsh area in the south.

The total water withdrawal in Iraq is about 42.8 km^3/year (1357 m^3/sec) in 1990 which is used for agricultural (90%), domestic (4%) and industrial (6%) purposes (Al-Ansari, 1998 and 2005, Sadik and Barghouti, 1993). According to the recent estimates, 85% of the water withdrawal is used for agricultural purposes. It should be mentioned however, that safe water supplies reach 100% of the urban areas and only 54% of rural areas. The situation had deteriorated after the Gulf war for both water and sanitation sectors. Since Sumerian times (7500 years ago) the land between Tigris and Euphrates had been irrigated by the water from these rivers. The irrigation potential (requirement) is 63%, 35% and 2% for Tigris, Euphrates and Shat Alarab rivers respectively.

It is estimated that 11.5 10^6 hectares are cultivated which form 26% of the total area of Iraq. The area used for agriculture is 8 10^6 hectares which forms 70% of the cultivated area. Due to fallow practices and unstable political situation only 3 to 5 10^6 hectares are now actually cultivated annually. In 1993, it is believed that only 3.73 10^6 hectares were cultivated of which 3.46 and 0.27 10^6 hectares were consisted of annual and permanent crops respectively. Considering the soil resources, about 6 10^6 hectares are classified as excellent, good or moderately suitable for flood irrigation. With the development of water storage facilities, the regulated flow had increased and changed the irrigation potential significantly. Irrigation development depends into a large extent on the volume of water released upstream. Existing data estimates that the contribution from the agricultural sector is only 5% to gross domestic product (GDP) which in Iraq is usually dominated by oil (more than 60%). About 20% of the labor force is engaged in agriculture. The Iraqi water strategy is highly influenced by the Euphrates water as more than 90% of its flow comes from outside the country. While only 50% of the Tigris flow comes from Turkey. Iraq is supposed to receive 58% of the Euphrates flow, which crosses the Turkish- Syrian border, while Syria receives 42% according to mutual agreement between the two countries. Turkey promised in the past to secure minimum flow of 15.8km^3/year at its border which gives Iraq 9 km^3/year. Up to now there has been no agreement between the three countries concerning the Euphrates and Tigris water. Present estimates indicate that Iraq is receiving about 0.03 km^3/year of the Euphrates water only.

2. River Tigris

The total length of the River Tigris is about 1718 km. It rises in the southeastern parts of Turkey on the southern slopes of Touros mountain range. It drains an area of area of 473 10^3 km^2 which is shared by Turkey, Syria and Iraq as shown in Figure 2 and Table 1. About 58% of the basin lies in Iraq. Three major tributaries (Butman Su, Karzan and Razuk) join the Tigris before it enters the Turkish/Iraqi border. The mean annual flow of the river does not exceed 64 m^3/sec and it increases at Razuk to 413 m^3/sec.It enters Iraq at Fiesh Khabur where Khabur tributary joins the main river at a small distance to the south. The mean annual flow of Khabur is 68 m3/ sec. The River Tigris flow toward the south and reaches the first major city (Mosul). Its mean discharge at Mosul reaches 630 m3/ sec.

Table 1: Drainage area of the Tigris River basin.

Country	Catchment area (km^2)
Turkey	57614
Syria	834
Iraq	253000
Total	471606

Fig.2. Tigris and Euphrates Rivers

About 60 km south of Mosul, the Greater Zab River joins the Tigris. The confluence of the two rivers is situated midway between Mosul and Sharkat cities. This tributary drains an area of 25, 8 10^6 km^2 of which about 62% lies in Iraq. This tributary is one of the largest with a mean annual flow of 418 m^3/ sec.

