

The Challenges of Water Sustainability in Iraq

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ABSTRACT

The sustainable development in Iraq is being hindered by several obstacles. Water, being related to the food security, is a main concern that could duplicate the already present socio-economic dilemmas. Unless practical measures are immediately initiated, the consequences are expected to demolish the development achievements, though so modest, and become a real threat to the lives of the Iraqis within the near future. This paper aims to present a holistic view at the current development challenges and to concentrate on the socio-economic challenges to water sustainability in Iraq. Also, stresses on the need for a comprehensive national plan for the conservation of water and other natural resources and how to reverse the environmental challenges into practical opportunities for sustainable development.

Key words: Sustainable development, water crisis, water sustainability challenges.

تحديات استدامة المياه في العراق

الخلاصة

التنمية المستدامة في العراق تواجه عدة معوقات، من أهمها المياه وذلك لصلته الوثيقة بتحقيق الامن الغذائي وما يترتب عن فقدانه من تضاعف الاثار السلبية للمعضلات الاجتماعية-الاقتصادية الموجودة اصلا.

ان عدم اتخاذ خطوات عملية، مباشرة وأنية، لاستدامة المياه في العراق سيؤدي حتما الى الاجهاز على المنجزات التنموية برغم تواضعها وسيصبح خطر حقيقي يهدد ارواح العراقيين في المستقبل القريب.

تهدف هذه الورقة الى تسليط الضوء على مجمل التحديات التنموية وتركز على التحديات الاجتماعية-الاقتصادية بالاضافة الى البيئية التي تواجه استدامة المياه في العراق. كذلك تشدد على ضرورة وضع خطة وطنية شاملة للمحافظة على المياه والموارد الطبيعية وكيفية عكس التحديات البيئية في توفير فرص حقيقية لتحقيق التنمية المستدامة.

INTRODUCTION

Iraq, with a population of more than 32 million [1], borders Syria to the northwest, Turkey to the north, Iran to the east, Jordan to the southwest and Kuwait and Saudi Arabia to the south. Iraq has a narrow section of coastline measuring 58 km (36 mi) on the northern "Arabian" Gulf. The capital city, Baghdad is in the center-east of the country.

Two major rivers, the Tigris and Euphrates, provide Iraq with agriculturally capable land [2]. The region between the Tigris and Euphrates rivers is often referred to as the cradle of civilization and the birthplace of writing, law and the wheel [3].

Roughly 90 percent of the annual rainfall occurs between November and April, most of it in the winter months from December through March. The remaining six months, particularly the hottest ones of June, July, and August, are dry [4]. The combination of rain shortage and extreme heat makes much of Iraq a desert. Because of very high rates of evaporation, soil and plants rapidly lose the little moisture obtained from the rain, and vegetation could not survive without extensive irrigation. Accordingly the two rivers' valley is main agricultural source for the Iraqis and its sustainability is directly related to the food security in Iraq which is increasingly becoming a major challenge to the green growth in Iraq.

Iraq's recent history witnessed a chain of wars which have exploited its natural resources, human and social capital and ruined what has been invested on the infrastructure and built capital. Regardless of the reasons after those wars, the development that have had been achieved, was almost completely demolished after the 2003 occupation and Iraq now finds itself confronting several challenges; social, economic and environmental. Being interconnected, none of the Millennium Development Goals (MDGs) would be achieved unless built harmonically together with relative relevance. Now, Iraq lags significantly behind in achieving the MDG targets, making it unlikely that they will be able to meet the majority of the targets by 2015 [5].

Potentially Iraq is one of the richest countries in the Middle East [6]. Despite the high foreign currency revenues, estimated in 2011 to be USD 72,400,000,000 and enlisting Iraq internationally as the 38th highest income country, the unemployment rate is still high and the poverty is overshadowing the scene. The Central Bureau of Statistics of the Ministry of Planning reported that the unemployment rates for the year 2012 witnessed a decline compared to the latest figures announced in 2008, pointing out that the ratios show that unemployment has become 12% instead of 15 % [7].

