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IDENTIFYING FACTORS AFFECTING WATER RESOURCES OF IRAQ BY APPLICATION OF KNOWLEDGE DISCOVERY IN DATABASES

Angham E. Ali Al-Saffar

University of Baghdad, College of Engineering, Civil Engineering Department

E mail: anghamalsaffar@yahoo.com

Ahmed Zghair Jaber Al-Joboury

University of Al-Qadisiyah, College of Engineering, Civil Engineering Department

E mail:ahmed.jaber@qu.edu.iq

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***Abstract**: This study is concerning in recognizing and defining the factors affected on water resources in Iraq, by application of knowledge discovery in database (KDD) techniques, KDD is a useful technique to discover the underlying concepts and unusual knowledge and that were not previously known from databases through a systematic process. There are lot software package usages with (KDD), while in this paper (Microsoft Excel) was used, since it is availableness and Easygoingness. Many factors are detected which have an impact on water resources in Iraq. External factors have not controlled by Iraq management such as water policies of riparian countries and climate factors (natural) while internal factors are under Iraqi control such as irrigation methods and losses. Some of these factors affected on quantity or quality or both. Finally a successive management shall take care all these factors.*

Keywords: KDD, water resources in Iraq, Climate factors, Population growth rate, Water losses, Daily water consumption, Population growth rate

INTRODUCTION

This Water plays important roles in the life of the community, as it needs to sustain life directly by using it for drinking and in making its own food, and indirectly, as in agriculture, industry, power generation, health and other services. Investigation of various factors affecting water resources was the main task for researchers because shortage and the degradation of water quality at last 10 years ago. So many researchers were studied factors have an influence on water quality and quantity, where (Jim 2002) demonstrated that freshwater resources will be subject to enormous pressures in the near future due to population growth. The most acute pressures will be in developing countries where water is scarce and population growth is high. (Ilyas 2009) concludes that extremely difficult facing water supply for all sectors' demands especially for dry years now and in the future because climate changes, high inconsistency of stream flows, continuing planning of development and land use. (Mohammed 2011) studied Verde River Watershed in Arizona, USA, through developing and applying a group of scenarios. In this exercise, three dimensions extremes were identified: climate change, demographics, and the economy. (Dawadi 2013)

stated the climate variability and the rapid population growth were considered as major challenges of the water sustainability in the Las Vegas Valley in southern Nevada,USA. (AL-Washali 2011) found that volume of quantity of non-revenue water in Sana'a water distribution system made up 38.75% of system input volume, While in Iraq (Al-Ansari 2013) & (Al-Ansari et al.2015) have pointed out that the factors affecting water in Iraq are divided into regional and local, regional including climate change and the Cape project in Turkey, while local factors include demand, distribution and drinking water systems. Since, none of the previous researchers have discussed the factors affecting water resources in Iraq in a comprehensive manner, so this study trying to do

1. KNOWLEDGE DISCOVERY IN DATABASES (KDD)

Knowledge discovery in databases (KDD) means to discover the underlying concepts and unusual knowledge and that were not previously known from databases through a systematic process consisting of a number of stages(Dunham 2003). KDD is not an easy process, which depends upon the data collection and management; Figure (1). It also extends to the analysis, expectation, and prediction of what will happen in the future (Fayyad et al. 1996).

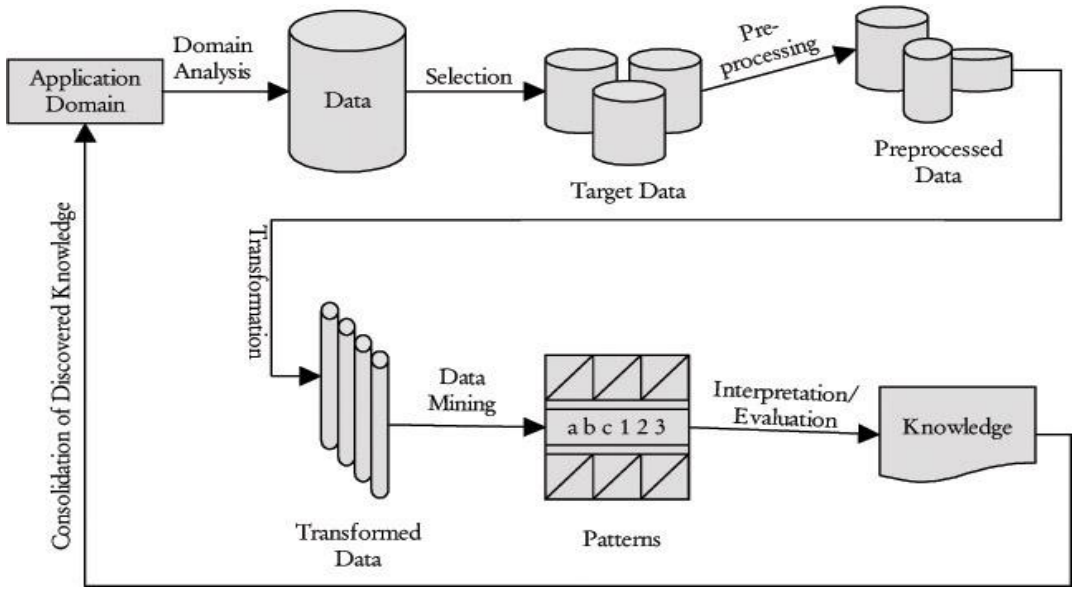

Figure (1): The process of knowledge discovery in databases (Fayyad et al., 1996)

The (KDD) process includes many phases such as Data Discovery, Data cleaning, Data Integration, Data Selection, Data Transformation, Data mining, Pattern evaluation, and Knowledge presentation (Ibrahim et al. 2013). While the final stage of knowledge discovery in databases is deems the beneficiary. This stage uses basic visual method to assist the beneficiary in understanding and interpreting the results of data mining (Tsui et al. 2005).

KDD is applied in many fields, especially in the field of management. It is applied in Developing and the creating brief reports for a specific topic (Fayyad et al.1997).The analysis of the general behaviour of the data (Tuzhilin et al. 1996). To determine a particular characteristic this is similar in all data (Ibrahim et al. 2013). Finding a particular model for data analysis (Klemettinen 1999). Comparing strategies with each other to determine the most effective and influential relationship, Finding aggregate relationships (Ibrahim et al. 2013).

In this study, the knowledge discovery technique is used to find and define the relationship between Iraqi water resources and factors affecting these resources. Data were collected for Iraqi water resources from the following entities: -

- The Ministry of Water Resources(MoWR).

Vol. 10 , No. 3
ISSN: 1998-4456

- The Ministry of Agriculture(MoA).
- The Ministry of Environment(MoE)
- The Ministry of Municipalities and Public Works(MoMPW).
- The Ministry of Planning / Central Statistical Organization(MoP/CSO)
- The Ministry of Health(MoH).
- The Ministry of Transportation(MoT).
- The Ministry of Industry(MoI).
- Directorate of Water Resources of Al-Qadisiyah province.
- Environment Directorate of Al-Qadisiyah province.
- Directorate of Agriculture of Al-Qadisiyah province.
- Directorate of water of Al-Qadisiyah province.
- Directorate of sewage of Al-Qadisiyah province.

2. FACTORS AFFECTING WATER RESOURCES

Water resources are usually affected by many factors. Some of these factors affect the quality and others affect the quantity while some have effects on both quality and quantity.

2.1. WATER POLICIES OF RIPARIAN COUNTRIES

Most Iraqi surface water sources are running from neighboring countries such as Turkey and Iran, or pass through, such as Syria. Figure (2) shows the participation rates of these countries of water incoming to Iraq and the distance traveled by the water river through those countries. Thus, effects of water policies and projects implemented by those countries on the water supply to Iraq are shown in Figures (3) and (4) which illustrate the decrease in the rate of supply of the Euphrates and Tigris rivers, respectively. These projects have had the effects of decreasing water supplies entering Iraq. As obvious, the shortfall in supply of the Tigris River is small compared to the supply shortage of the Euphrates River. This is caused by the large number of dams built on the Euphrates River basins compared to the Tigris River as shown in Figures (5) and (6) which show storage capacity and location of those projects.