Further south of Fatha, the Lesser Zab Tributary joins the Tigris. This tributary drains an area of 21, 5 10^6 km^2 (25% in Iran) with a mean annual flow of 227 m^3/sec, whiles the mean annual flow of the Tigris reaches 1340 m^3/sec after this confluence. South of Fatha, the Adhaim tributary joins the Tigris. This tributary drains an area of 13 10^6 km^2 and lies totally in Iraq (Al-Ansari et al, 1986 a). The mean annual flow of this river reaches 25.5 km^3. This tributary runs dry during June to November each year. Further to the south, the last major tributary, Diyala River joins the Tigris south of Baghdad. Diyala basin is 31, 8 10^3 km^2 of which about 20% lies in Iran. The mean daily flow of this tributary is 182 m^3/ sec.

No major tributary joins River Tigris south of Baghdad (Al-Ansari et al, 1986b and 1987). Few canals draw water from the Tigris in this region for irrigation purposes. For this reason the mean annual daily flow of the river falls below its value at Baghdad (1140 m^3/sec) in Kut and Amara cities at the south.

The Tigris River mean discharge at Mosul city prior to 1984 was 701 m^3/ sec and dropped to 596 m^3/ sec afterward as in Figure. 3. This implies that the river discharge had been decreased with 15%.

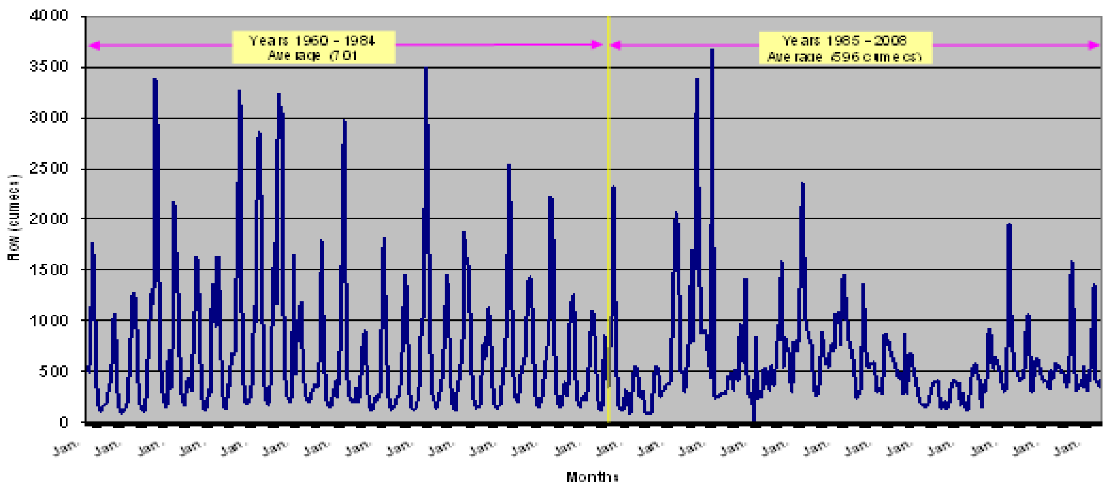

Fig.3. Water Discharge of River Tigris at Mosul City for the period 1960-2008.

3. River Euphrates

River Euphrates rises (2781 km long) like the River Tigris from the southeastern parts of Turkey (Fig. 2). It drains an area of 444 10^3 km^2 shared by four countries (Table 2). The Rivers Karah Su and Murad Su join together in the southeastern parts of Turkey at Kuban forming the River Euphrates. The River enters Syria at Jarablis where it runs 675 km and then enters Iraq. 30 kilometers south of Jarablis, Sajor tributary joins the Euphrates. Later, two tributaries, Balikh and Khabur, join the main river after which it enters the Iraqi border at Hasaibah. The mean daily discharge of the Euphrates River inside Iraq (at Hit) is 909 m^3/ sec (Al-Ansari et al 1981; Al-Ansari et al 1988).No tributary contributes to the river inside Iraq. The river supplies number of small tributaries in the central and southern parts of Iraq for irrigation purposes as in Figure 1.

During floods, some of its water is diverted to Habaniya reservoir which is situated about 40 km south of Ramadi (Fig. 5). Further to the south, (about 135 km south of Faluja) Hindiya barrage diverts a maximum discharge of 471.5 m^3/ sec to small parallel tributaries (Al-Sahaf, 1976).