Almost seven million Iraqis (23% of the total population) live in poverty (spending less than 77, 000 Iraqi Dinars per person per month, or 2.2 US\$ per person per day). Iraq has taken a backward step since 1990 to achieve full and productive employment for young people. Rising from 7% in 1990, youth unemployment rate is 30% double the national average of 15%, far from the target of 4% in 2015. The economy is unable to produce enough jobs to employ the 450,000 Iraqis entering the labor force each year. Three quarters of workers without an intermediate education lack social security, compared

to 55% of all employed [8]. In every case, 75% Iraqis identified the need to reduce the country's poverty as the most pressing need [9].

Iraq used to be one of the leading Middle East countries in education. Prior to 1991, the education system was one of the best in the region with over 100% Gross Enrolment Rate for primary schooling and high levels of literacy, both of men and women whereas the Higher Education, especially the scientific and technological institutions, was of an international standard, staffed by high quality personnel [10]. It is now hindered by outdated curricula and teaching methods and poor infrastructure [1]. The poor state of primary education leads to a high drop-off in enrolment rates going into intermediate and secondary education. The net intermediate enrolment ratio is 37%, while the ratio at secondary level is even lower at 21%. Net primary enrolment dropped from 91% to 85% between 1990 and 2007, and is particularly low at 70% among girls in rural areas. Dropout rates between primary, intermediate and secondary levels are high: net intermediate enrolment is 39% while net secondary enrolment is just 21% [8].

Iraq's health sector faces considerable and complex challenges, despite recent improvements. Access to quality primary healthcare has improved, but primary healthcare centers remain out of reach for many Iraqis.

As a direct result to the health care, the maternal mortality rate; Under-five mortality rate is the probability per 1,000 that a newborn baby will die before reaching age five, has not recovered since 2007 when it was 40 and has become only 39 in 2010 [1]. The proportion of children dying within the first year of life has dropped from 50 to 35 for every 1,000 live births, but these infants account for 85% of deaths among children aged fewer than five [8].

Being unexceptional, Iraq's environment has suffered greatly from the impact of poor policies on pollution and resource management. As a result, the country is exposed to a range of environmental issues, including drought, desertification and increasing soil salinity. Agriculture accounts for the vast majority of water consumption in Iraq, withdrawing 92% of total freshwater for irrigation and food production. Inefficient use of water in 2005 resulted in farmers achieving only 20% of potential production in rain-fed crops [11]. 39% of Iraq's agricultural land suffered a reduction in cropland between 2007 and 2009 [12]. Air, water and soil pollution is a growing problem. In 1995, satellite images showed that 90% of the Mesopotamian marshlands were dried [13]. Years of war and internal conflict have left a dangerous legacy of landmines and unexploded ordnances (UXOs). The widespread contamination is one of the largest in the world. Contaminated sites cover an estimated 1,730 square kilometers and affect around 1.6 million people in over 1,600 communities.

On top of all the pre-mentioned dilemmas, the widespread corruption is hindering the sustainability wheels and completely jamming the development process. International Transparency (IT) through The Corruption Perceptions Index that ranks countries/territories based on how corrupt their public sector is perceived to be, has ranked Iraq 175 out of 182 in 2011 [14].

WATER CRISIS IN IRAQ

Apart from the pre-mentioned obstacles, the water issue could be another burden to development in Iraq. The MDGs, a series of targets for reducing social and economic ills, all by 2015, includes the goals of halving the proportion of people who cannot reach or afford safe drinking water and halving the number who do not have basic sanitation. In 28 July 2010, the General Assembly adopted a resolution (GA/10967), recognizing the access to clean water and sanitation as a human right. Availability of water for agriculture, industry and household supplies is a major issue for Iraq. The quality and quantity of the country's water has been impacted by upstream damming, pollution, climate change and inefficient usage. The amount of water available per person per year decreased from 5,900 cubic meters to 2,400 cubic meters between 1977 and 2009.