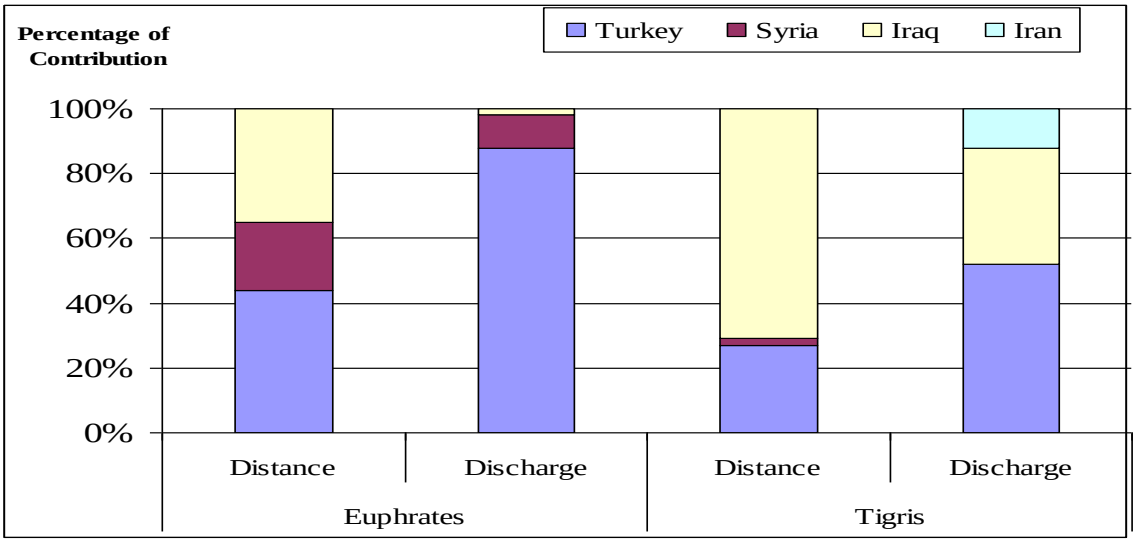

Figure (2): Percentages of riparian States contribution in distance and waters of Tigris and Euphrates rivers. ((MoWR, 2015) data/Researcher)

AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES
Vol. 10 , No. 3
ISSN: 1998-4456

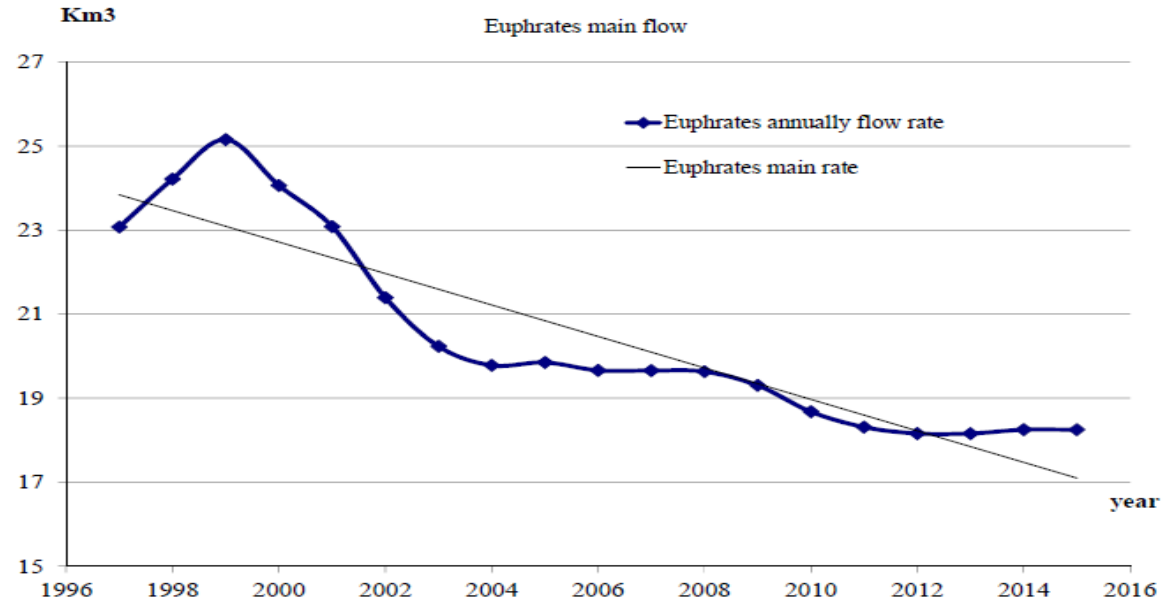

Figure (3): Decrease in the overall rate of Euphrates River supply ((MoWR, 2015) Data/Researcher)

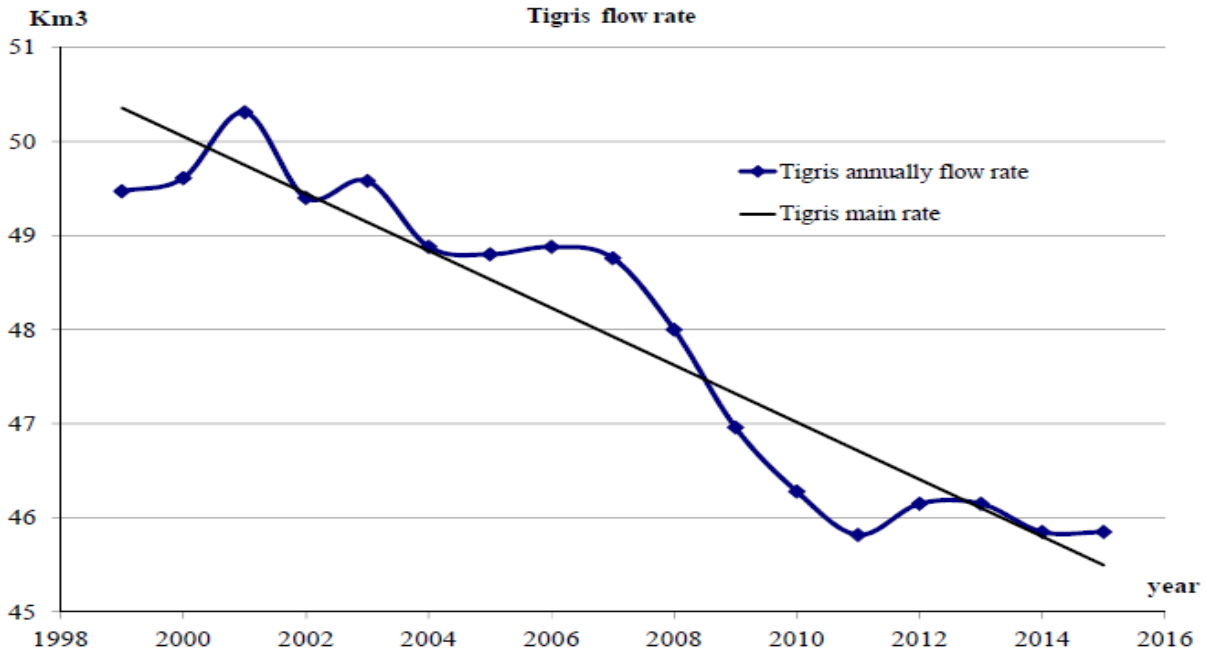

Figure (4): Decrease in the overall rate for the supply of the Tigris River ((MoWR, 2015) Data/Researcher)

AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES

Vol. 10 , No. 3
ISSN: 1998-4456

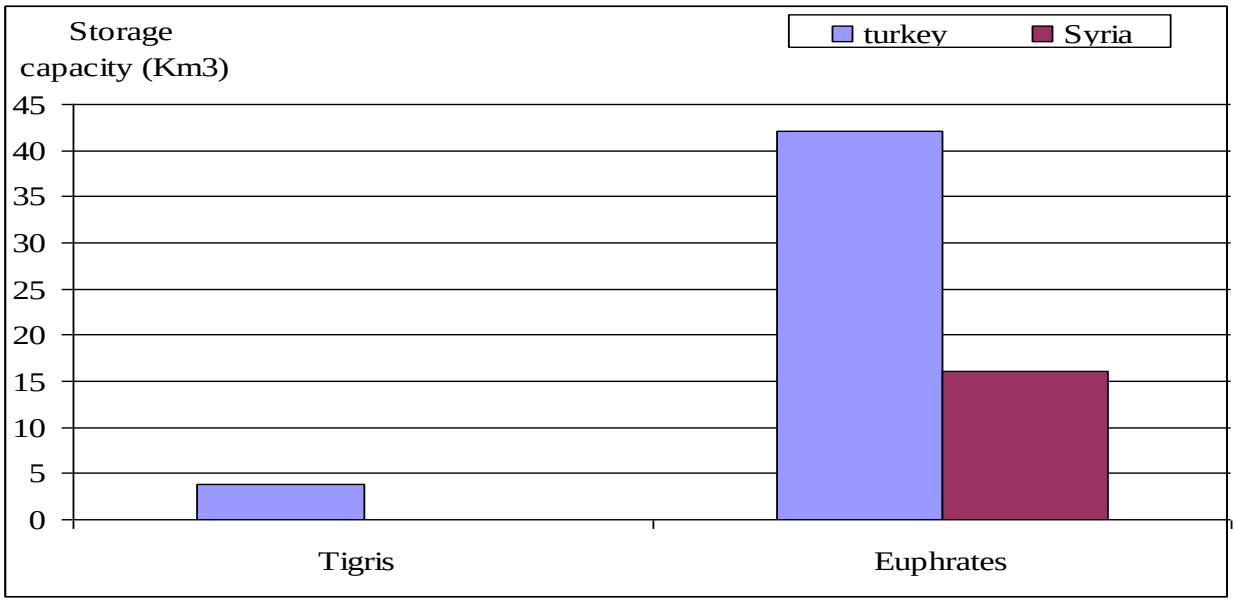

Figure (5): Storage capacity of the storage projects built on the Tigris and Euphrates rivers in riparian States. ((MoWR, 2015)Data/Researcher)

Figure (6): Map of locations of dams and control projects on the Tigris and Euphrates basins in the riparian countries (MoWR, 2013)

Vol. 10 , No. 3
ISSN: 1998-4456

In addition, the riparian countries at the top of the river basin (as mentioned previously) have effects on water quality as a resultant of establishment of dam projects, and agricultural projects. These projects lead to high concentrations of dissolved salts (TDS) in the water. On the other hand, those projects cause a major reduction in Iraqi water share and that leads to high concentrations of dissolved salts in the water. Table (1) shows concentrations of total dissolved salts in the water of the Euphrates River during the period (1925-1973) compared to the period (1975-1998)(Al-Hadithi 1978), (Parton 2001), a period that followed the establishment of Keban and the Al-Tabaqa dams in the upper river basin.