Table 2: Drainage area of the Euphrates River basin

Country	Catchment area (km^2)
Turkey	125000
Syria	76000
Iraq	177000
Saudi Arabia	66000
Total	444000

The Euphrates channel south of Kifil is divided into two main channels (Kufa and Shamiya) and they join again at Mushkhab as illustrated in Figure 2.

Later, the channel splits again about 25 km south of Shanafiya and rejoins near Simawa. Then the river enters Hamar marsh, where it forms two main channels within Hamar marsh. One of the channels (northern) joins the Tigis River at Qurna forming what is known as Shat Alarab River while the other channel join Shat Alarab River at Karmat Ali.

The Euphrates River mean discharge at Hit and Haditha cities prior to 1972 was 967m^3/sec and dropped to 553 m^3/ sec after 1985 as shown in Figure 4. The percentage decrease in river discharge is thus 43%.

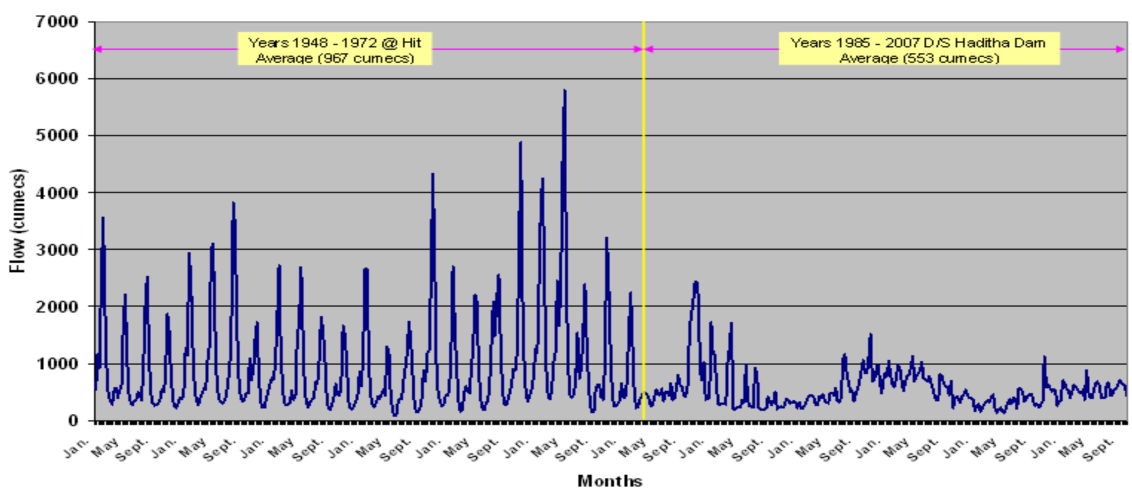

Fig.4.Water Discharge of River Euphrates at Hit and Haditha cities for the period 1948 2007.

4. River Shat Alarab

This river forms at Qurna where the Tigris and Euphrates Rivers join together. It flows to the gulf as shown in Figures. 1- 2). Its total length is 192 km and drains an area of 80, 8 10^3 km^2 and its annual discharge at Fao is 1116 m^3/sec.Two main tributaries (Suwaib and Karun) join the main course of the river. Most of the flow of these tributaries is halted by the Iranian water projects now.

5. Dams on the Tigris and Euphrates Rivers

A. Turkey: The idea of utilizing the water of Tigris and Euphrates Rivers started in the 1930s due to the need of electrical energy. Since then number of studies and investigations have been carried out. In 1977 the overall picture of the project was set and referred to as Southeastern Anatolia Project (GAP). This project covers an area in 9 administrative provinces (Adiyaman, Batman, Diyarbakir, Gaziantep.Kilu, Mardin, Siirt,Sanliurfa and Sirnak) in the Euphrates and Tigris basins (GAP, 2006).