Changes in water quality are primarily the result of human activities that would discharge water pollutants or alter water availability. The highest water quality is typically found upstream, while the most degraded is found in the downstream areas. It is reported that the improper wastewater disposal is considered as a major cause of degradation of water resources, it has been estimated that Iraq during 1997 produced 285 kg per capita of municipal waste per year. Available reports confirmed that all sewerage treatment plants suffered major breakdowns, and there are no functional treatment facilities and untreated sewage and sludge with an estimate of 500,000 cubic metres of raw sewage being discharged daily into rivers [2].

Decreasing water supplies have been exacerbated by drought conditions between 2005 and 2009, which have devastated agriculture and caused drinking water shortages, particularly in rural areas. 39% of cropland suffered a reduction in coverage for two years in succession between 2007 and 2009, and livestock has been decimated. The Tigris and the Euphrates, Iraq's two major surface water sources, may dry up by 2040 if current conditions prevail.

Sustainable access to safe water is poor; the proportion of households using an improved water source has remained at around 80% since 1990. In rural areas, this figure is just 57%. Problems with infrastructure mean that the supply of water often suffers from interruptions and poor quality. Iraq also faces considerable challenges in sanitation.

Just 26% of the population is covered by the public sewage network, dropping to 2% in rural areas. An alarming 83% of Iraq's wastewater is left untreated, contributing to the pollution of Iraq's waterways and general environment [2].

The Iraqi population's access to safe water has become worse in the past 20 years with 87% of the population having access to safe water in 1986, 10% more than the 77% with access to safe water in 2006. Around 90.6% of Iraqi people will have access to safe water if Iraq succeeds in attaining the MDG target of increasing the current coverage of 83.7% to 90.6 % by 2015. 1 in 5 or around 6 million Iraqis (3 million children) do not have access to safe water, of which the vast majority is in rural areas (Over 500,000 children access their water from a river or creek. Over 200,000 children access their water from an open well). In rural areas, the situation is worse with 1 in 4 accessing their

water from rivers and creeks and nearly 1 in 10 using tanker trucks and open wells respectively.

An International report recently warned that the Tigris and Euphrates rivers could completely dry up by 2040 because of the compounded effect of climate change, reduced upstream supply and increase in domestic and industrial use [15].

The average volume of daily production of water in Iraq is reported as 7.2 million m³. This is an average of 327 liters/capita/day. By international standards this amount of water per capita is considered high [16]. However, despite the high level of production, only 77% is continuously provided to people, which drops to only 64% for people living in rural areas. 50% of water produced is lost due to seepage, leakage and wastage due to system inefficiencies and domestic wastage. 92% of the total freshwater in Iraq is used for irrigation and used production. In most areas, water consumption is not metered. Of the households that have installed meters, in Baghdad, 90% are not functional [16].

Water is expected to be required in 2015 as shown in the Table 1 [17].

Table (1) 2015 forecast for water requirement in Iraq.

Water sector	Quantity (billion m ³)
Agriculture	40.5
Marshland maintenance	11
Evaporation and other losses	8.4
Civil use	3.78
Industry	2.77
Power generation	0.4

WATER CHALLENGES

Iraq is in the midst of a water crisis and its worst drought in decades. At the current rate of decline, Iraq's water supply will not be enough to avert a widespread humanitarian crisis. The continuing water crisis has directly contributed to rising levels of food deprivation, displacement and poverty in Iraq. This alarming trend has propelled water issues to the top of the government's agenda [18].

Decades of conflict, sanctions and neglect of infrastructure have undermined Iraq's water resources management system. As a result, Iraq faces difficulties in meeting the target of 91% of households using a safe drinking water supply by 2015 [19]. However, the main challenges to the sustainability of water in Iraq are:

Environmental Education

The formal education lacks the modern procedures to become incapable of upgrading the citizens' mentality to confront the current environmental dilemmas. Secondary Schools' students, despite being at the ideal youth age, are eager to participate in different environmental activities and willing to volunteer as environmental defenders while the educational; curriculum and practices, fully ignore their desires and wishes to improve the already degraded environment.