Table (1): Mean annual TDS within Euphrates River in Iraqi border before and after the construction of Keban and the Al-Tabaqa dams (Al-Hadithi 1978; Parton 2001)

Station	TDS (ppm)	
	period (1975-1998)	period(1924-1973)
Al Qaim	1000	467

2.2. CLIMATE FACTORS (NATURAL)

Many changes happen in the climate and atmosphere of the earth and these changes are due to high concentrations of carbon dioxide and other greenhouse gases. The temperature of land and oceans has raised by (0.5) degrees Celsius in the last fifty years (FAO 2013), while the temperature in Iraq has raised by average 1.5 ° C as shown in Figure (7).

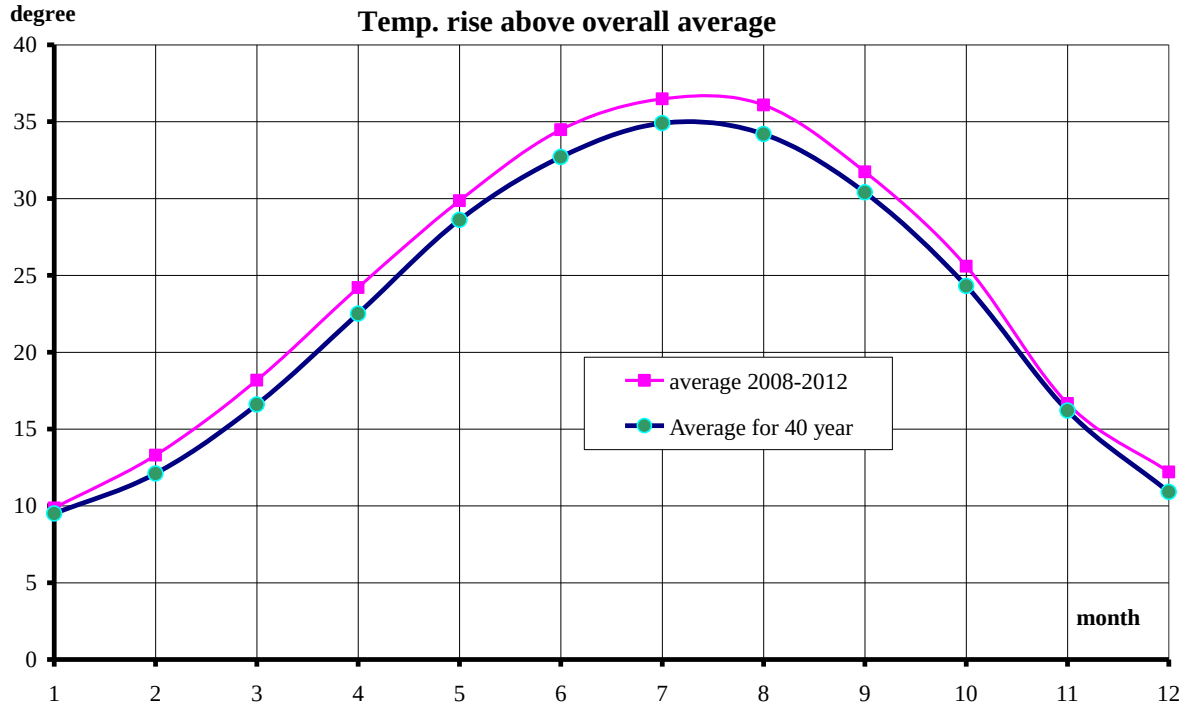

Figure (7): Temperature rise over Iraq above overall average ((MoT, 2013) data/ Researcher)

AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES

Vol. 10 , No. 3
ISSN: 1998-4456

Among the most prominent repercussions of global warming is the high annual rate of evaporation (due to high temperatures and low relative humidity). These are observed especially in arid, semi-arid, and sub-humid areas, including Iraq and the headwaters of Euphrates and Tigris rivers. Figure (8) shows lower rates of relative humidity in Iraq. It also results in a significant decrease for rainfall as shown in Figure (9). The lack of rates of falling rain compared to rates of evaporation from reservoirs and waterways, as shown in Figure (10), regarding the main reason for the decrease of water resources in Iraq. In addition, there are an impact of weather conditions and climate on water quality through high temperatures and low relative humidity and rain, which cause high rates of evaporation, which leads to high concentrations of salts particularly in water reservoirs

2.3. FACTORS AFFECTING THE MUNICIPAL DEMAND

They represent the factors that cause the increase in demand for water used by the population for domestic use such as preparing food, drinking, bathing, and others. The amounts of water necessary for these activities are usually different from state to state. In Iraq, these amounts are determined for the purposes of the designs and calculations by the Directorate General of Water / Ministry of Municipalities and Public Works up to 300 liters per person per day. (CSO 2013) Therefore, the affecting factors on demand for municipal are:

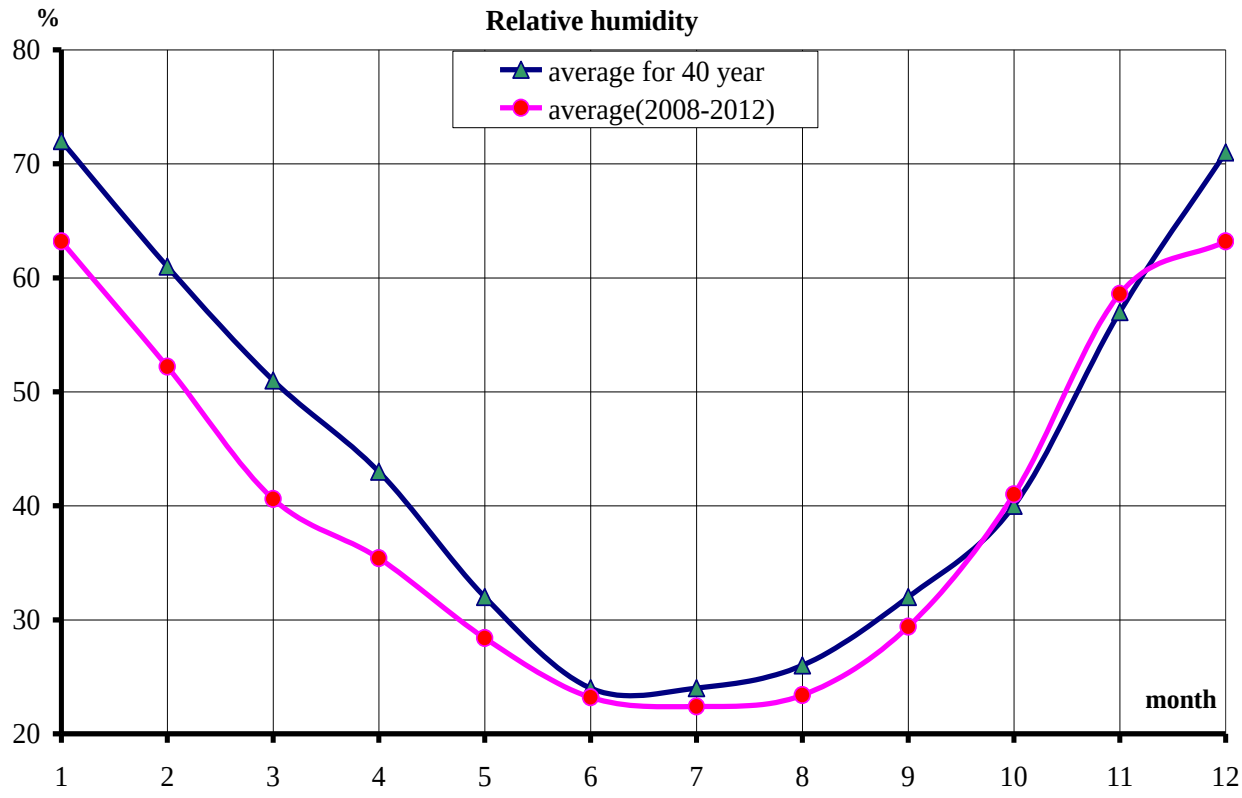

Figure (8): Decrease relative humidity below overall average over Iraq ((MoT, 2013) data/ Researcher)

AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES

Vol. 10 , No. 3
ISSN: 1998-4456

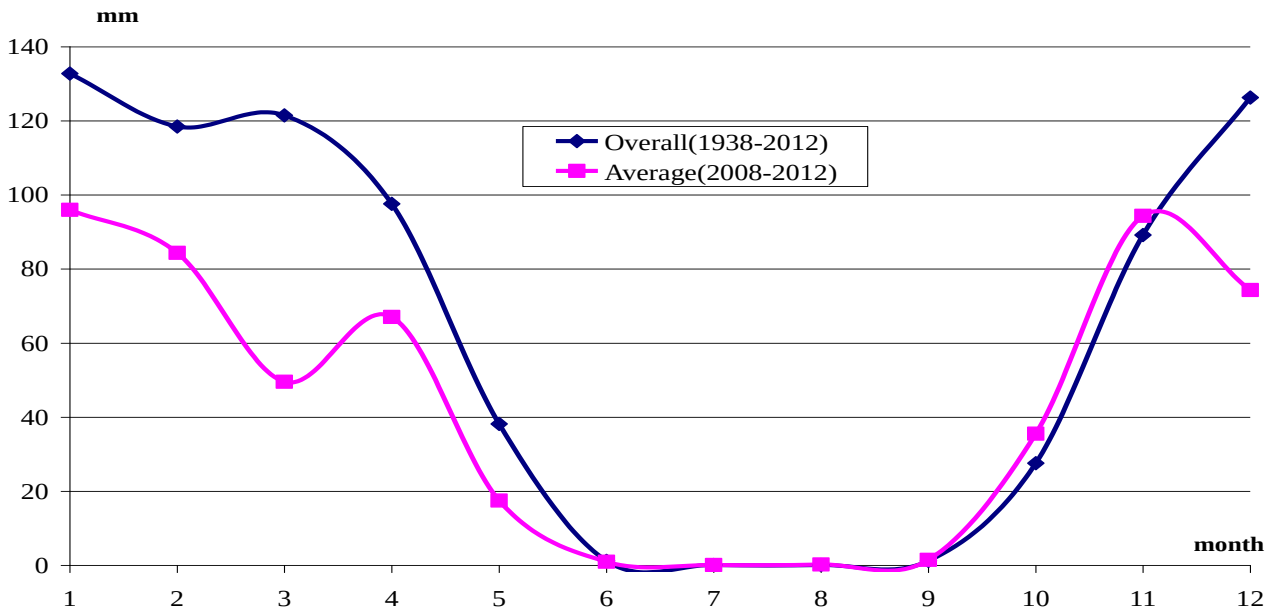

Figure (9): Decrease precipitation below overall average over Iraq ((MoT, 2013) data/ Researcher)

Figure (10): Losses in volume due to evaporation in Iraqi dames ((MoWR, 2015) data/ Researcher)

Vol. 10 , No. 3
ISSN: 1998-4456

2.3.1. Population growth rate.

The control of growth rate is directly reflected on quota per capita of water share. The international organizations assume (1000 m3 per person per year) (FAO 2013) for water scarcity, where water scarcity represent the lowest amount of quota per capita of annual revenue of water for drinking, hygiene, agriculture, industry and municipal services and meet all their needs. Figure (11) shows the decreasing quota per capita of these supplies.

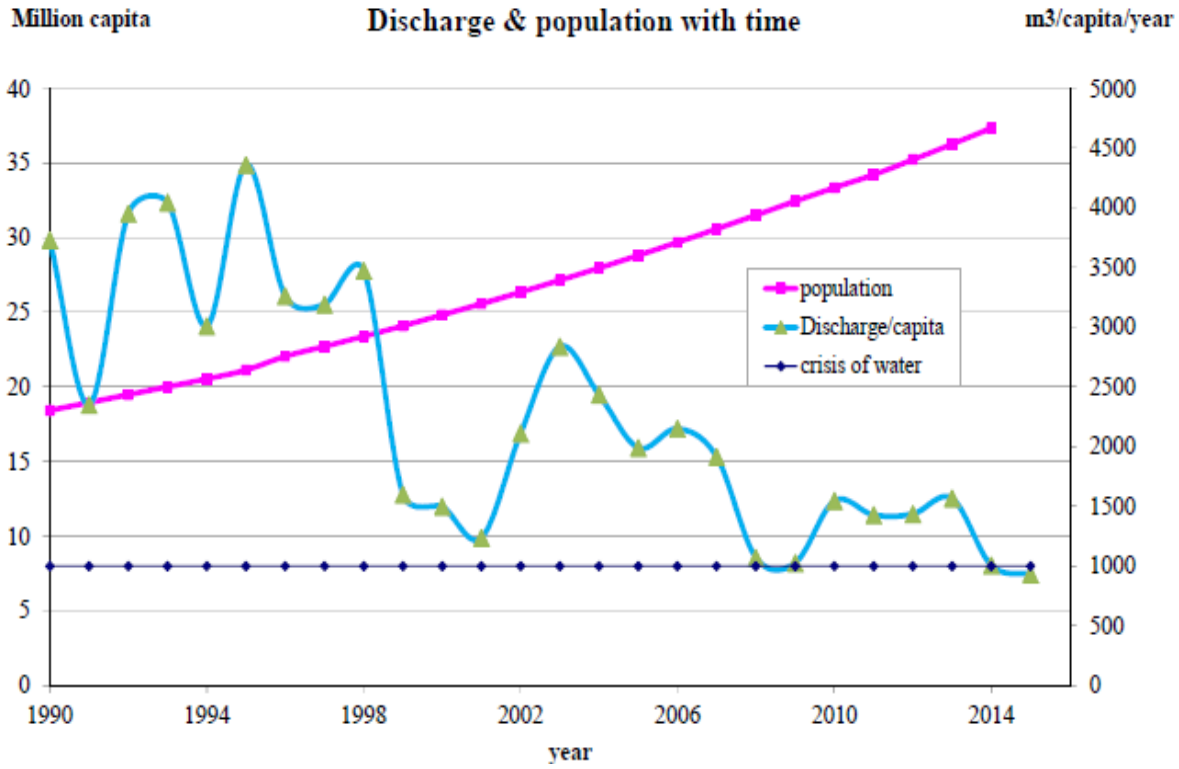

Figure (11): Decreasingly of ration per capita of water revenue

The population growth directly rate affects the increase in municipal water demand with time. Figure (12) illustrates the increasing demand from (3.7 billion cubic meters) in (2012) to (7.7 billion cubic meters) in (2060) for growth rate (1.5%), while, increase demand to (12.9 billion cubic meters) in (2060) for growth rate (3%), so the sensitivity coefficient of municipal water demand to growth rate of the population was (68.2%) (Al-Joboury 2014).The increase of population is a major reason to increase agricultural water demand, because it was increasing demand for food and agro-industrial products.

Pollution of municipal activity highlights the most considerable impact of contaminants such as untreated sewage, water-borne tanks, and tanker trucks, Table (2) describe it. The following can be observed:

- The percentage of sewage networks does not exceed (33%) of the total area of urban cities therefore, a large proportion of untreated water is thrown into rivers and streams.
- Most of the sewage treatment plants operate at higher capacity than their design capacities resulting in low efficiency of the treatment, which lead to water contamination.
- There are activities and pollutants sources behind municipal activities, which disposal to treatment units and rivers.

Vol. 10 , No. 3
ISSN: 1998-4456

Table (2): The number of activities that the disposal of contaminated water into sewer systems (wastewater, rain, common) in Iraq (MoMPW, 2013)

Slaughter houses		Other		Total treated activities	Total activities untreated
No. of treated activities	No. of untreated activities	No. of treated activities	No. of untreated activities		
0	6	34	197	34	203

2.3.2. Daily water consumption

The amount of daily consumption of water by a single person has a direct impact on municipal water demand. Figure (12) illustrates the changing water demand when the amount of municipal water consumption per person per day was changed. Demand was increased from (2.5 billion cubic meters) in (2012) to (8.6 billion cubic meters) in (2060) when the rate of consumption (200 liters per day), while increasing the demand from (3.7 billion cubic meters) in (2012) to (12.9 billion cubic meters) in (2060) when the rate of consumption (300 liters per day). Therefore, the sensitivity coefficient of municipal water demand to daily consumption amount was (100%)(Al-Joboury 2014).

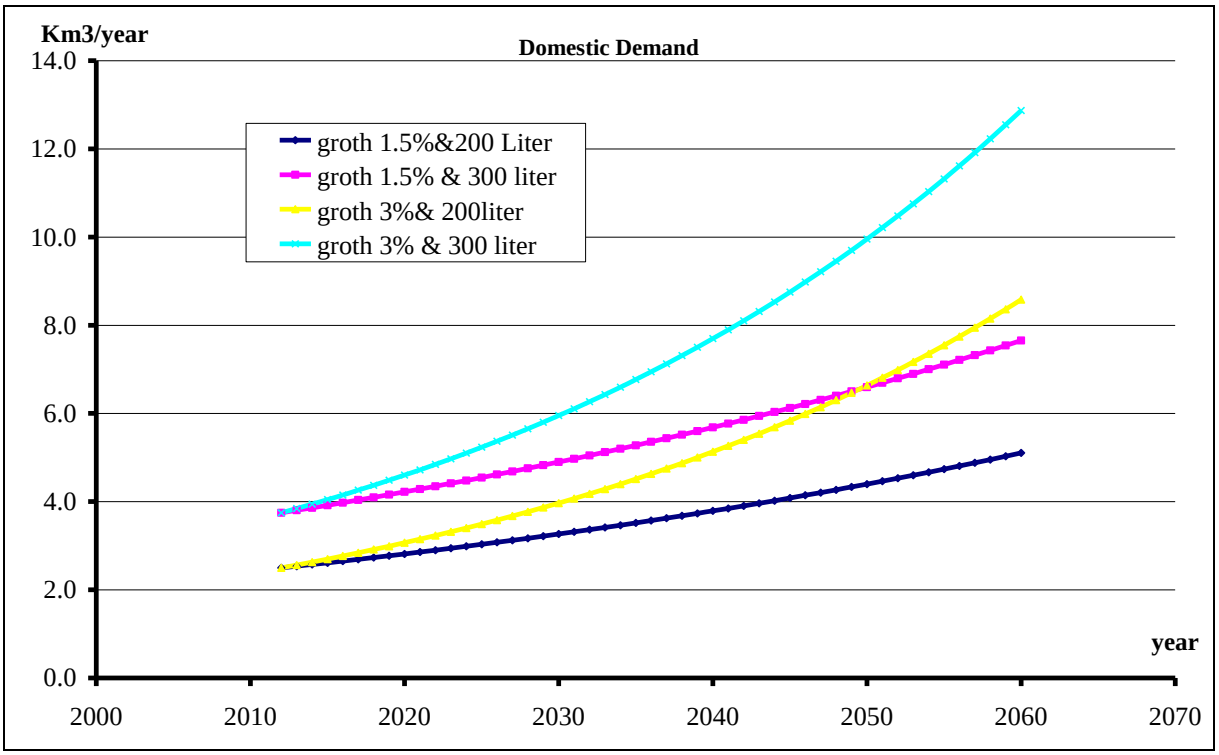

Figure (12): Influence of population growth rate and daily consumption on water demand. ((CSO, 2015) data/Researcher)

AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES

Vol. 10 , No. 3
ISSN: 1998-4456

2.3.3. Water losses

Loss of water within the network of rivers and canals, streams and irrigation network Figure (13) shows types of irrigation's channels, lengths, and lining material for these canals (MoWR, 2013). This Figure illustrates that the proportion of erodible canals length to the total length of canals was approximately (90%)(MoWR, 2013). This indicates large losses in water supplies, which may be up to 30% of the revenues of water (Al-Joboury 2014). These losses are caused by leakage from the walls and seepage from canals bed. Another source of losses in water quantities is losses in water supply networks (water distribution systems).

Loss of water in supply networks is a worldwide problem, particularly developing countries in arid and semi-arid regions. In Iraq, there are no water meters to measure water consumptions in most Iraqi cities, therefore, no accurate statistics for losses, so methods of measuring losses are absent. Hence, daily treated water represents daily water consumption with zero losses.

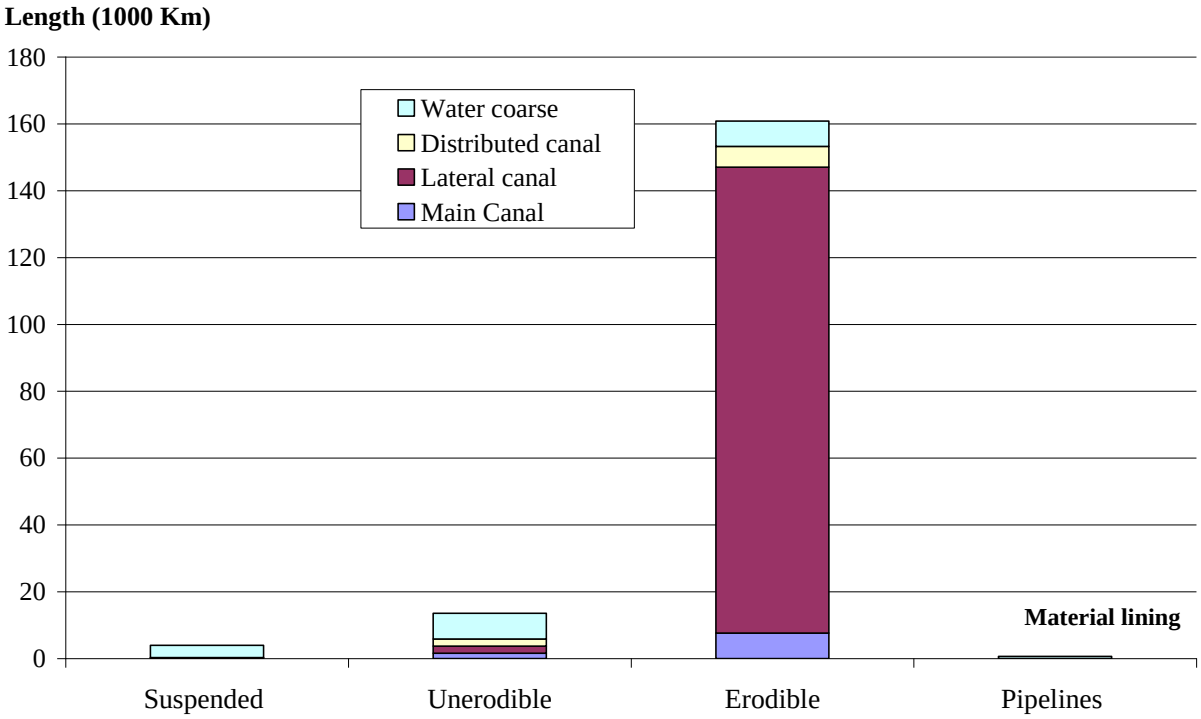

Figure (13): Lengths of ducts for water depending on the material lining for the canals ((MoWR, 2013) data/Researcher)

2.3.4. Urbanization

Urbanization that means transformation of undeveloped land into developed land. That leads to an increasing in demand of water supply (municipal and industrial) in addition to increasing in sewage productions.

2.4. FACTORS AFFECTING THE AGRICULTURAL DEMAND

Agricultural water demands in Iraq represent one of the highest demands. The proportion of consumption in this sector was (86%) of the total water consumption (MoWR, 2013). Figure (14) shows the proportions of water consumption for the various sectors in Iraq. Therefore, the factors affecting water

Vol. 10 , No. 3
ISSN: 1998-4456

consumption in the agricultural sector have a significant impact on the water demand. This factor represented by Irrigation methods.

Irrigation methods are one of the main reasons for high agricultural water demand, because its impact on the losses of water in addition to their direct impact on productivity. Each methods of irrigation have efficiency of transfer, efficiency of application, and efficiency of production. Therefore, the selection of appropriate irrigation method has higher efficient means, higher productivity, and consequently less areas of land and less agricultural water demand. Table (3) shows the efficiency of conveyance and application of various methods of irrigation.

Agriculture is one of the most commonly used water sectors in Iraq. Large proportion of this water was back return directly to the waterways by drainers' networks or indirectly through natural drainage by groundwater. So agricultural drainage is one of the largest contaminants because, its flow size and soluble salts compared to the rest of other pollutants. Figure (15) shows drainers which drained into the Euphrates River. In the other hand, Agricultural sector has wastes of chemical fertilizers, pesticides, and toxins, which are used neither control nor technical guidance by specialized institutions.

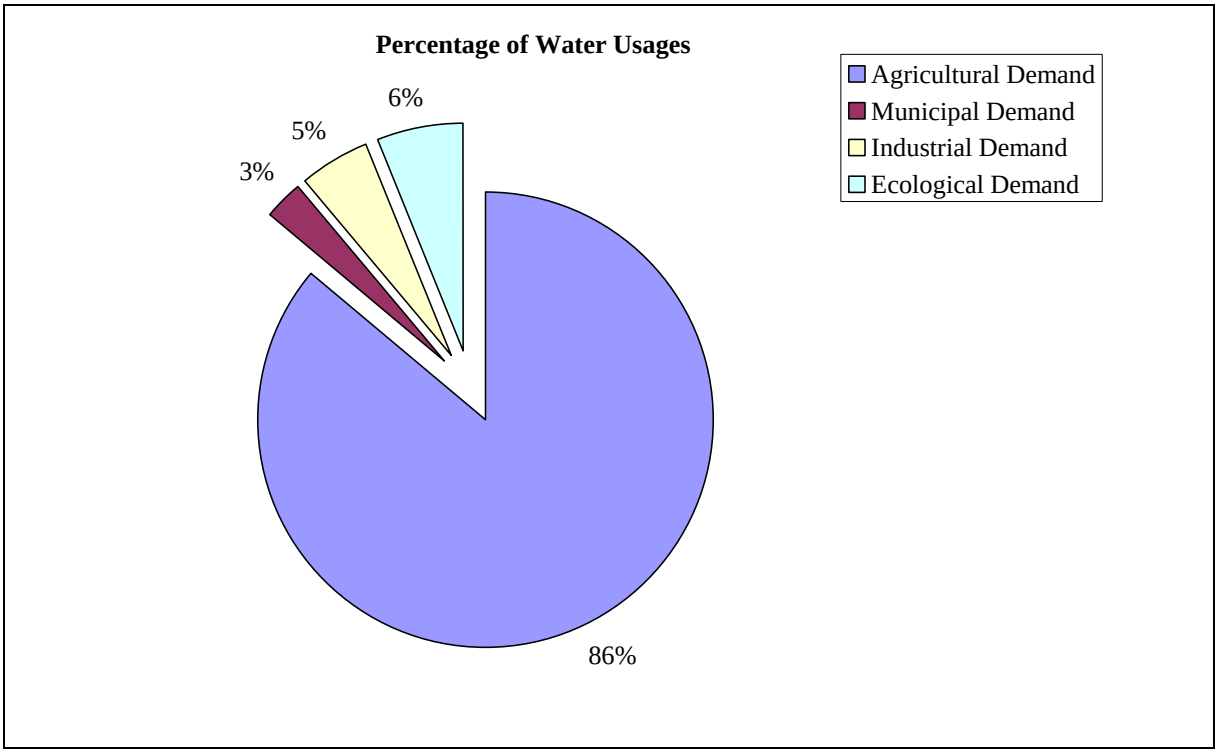

Figure (14): Ratios of water demand by various sectors ((MoWR, 2013) data/Researcher)