The component of the project includes 22 dams and 19 hydraulic power plants which are supposed to irrigate 17 10^3 km^2 of land (Unver, 1997). The estimated time for the completion of the project is year 2010 (GAP, 2006; Olcay Unver, 1997) and due to financial, technical and political problems it has not been completed yet. The overall volume of water to be captured is about 100 km^3 which is three times more than the overall capacity of Iraq and Syrian reservoirs. Some of the dams have been constructed while others are either under construction or to be constructed at a later stage (Table 3). The Turkish Government considers GAP as a multi integrated regional development project (GAP, 2006). The project is supposed to develop the southeastern provinces which cover 9.7% of the total area of Turkey and forms 20% of the agricultural land of the country. Furthermore, it is to produce annual energy which reaches 27 TWh. The government claims that the project will raise the standard of living of the locals within the vicinity of the project.

Table 3: Dams of GAP project in Turkey

River Basin	Name of the Dam	Year of completion	River Basin	Name of the Dam	Year of completion
Euphrates	Ataturk	1992	Tigris	Batman	1998
	Birecik	2000		Dicle	1997
	Camgazi	1998		Kralkizi	1997
	Hancagrz	1988		Cizre	Suggested
	Karakaya	1987		Garzan	Suggested
	Karkamis	1999		Kayser	Suggested
	Buykcay	Suggested		Ilsu	Under construction
	Catallepe	Suggested		Silvan	Suggested
	Gomikan	Suggested			
	Kahta	Suggested			
	Kayacik	Suggested			
	Kemlin	Suggested			
	Koeali	Suggested			
	Sirmtas	Suggested			

Despite the continuous declarations from the Turkish Government that GAP is purely a development project, it seems that there are number of internal and external goals involved as well (Waterbury, 1993; Alsowdani, 2005; Shams, 2006; Alnajaf, 2009; National Defense Magazine, 2009).

B. Syria: The water of the Rivers Euphrates, Alkhabur and Alasy form 82%, 5% and 1.8% of Syria water resources respectively (Ministry of Irrigation Syria, 2009 and VB Syria, 2009).Until year 2000 three main dams have been constructed on the Euphrates in Syria with a total storage capacity of 16.1 km^3 as shown in Table 4. The construction of these dams is for the purpose of both irrigation and electricity generation.

Table 4: Dams of the River Euphrates in Syria

Dam	Storage capacity (km^3)	Year of Operation
Forat	14.163	1978
Baath	0.09	1989
Teshreen	1.883	2000
Total	16.135	

C. Iraq: The idea of building dams in Iraq started in the first half of the twentieth century. Primarily it was to protect Baghdad, the capital, and other major cities from flooding. The first big dam (Dokan) was constructed in 1959 on the Lesser Zab River.

Later, dams were constructed for irrigation and power generation purposes (Table 5 and Fig. 5) (General Commission for Dams and Reservoirs, 2009 and Iraqi Parliament, 2009). The Iraqi Government realized the process of building dams should be speeded up due the huge increase of water demand and the threat of halting water of the rivers by Turkey and Syria. The process stopped in the 1990s due to the second Gulf war and UN sanctions. None of these dams have been filled to its maximum storage capacity until year 2010. This is due to the depletion of flow in the Euphrates and Tigris Rivers by the Turkish and Syrian dams. It is noteworthy to mention that Haditha dam is almost of no use today due to the severe depletion of the flow in Euphrates. In addition there were few concerning and worrying circumstances with some of the existing dams like Derbendikhan and Mosul dams. Mosul dam was built on highly soluble, fractured and jointed gypsum beds (Al-Ansari et al, 1992; Al-Ansari et al 1993) which left this dam in a highly risky condition and in a state of being close to a complete collapse (Muir, 2007). Another reservoir with mall function is the Darbandikhan reservoir, where huge masses of rocks have slided down into the reservoir and towards the dam. Accordingly the water level in this reservoir has been kept high to ensure the stability of the sliding rock masses.