Consumption Patterns

Iraq is the second after Turkey (2890 m³/capital) in water availability in the region with 2400 m³/capital compared to; 1876 for Iran, 791 for Syria and Kuwait, 152 for Jordan and 95 for Saudi Arabia [19]. Traditionally, the Iraqis are huge consumers and this phenomenon has become a habit. Some of those habits are inherited; sometimes, explained as generosity, others are a direct result of the governmental subsidies that the Iraqis used to get for the last half a century. As an example; domestic water in Iraq is heavily subsidized. The tariff is almost 12 times lower than the tariff applied in Egypt which has the lowest tariff among all Arab countries. The tariff for water in Iraq is US\$ 0.0034/m³ and the public water revenue covers only 2-5 percent of the costs of operation and maintenance [16].

Study of Pillar Problems

As a result of different factors, the scientific research is mostly irrelevant to the existing water problems. Some factors are related to the lack of coordination between the different institutions, others are just because of misinterpreting the background of the problem; especially when related to the human behavior.

Demographic (urban and rural population)

The population of Iraq was estimated at 26,340,000 people in the year 2003, and expected to increase to 40 million in year 2025. 67% of the total population is urban. However, the average population growth was estimated at 3.6% in the period 1980-1990, but emigration of foreign workers and severe economic hardship have reduced that rate since 1990, with estimated growth of 2.7% in 2003 [2].

Water Shortage to Comply With the Social and Economic Demands

The climatic changes and consumption patterns, coupled with water mismanagement and shared (trans-boundary) water resources, will lead to a real shortage in water supply, and expected to escalate throughout the coming years.

Iraqi land exceeds 430,000 km² and it is an arid country, with an average annual precipitation; ranges from less than 100 mm in the southeast to more than 400 mm in the northeast [20], while the use of fresh water increased dramatically over the past century. Reservoirs, lakes and rivers in Iraq are diminished to critical levels because of considerable change in climate, upstream supply and domestic use. Water levels in the Tigris and Euphrates rivers, Iraq's primary sources for surface water, have fallen to less than a third of normal capacity [19]. Moreover, the Turkish government started to implement ambitious water development schemes called as the South-Eastern Anatolia Project (GAP).

Water Pollution

Pollution is continuously becoming a serious problem, mainly caused by the disposal of untreated sewage and industrial waste, nitrates from animal waste and chemical fertilizers. It is important to report that the continuous increase the demographic and the urbanized expansion and the increased weight for inhabitants of the cities. Recently, it has been reported that all sewerage treatment plants suffered major breakdowns, and there are no functional treatment facilities and untreated sewage and sludge with an estimate of 500,000 cubic metres of raw sewage being discharged daily into rivers [2].

Internal Migration

The continuous migration from the rural to the urban areas is becoming a real threat and warns of a random demographic growth. Such a movement is a direct cause to lowering the number of the farmers, soil degradation and expanding the urbanized cities on the account of the agricultural lands; accordingly, spreading of unsuitable housing and abandoned farmlands.

Unilateral Water Resource (Complete dependence on Euphrates and Tigris for agriculture and drinking)

Tigris and Euphrates are the only source of water, yet they flow southwards from Turkey through one of the most arid regions in the world for over 1,000 and 1,300 kilometers respectively before they converge at Al Qurnah, and are relied on by an increasing number of people for agriculture, urbanization and industrialization [21].

Trans-Boundary Nature of the 2 Rivers; Tigris and Euphrates

Only 8% of the Iraqi running water is internal, while 71 % from Turkey, 6% from Iran and 4% from Syria [19].

Iraq relies on precipitation falling outside its borders for more than half of its water, making it vulnerable to climate change and storage projects in Turkey, Syria and Iran [22]. The average Discharge of Water to Iraq for the Tigris in 2009 was 49.2 (billion m³) and expected to become 9.16 in 2025 whereas for the Euphrates, 19.34 and 8.45 respectively [19].