Table(3): Efficiency of conveyance and application according to Irrigation method ((FAO 2013) data/ Researcher)

Irrigation method	Efficiency of	
	conveyance	Application
Surface	0.9	0.60
Sprinkler	0.95	0.80
Trickle	0.99	0.90

Vol. 10 , No. 3
ISSN: 1998-4456

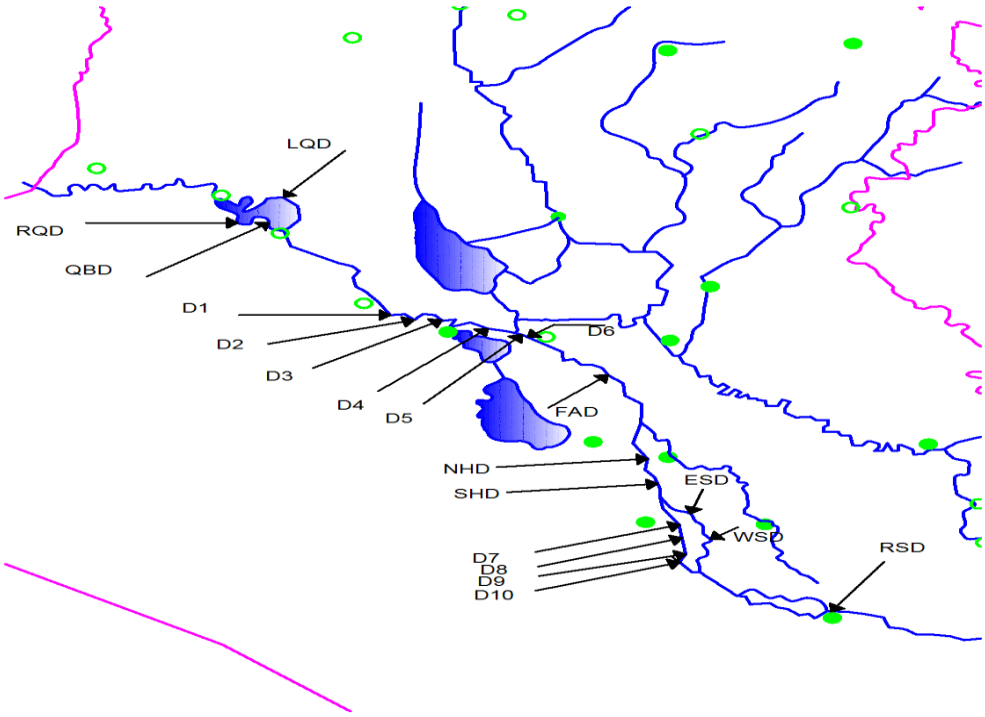

Figure (15): Drainers that drained into the Euphrates River. (MoE, 2006)

2.5. FACTORS AFFECTING INDUSTRIAL DEMAND

The most important factors affecting the industrial demand are the potential growth of this sector, where this sector was suffering from stagnation and backwardness for long periods. The potential growth is concluded in Figure (16). This figure shows the number of projects and industrial plants, which began in (5 years). Industrial sector had a rate of (100) plant for each period within interval (1970-2000), but increased within interval (2006-2012) to reach (493) projects (CSO 2013).

In quality scope, there are hundreds of food industries, chemical, construction and petrochemical ... etc., which contributes effectively to the pollution of fresh water. Industrial sectors have necessarily needs of water as a raw material in industry or as a means to cool the engines and equipment used by these industries. So, most of these factories are located nearby rivers. Perhaps the most polluting industries for water are the chemical and petrochemical industries such as the pharmaceutical industry, pesticides and toxins, detergents, food industry. These chemicals and organic materials lade by huge amounts of contaminated water. Figures (17) and (18) show quantities of industrial pollutants discharged into rivers. In addition, the drainers to the sewer system and to ditches will return to the rivers because they relate to rivers at the end of the session. The impact of pollutants resulting from the municipal activities, agricultural, and industrial can be observed by increasing the concentration of contaminated items such as (TDS, SO4, TH, Cl) inside Iraqi territory as shown in the figures (19), (20), and (21). These figures were painted based on data collected from monitoring stations, there location shown in figure (22).

Vol. 10 , No. 3
ISSN: 1998-4456

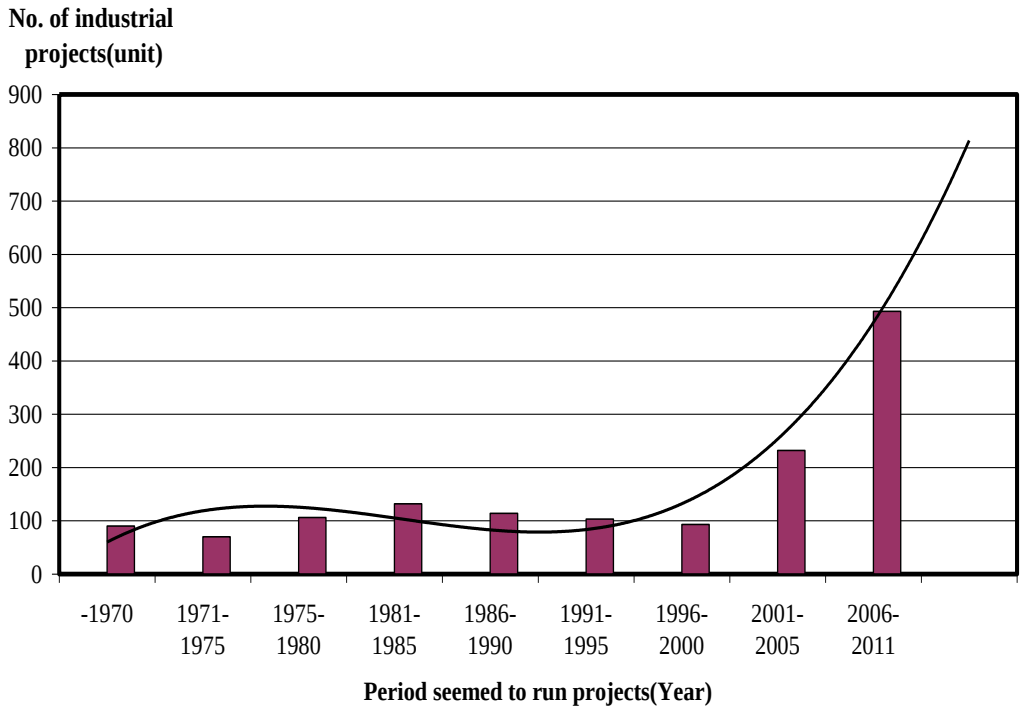

Figure (16): Number of projects and industrial plants depending on the history of engaging ((OSC. 2013) data/Researcher)

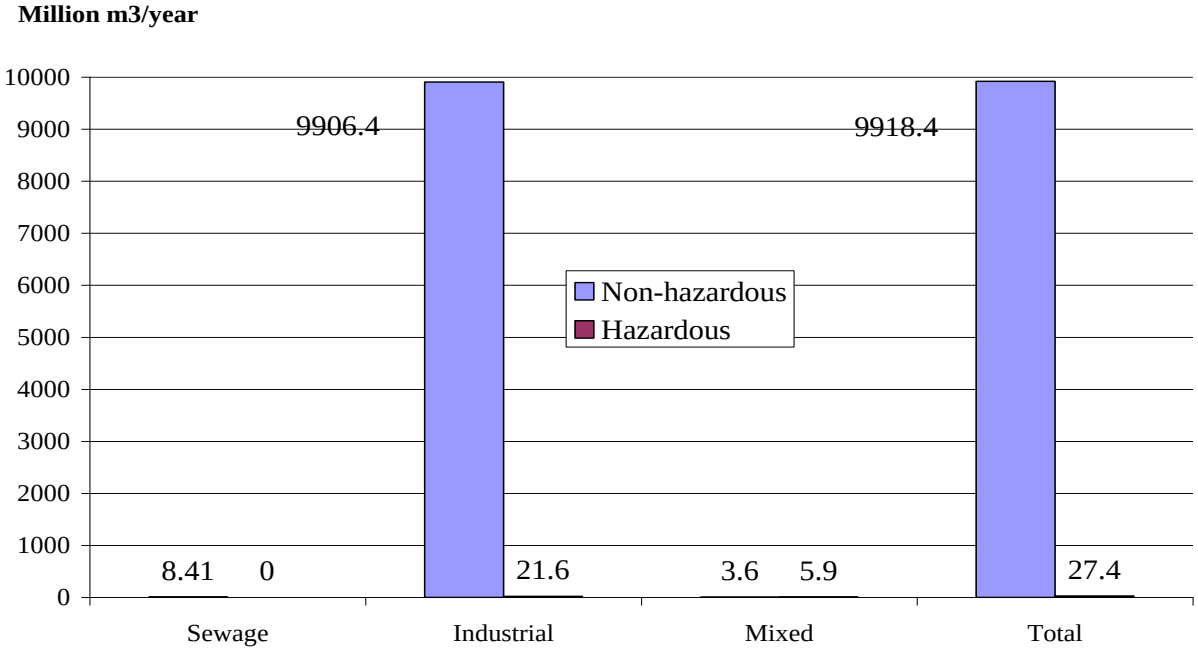

Figure (17):The amount and type of water discharged from industrial facilities ((OSC. 2013) data/Researcher)

AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES

Vol. 10 , No. 3
ISSN: 1998-4456

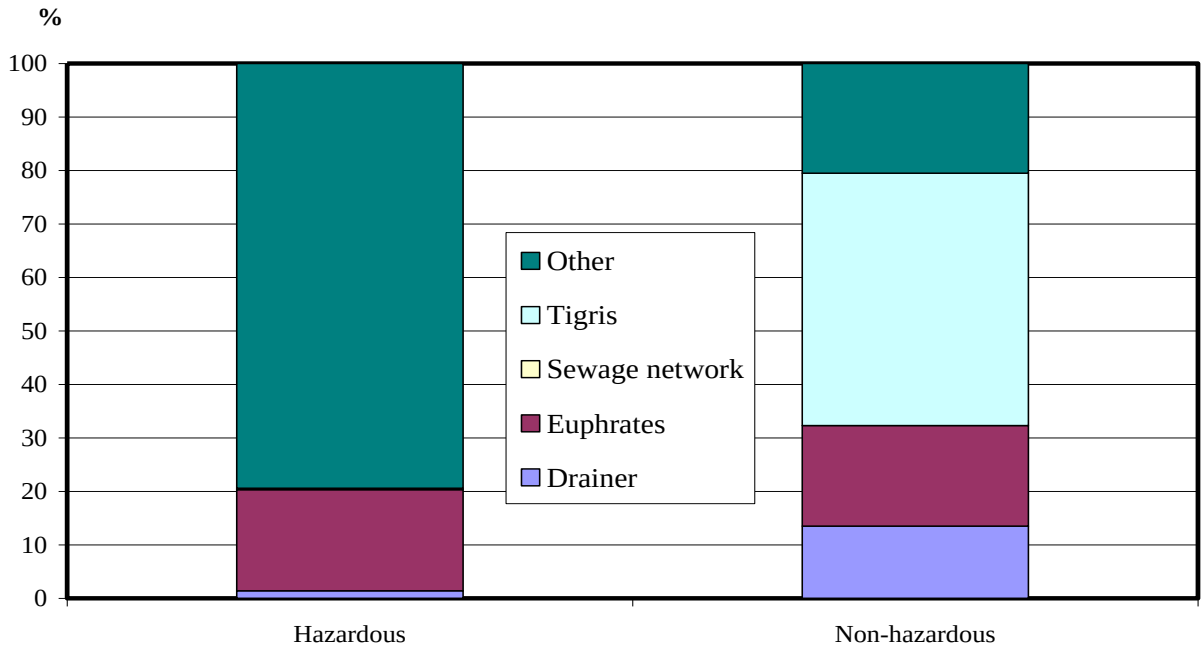

Figure (18) : Destination of discharge and ratio of hazardous and non-hazardous waste ((OSC. 2013) data/Researcher)

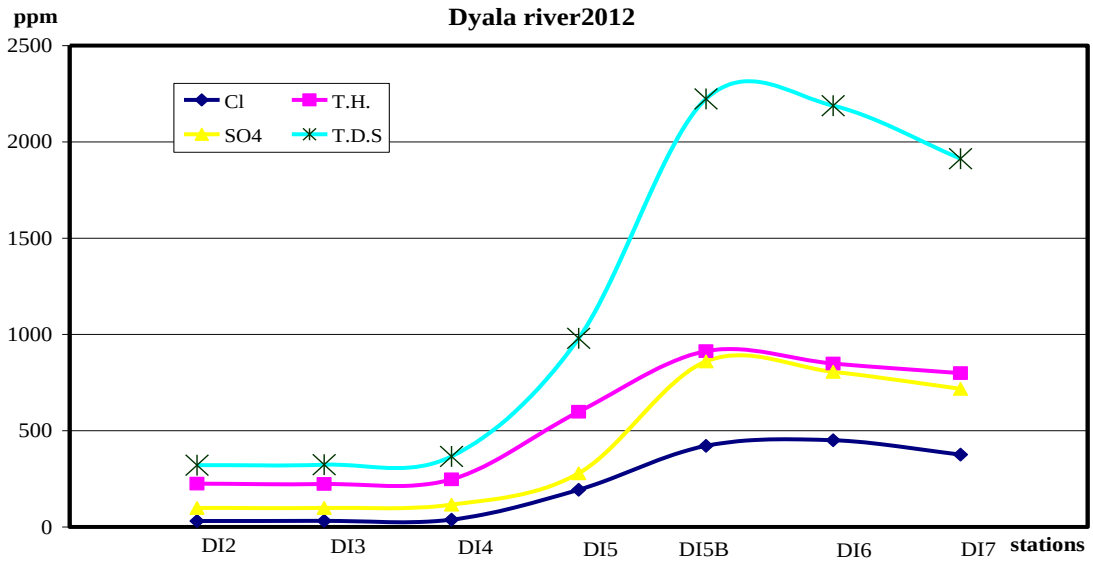

Figure (19): Changing concentration of pollutants in Diyala River with respect to distance ((MoE, 2013) data/Researcher)

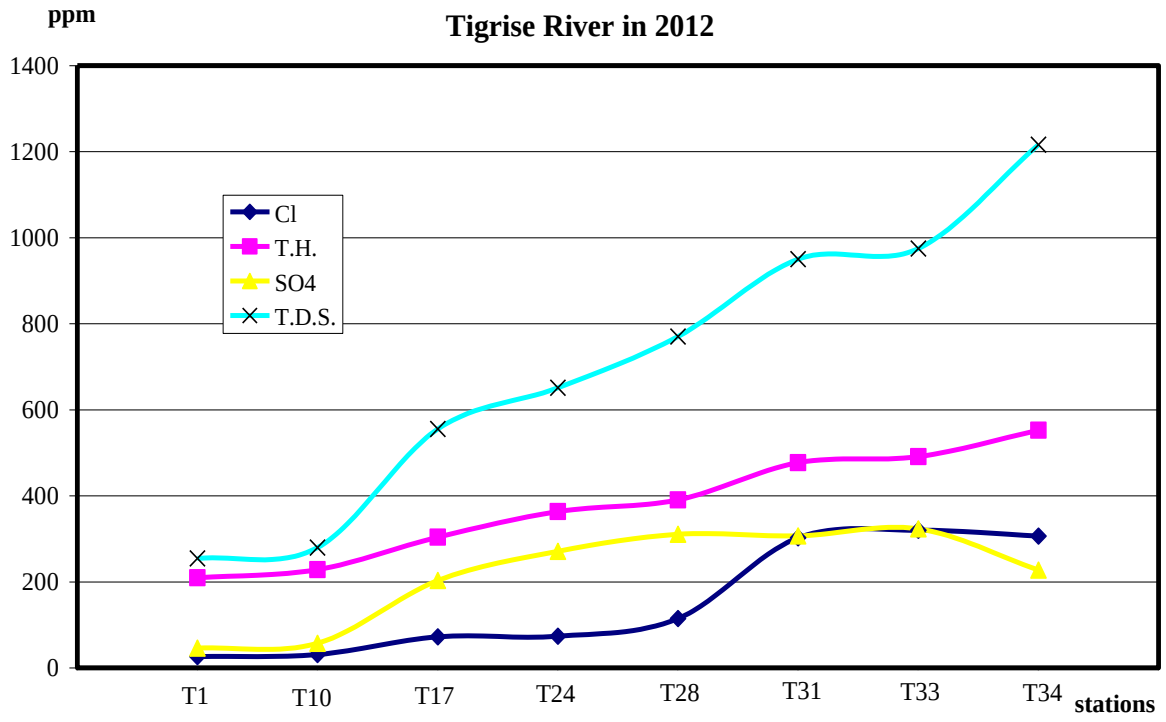

Figure (20): Changing concentration of pollutants in Tigris River with respect to distance ((MoE, 2013) data/Researcher)

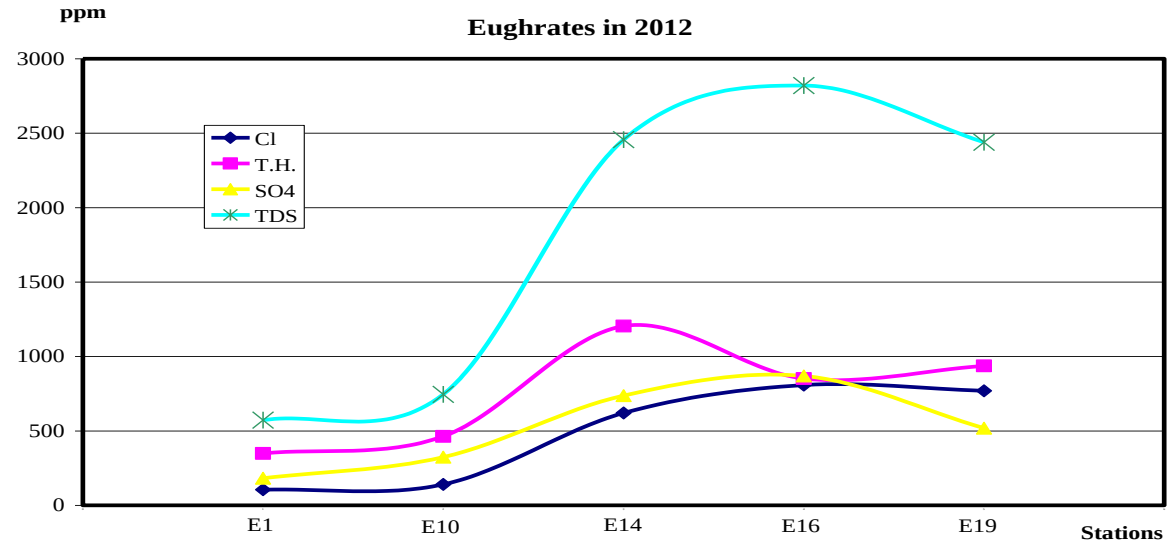

Figure (21): Changing concentration of pollutants in Euphrates River with respect to distance ((MoE, 2013) data/Researcher)

AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES

Vol. 10 , No. 3
ISSN: 1998-4456

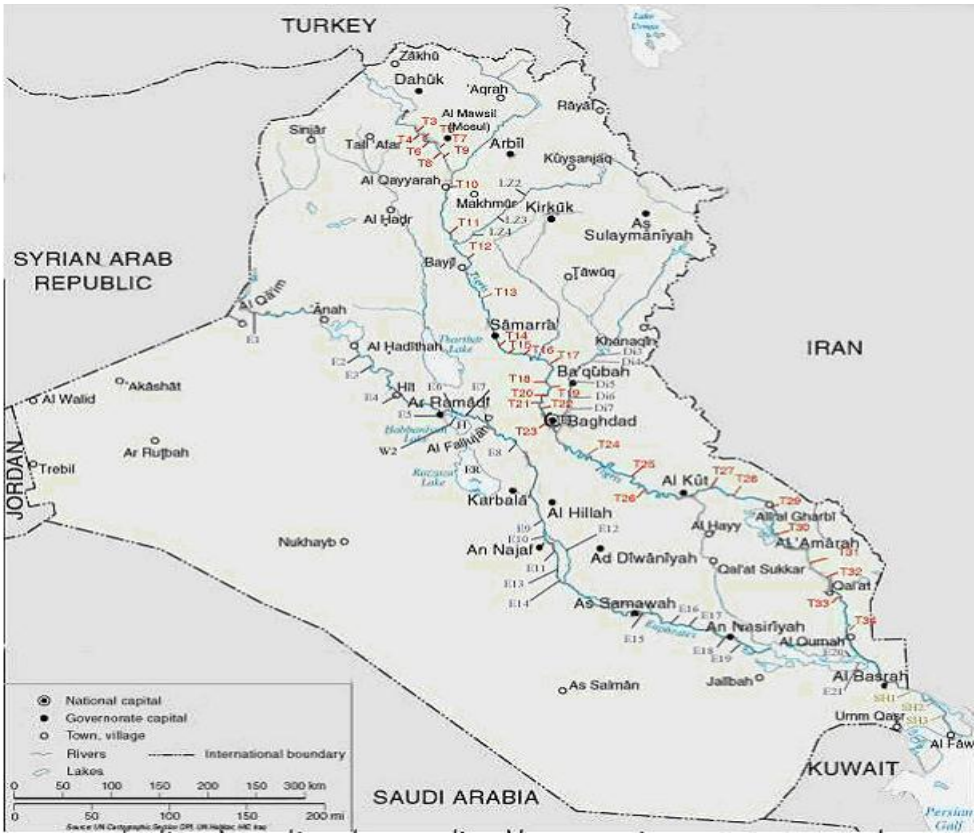

Figure (22): Locations of monitoring stations (MoE, 2013)

CONCLUSIONS

According to previous charts and tables can be concluded:

- Annually ration per capita was continuously decreasing and reached about level of crisis, these was due to water policies of riparian countries and global warming.
- Annual losses due to evaporation of water bodies in reservoirs is very large, equivalent to 1% of Iraq's annual water revenues, (i.e. satisfied 30% of municipal demand). In the other hand lost quantities were cause increasing in concentration of pollution such as TDS, TH, SO4, and Cl
- Agricultural sector has a large ration of consumed water, therefore has a large ration of losses. Main losses in agricultural were due to using an Ancient irrigation ways and erodible canals. These losses were about to be (31.6%) of agricultural demand, or equal (11.556 MCM/year), (i.e. 31% from Iraqi water revenue in 2014).
- Industrial sector consumed for industrial proses approximately (50%) from total industrial demand, these water can be recycled by using closed production cycle, (i.e. satisfied 80% of municipal demand)
- However, Municipal sector has a smallest demand among other sectors, but can be saving about (30%) of municipal demand by reducing daily water consumption per capita. These processes can be done by arising efficiency of water usages and reducing water losses in network

AL-QADISIYAH JOURNAL FOR ENGINEERING SCIENCES

Vol. 10 , No. 3

ISSN: 1998-4456

- The main reasons to degradation in water quality are discharge agricultural drain, municipal sewages and arising level of ground water (obviously in station (E10) on Euphrates, in station(T17) on Tigris an station(DI4) on Dyala)

So, water resources are affected by many factors, those factors classify in to factors have influences on quality of water and the other have influences on quantity of water. Water resources management when have an ability to control those factors, so it is regarded as an internal factors. While when water management do not have to do anything to prevent those factors, so called external factors. Some of those factors affect water demand and others affect water supply. Then the main factors affecting water resources in Iraq can be summarized in Figure (23). In the other side, factors affecting water resources of Iraq don't have the same impact on water resources. Therefore, a successful water management must consider all these external and internal factors in their policies and plans.

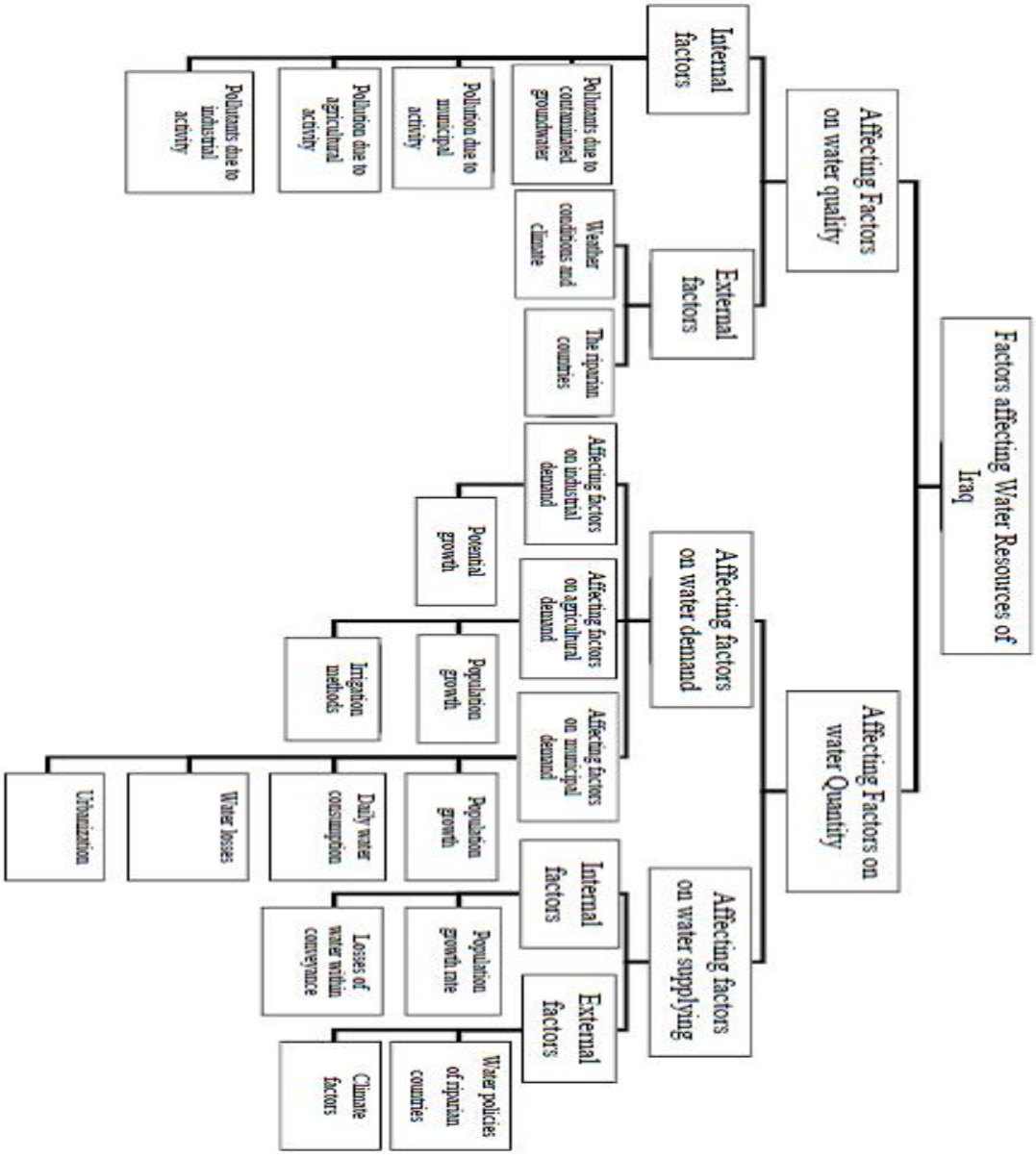

Figure (23): Factor affecting water resources

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