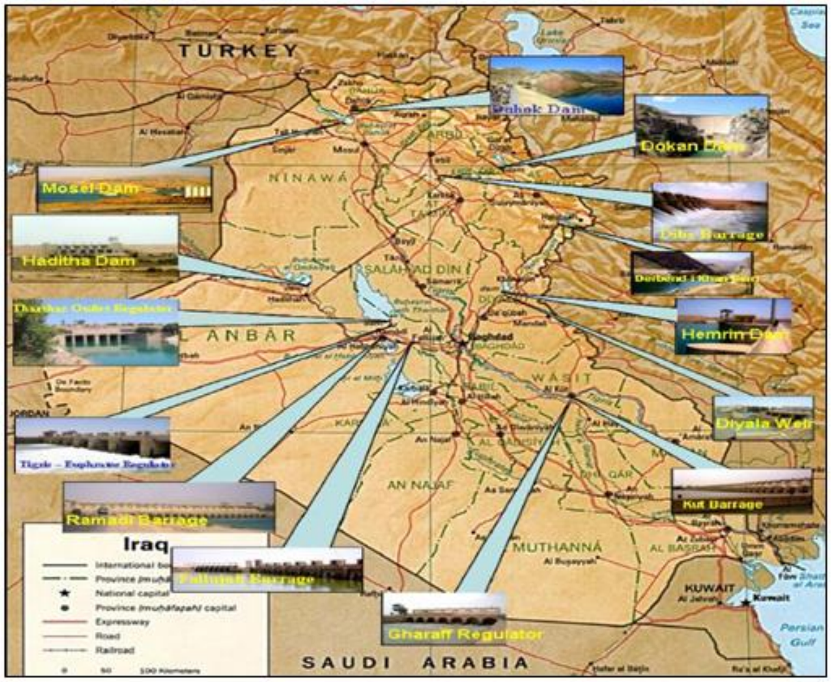

Fig.5. Water projects in Iraq

Table 5: Dams of the Rivers Tigris and Euphrates basins in Iraq

River Basin	River	Dam	Reservoir Capacity (km^3)	Year of Construction
Tigris	Lesser Zab	Dokan	6.8	1959
Tigris	Diyala	Darbandikhan	2.8	1961
Tigris	Diyala	Hemrin	2.4	1981
Tigris	Tigris	Al-Mosul	11.11	1986
Tigris	Robardo	Dohuk	0.475	1988
Tigris	Udhaim	Al-Udhaim	1.5	1999
Euphrates	Euphrates	Haditha	8.28	1986
Tigris	Greater Zab	Bakhma	17	Partially Constructed
Tigris	Tigris	Badoush	10	Partially Constructed
Euphrates	Euphrates	Al-Baghdadi	0.499	Partially Constructed

In view of the above, the Iraqi Government started in 1990 a big campaign to build two huge dams (Bakhma and Badoush), with a total storage capacity of about 27.5 km^3 as illustrated in Table 5, to overcome the water demand problem and to minimize the effect of a potential collapse of the Mosul dam.

However, the construction of these dams stopped due to Iraq-Kuwait conflict. It should be mentioned however, that the flow of the River Euphrates was highly reduced due to the impounding of Forat reservoir in Syria during the 1970s. To overcome these conditions, a canal was constructed to pass excess water from the Tigris River to the Euphrates River to maintain the life of inhabitants in the central and lower reaches of the Euphrates basin. Later in 1976 it was agreed that the Syrians should release at least 500 m^3/sec of water at the Iraqi border.

6. Effect of GAP on Water Resources in Iraq

The Gap project has been designed to irrigate 1.82 10^6 hectares (GAP, 2006), and that means that the required water for irrigation is about 29 km^3 while the reservoirs of the project stores 100 km^3. As far as the Euphrates River is concerned, the Turkish, Syrian and Iraqi water requirements are 15.7, 11 and 13 km^3 respectively to irrigate all the cultivated lands of today. It should be mentioned that other authors have cited different Fig.s for the water requirement for Turkey, Syria (7.95 km^3) and Iraq (19 km^3) (Kamona, 2003).