Turkey in the 1970s launched the Southeastern Anatolian Project (GAP) for dam construction on both the Euphrates and Tigris rivers, and has since 1981 built 12 dams (out of a planned 22) on the 2 rivers. Syria has also dammed the Euphrates and some of its tributaries, and Iran too is exploiting water sources on its side of the marshes, significantly affecting the volume of water flowing into the Iraqi side. In this respect, it should be mentioned that the upper reaches of rivers feeding into the Mesopotamian marshlands lie in other countries complicate the water issues of this region. Therefore, the destruction of the Mesopotamian marshlands is one of the major humanitarian and environmental challenges facing Iraq, requiring both an immediate and long-term planning response for the sustainable rehabilitation of the marshlands. It should be considered as the important one in the environmental priorities in Iraq, require a control plan and huge help from international donor countries, international agencies, Non Governmental Organizations (NGOs), etc.

The Euphrates River and the Tigris and most of its tributaries cross the borders of more than one country. Iraq is the most downstream riparian is vulnerable to the water resources management practices in the upstream countries. In the absence of a long term water sharing agreement among the riparian countries, Iraq is by far the most disadvantaged country. The lack of water sharing agreement represents a direct threat to water security in Iraq [23].

Increased Levels of Salinity

The Euphrates River water salinity (expressed as TDS), as it enters Iraq, has more than doubled compared to that of 1973. Downstream of Al Hindiah Barrage located south of Baghdad; the salinity has increased steadily over the last thirty years. The annual average TDS at Al Nassiriah has increased from 1080 ppm in 1979 to more than 4500 ppm in 2001. Water quality of the

Euphrates deteriorated due to the decrease in quantity and the increase in salinity of the flow that is entering Iraq, and to flow diversions to the river from the Tharthar Lake and irrigation return-flow within Iraq. The decreased flow from Turkey and Syria is the primary cause of the alteration of water quality. Due to this flow diversion, water from Al Tharthar Lake and from irrigation return flow is being diverted to the Euphrates to compensate. An environmental flow rate of 178 cms (annual minimum flow 5.6 bcm, 1/3 of historic minimum flow) is proposed as the minimum flow that must be released into Iraq to preserve the environment of the Euphrates River in Iraq. A flow of twice this amount would allow more reasonable downstream management with an input average salinity of 760 ppm [24].

Throughout history the irrigated agriculture of Iraq's central and southern region has been menaced by salinization. Salinity was already recorded as a cause of crop yield reductions some 3 800 years ago. It spread across much of the irrigated fields as the Government ended its maintenance of the irrigation system. The water table of southern Iraq is saline and so close to the surface that it only takes a little injudicious over-irrigation to bring it up to root level and destroy the crop. High groundwater tables affect more than half of the irrigated land. Once severe salinization has occurred in soil, the rehabilitation process may take several years [25].

Pesticide and fertilizer run-off

The multitudes of toxic chemicals all over the world have led to degradation of ecosystems where those chemicals have been dumped or sprayed. Pesticides, herbicides and fertilizers, in particular, leach into soils and waters and affect the entire food chain. Industrial effluents are pumped into lakes, rivers and oceans, affecting the growth and reproductive cycles of aquatic organisms. Industrial accidents, involving spills of large quantities of toxic chemicals into the environment, are occurring with greater frequency. Despite the large quantities of water currently available from the Euphrates and Tigris rivers, it is becoming increasingly important to improve the management of these resources as further irrigation developments in the upper tri-state (Turkey-Syria-Iraq) Euphrates-Tigris Basin progress [26].

Increased Sewage Discharge from the New Urban Centers

The amount of industrial and domestic water requirements (about 10-15% of the demand for water in Iraq), is small compared with irrigation requirements. However, recent data indicate that the industrial and domestic water requirements were not being met adequately (and there are also severe differences among the geographic regions in the provinces). The expected situation of waste water management, which is part of this water, will be very bad; with only 17% of this water have been subjected to treatment. The sanitation services in Iraq in 1990, were covering about 75% of the urban population (25% related to sewage systems and 50% with septic tanks on-site), and about 40% in rural areas [12, 28].