When all the GAP dams are constructed then 80% of the Euphrates water will be controlled by Turkey (Beaumont, 1995; Alyaseri, 2009; Robertson, 2009). Prior to 1990, Syria used to receive 21 km^3/year of the Euphrates water which dropped to 12 km^3/ year in 2000 onward (40% reduction). As far as Iraq is concerned, the volume of the water received dropped from 29 km^3 before 1990 (Mageed, 1993) to 4,4 km^3 (90% reduction) today.

This fact has reduced the agricultural used land in both countries from 650 10^3 hectares to 240 10^3 hectares being a reduction with 63%. In addition, the quality of water deteriorated due to back water irrigation directed toward the main channel in its upstream reaches.

Iraq used to receive 20.9 km^3/year of water from the Tigris River and once Ilisu dam is constructed this is likely to drop to 9.7 km^3/ year (Alalaf, 2009). It implies that 47% of the river flow will be depleted. This means that 696 10^3 hectares of agricultural land will be abandoned due to water scarcity.

The overall Turkish water supplies reach 195 km^3/year while the demand does not exceed 15.6 km^3/year (Kamona, 2009). If we consider the existing population growth rate in Turkey, then its population will be 91 million in 2025 and the corresponding demand will then reach 26.28 km^3/ year. This fact had been reflected on the Turkish Government policy where it has offered an export of 500 10^6 $m^3$of water/year to Israel (Kamona, 2003).

The fact that Turkey can exert virtual control over the water of the Tigris and Euphrates Rivers is of vital concern to Iraq which depends on these two rivers for much of its water supply. The collapse of water levels in the rivers had been swift where it dropped in the Euphrates from 950 m^3/ sec before 2005 to less than 230 m^3/sec now (Economic view of the Middle East and the world, 2009). We can summarize the consequences of this shift as follows:

a) Large parts of Iraq turned to arid desert while used to be productive farm land. Formal officials claim that 40 to 50% of what was agricultural land in 1970s now is desert land.
b) Fishermen and farmers have been driven from their land and consequently they are trying to settle in towns to find jobs in order to survive (Alyaseri, 2009).
c) The drop of water quantity has led to a reduction of the water quality and due to this pollutions have reached very high levels of concentrations (1800mg/L) especially in the southern parts of Iraq. Centuries of irrigation without draining in addition to bad water quality have speeded up salinization of the soil. As a consequence, the central and

southern parts of Iraq, which were highly productive in the past, have become barren. In addition, the drop of water level in Shat Alarab River will have very negative effects on fish and to other animals living in low saline water environment. It is expected that large number of species will be eradicated. The effect seems to be of regional nature where it was noticed in Kuwait (Al-Yamani et al, 2007).

d) Iraq is importing all its food now (Robertson, 2009, Cockburn, 2009) .The country was one of the few regional cereal exporting countries in the region in the past. Now it is evident from food shops in Baghdad (for example) that every thing is imported apart from dates, which implies that the agricultural outcome is disastrous Robertson, 2009, Cockburn, 2009 .
e) The reduction of agricultural land has been clearly noticed this year where huge and intensive dust storms have taken place. Furthermore, it is believed that due to farm reduction, climatic changes have been noticed and higher temperatures are to be expected and consequently regional environmental effects will show.
f) It is expected that ground water levels will drop further down due to the reduction of infiltrated water from the rivers.. The area of the big marshes is about 10 10^3 km^2 which needs at least 2 km^3/year (64 m^3/sec) to overcome evaporation if it is to be maintained. In addition, the drastic drop of water levels in the rivers especially in southern Iraq affected the reptiles' natural habitat among the reed beds. Cockburn (2009) reported that people are terrified in places where huge numbers of snakes are attacking people as well as buffalo and cattle.
g) The effect of water depletion has already extended to include the hydroelectric stations. The power plants at Haditha dam is almost not working due to shortage of water. It is also expected that the same situation will be noticed at Mosul dam and Sammarah barrage once Ilisu dam is in operation. This will have tremendous effects on electricity supply (which is already suffering from number of problems) and will have its severe consequences on irrigation and industrial projects. Further, it is likely that the electricity demands will be covered by the use of oil heated power plants thus increasing emission of green-house gases like carbon dioxide.