Biodiversity

A rich and healthy environment is clearly portrayed on the ground whenever we find a rich and diverse flora and fauna. In Iraq's case, both are

suffering a great setback from the levels that existed even a few decades ago. This degradation of Iraq's biodiversity is due to a number of factors, some of which are easy to remedy simply by adopting strong and effective regulations, while others are very complicated and require long-term solutions with stakeholder involvement. One of the major setbacks (probably the most devastating of all) is what happened to the Marshes of Mesopotamia, which were nearly destroyed for military conveniences. Some of these devastating effects have actually been reversed immediately after 2003, when the Marsh Arabs broke some of the dykes that have built to drain the marshlands. As a result of this action between 40-60% of the Marshes were re-flooded in 2003 and life started to return to the area [28].

DISCUSSION

Deterioration of water quality results in a series of problems with negative impacts on human health and environment. The use of contaminated water in irrigation results in the transmission of contaminants to the irrigated plants and consequently to humans, as well as increasing soil salinity, reducing productivity and converting areas of agricultural land into barren land [29]. The deterioration of water quality definitely reduces the uses to which the water can be put, even if it does not render the water completely unusable for human or agricultural consumption. This can create a shortage in water supply, converting the quality problem into a quantity problem [30].

The Turkish government started to implement ambitious water development schemes called as the South-Eastern Anatolia Project (GAP), which was initiated in the 1970s. It involves 22 dams, 19 hydroelectric power plants and network irrigation canals for the Tigris and Euphrates rivers, to transform the region into an agro-related export base. Dams also caused considerable environmental damage, major adverse consequences for large numbers of people living in the region and together with associated activities such as irrigated agriculture, have been a major culprit in the decline of freshwater biodiversity observed in the recent decades. Prior to 1991, the population of Iraq enjoyed a relatively high level of water and sanitation services. Urban access to drinkable water supply was 95 % with an average of 330 litres per person per day in Baghdad, and 250-300 litres per person per day in other cities and towns. Rural water coverage was 75 % with an average supply of 180 litres per person per day [31]. Recently due to negative environmental impacts of the engineering developments and dam construction by Turkey and Syria, in addition to increased agricultural activities, pollution, population growth and activities in Iraq, freshwater shortage has been assessed as moderate or severe and the urban access to potable water fell from 95% to 92% and in Baghdad from 330 to 218 litres per person per day, and in other cities and towns from 250 to 171 per person per day; rural access to potable water fell from 75% to 30%, and from 180 to 91 litres per person per day [31].

It is becoming obvious that environmental development and desertification strategies complement each other and have to converge. For instance, supporting humanitarian missions and deploying their technologies to identify

environmental risks, and may also be directly involved in strategic environmental measures such as major afforestation programs

Desertification leads to a poverty trap in dry areas, which can, in certain circumstances, turn into a poverty-conflict trap. This is because there is a link between desertification, food insecurity, poverty, and human insecurity. It is reported that countries with low per capita gross domestic production are more likely to experience war or conflicts [32]. There are numerous ethnic, social and governance factors that influence the poverty-conflict link, but clearly agricultural research for development and development itself has a major role to play in helping the poor out of this trap.

There are several pathways out of poverty. Agricultural research is very important for establishing sustainable economic development in many of the world's poor areas [33].

The shortage of water had severe impacts on agriculture and consequently on local livelihoods. Elsewhere, water shortages prevented the flushing out of salts from irrigated land, leading to increased salinization. FAO reported that the flow of Iraq's major rivers declined by some 40%, due to reduction in water released downstream from dams constructed in the riparian state, Turkey [34].

Throughout history the irrigated agriculture of Iraq's central and southern region has been menaced by salinization. Salinity was already recorded as a cause of crop yield reductions. However, the rehabilitation process may take several years [25].