7. Possible Solutions

The depletion of flow of the Tigris and Euphrates Rivers in Iraq is considered to be national crises in Iraq. Number of officials and all the news media are highlighting this crisis. The Iraqi government has more prior and challenging things to address like terrorism, administrative, financial and political corruption, restoring electricity, water and waste water systems etc. Serious negotiations between Turkey, Syria and Iraq should take place to solve the described problem.

In view of the above and despite the outcome of negotiations between the countries concerned, it is believed that the Iraqi Government should take serious measures for prudent management strategy toward its water resources. These measures should include:

a) Maintenance of existing dams and irrigation schemes to make sure that they are properly and efficiently active.
b) Partially built dams should be completed and measures are to be taken to build the suggested dams and irrigation projects. This will increase the storage capacity of dams with about $27km^3$.
c) It is of prime importance to restore the waste water treatment systems and install such systems wherever required. Treated waste water can be used for irrigation purposes and this will minimize water demand by about 5 to 8 %.
d) Old water supply and distribution systems should be maintained properly and rehabilitated due to the fact that the systems are old and as a consequence the water loses within these systems are very high.
e) New techniques are to be used in irrigation in order to reduce irrigation losses (e.g. drip and sprinkler irrigation techniques). Present techniques consume large quantities of water due to both evaporation and infiltration. In addition, present practices enhance soil salinity.
f) Non conventional methods to augments water recourses are to be used. We believe that water harvesting techniques can be very effective and are relatively cheap and cost effective.
g) Drainage systems and canals are to be maintained and restored to decrease soil salinity and to increase land productivity. In addition all existing drainage systems should be diverted so that it will not discharge its water in the Euphrates/Tigris Rivers causing deterioration of water quality.
h) Iraq Ministry of Water Resources should rearrange its agenda for the priorities of its projects and concentrate on the central and southern parts of Iraq. These regions being more or less neglected by the ministry are highly effected regions due to the present hydrological conditions. In addition, prudent scientific water management strategy should be put in practice. Experts and scientists should put the outlines of such strategies and not the politicians and contractors having close relationships with top management.
i) Iraqi Ministry of Agriculture should closely cooperate with the Ministry of Water Resources to join efforts in establishing prudent agricultural strategy to enhance farmers to grow less water consuming products.
j) The Iraqi Government should seriously set public awareness program about water scarcity. This program should address all sectors of the society and it has to be included in the students educational programs at all levels.
k) Iraq Governmental organizations and NGOs should highlight the negative aspects of the GAP project on the life of people and on the environment in Iraq with severe consequences on the health of the people. This can be achieved through international and regional organizations. They should also approach Turkish NGOs and the contractors working on the GAP project in order to explain to them the effect and consequences of the project. Further, the effects on the health of the people and on the environment both in

Iraq and Turkey should be highlighted. As a consequence of this, Swedish and other companies have withdrawn their work in the project due to its implications on the environment.

l) Purely scientific institute is to be established to execute studies and research programs concerning water resources and agricultural practices suitable to local climatological, hydrological and environmental conditions of the country. Such institute should closely cooperates with similar international institutes, universities and organizations to achieve the following goals:

   i. Execute research to import new technologies in water resources and agriculture which suites Iraqi environment.
   ii. Carry out training programs for technicians, engineers and decision makers about modern technologies.
   iii. Establish a comprehensive data bank which includes reliable climatological, hydrological, geological, environmental and soil data to be used by researchers and decision makers.
   iv. Execute pioneer projects which help in augmenting water resources, developing land productivity, minimizing water use and consumption.
   v. Setting the outlines of public awareness programs both for water use and for agricultural activities.
   vi. Giving advice to universities and institutes to set special courses in arid region hydrology.

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