The risk of elevated soil salinity and waterlogging as a consequence of poor irrigation practices has long been a priority concern, and was already recorded as a cause of crop yield reductions some 3,800 years ago. It is estimated that in 1970 half the irrigated areas in central and southern Iraq were degraded in this way. In 1978, a land rehabilitation programme was initiated, comprising concrete lining for irrigation canals and the installation of field drains and collector drains. By 1989, a total of 700,000 ha had been rehabilitated [2]. Recent estimates showed that 4% of irrigated areas were severely saline, 50% moderately saline and 20% slightly saline (i.e. a total of 74% of irrigated land suffered from some degree of elevated salinity). Irrigation of date palms with highly saline water has been practiced since 1977, while the use of brackish groundwater for tomato irrigation has also been reported in the south of the country [2].

A shortage of water may arise between 2020 and 2030 in the Tigris and Euphrates rivers due to growing demand in the riparian countries and that an emergency situation will develop already around 2020 because the expected annual 4 km³ of water remaining as surplus in the two rivers will not be sufficient. Since water shortages are forecast to occur with the development of irrigation, solutions have to be found for an integrated basin-level planning of water resources development.

Another main issue in water resources management is protection of water quality. The level of salinity especially in the Euphrates River is high and is expected to increase with the development of irrigation in the basin and, as a consequence, the diminutions of the water flow particularly in the dry season. It is therefore, with excessive use of water in irrigation and high evapo-

transpiration rate, urgent that adaptive management practices such as drip irrigation, conventional residue management should be adopted throughout the watersheds in order to secure long-term ecosystem productivity and sustainable agricultural communities.

It can be concluded that carry out a comprehensive assessment for the sector as a whole to include water for: basic needs, cities, food security, industry and energy, maintenance of ecosystems and restore water and sewage services immediately to a minimum acceptable standard. In addition, responsibility improvement in water management in Iraq will require substantial investment, which must, at least initially, come from outside sources. Needs and opportunities for water-related investments must be identified and prioritized, costs estimated, economic feasibility determined, and financing and repayment plans prepared.

CONCLUSIONS

The quantity of water flowing into Iraq has declined in the recent years. Water quality has also declined due to the lack of sufficient water treatment facilities and malfunctioning of existing facilities; large percentage of untreated wastewater is directly discharged in the water courses, irrigation canals and drainage ditches. Iraqi strategic interest in water resources in vulnerable to the upstream practices.

The construction and operation of the Ilisu dam which is as the major component and the largest dam in the project network, will significantly affected the hydrology of the Tigris river through change the seasonal flow pattern by capturing all expect large flood flows in the spring and releasing them in the fall and it will create large daily flow fluctuations whose influence would be felt more than 65 km downstream at the Iraqi border. Therefore the majority of water in Iraq is affected by the GPA, project, which has already caused a significant change in the flow regime of the Euphrates and to a lesser extent the Tigris, both in terms of quality and quantity. The reduced flow of the Euphrates has already caused increased salinity in the lower reaches of the river, seriously affecting agriculture.

Desertification is one of the greatest environmental and development problems in Iraq. Some of the people live in the dry lands, whose biological productivity is under threat from the progressive degradation of soils and other natural resources. Desertification can trigger a vicious circle of environmental degradation, impoverishment, migration and conflicts, often also putting the political stability of Iraq at risk.

. The movement of large populations from one area to another can cause tension, hostility and sometimes violence among ethnic groups by:

- **Intensifying competition for land and water resources:** The decline in incomes from desertification, combined with factors such as population growth and limited access to labor markets, can exacerbate conflicts over land resources and stimulate migration.
- **Intensifying tension or hostility among ethnic groups:** Tension among different ethnic groups in some countries may increase if population movements force them to share scarce farmlands, forests, grazing lands, or water resources.

- **Intensifying pressure on urban centers, infrastructure and environmental resources: Our world is going through an ecological transition in which desertification and climate change are becoming major challenges. These challenges are not new, but they did not receive enough attention in the past. Desertification is caused by a combination of multiple social and biophysical factors rather than by a single variable alone. The recent Ecosystems Assessment Report indicates that desertification threatens over 41% of the land.**

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