Assessing the Over-Withdrawal Impacts on the Quantity and Quality of Water in the Karoun River in Iran

HOMAYOUN MOTIEE (Ph.D.)[1], FARHAD NADIM (Ph.D.)[2]

[1] Power and Water University of Technology (PWUT) – Tehran- Iran

Currently : Research Associate, Faculty of Engineering, University of Guelph ,Guelph, Canada

Email: hmotiee@uoguelph.ca, Motiee@pwut.ac.ir

[2] University of Connecticut, Department of Civil and Environmental Engineering,, Storrs, Connecticut USA. E-mail: fan02001@engr.uconn.edu

ABSTRACT

Karoun River is Iran's most important river with the highest amount of flow located in western part of the country. Karoun River plays a major role in developing the western provinces of Iran. A number of water projects such as large reservoir dams, pumping stations, diversion dams are already commissioned and operational in different parts of Karoun River. These structures have made significant changes in the hydrologic and hydraulic behavior of the River. Moreover, water transfer systems divert water from upstream section of Karoun for water demands of the arid and semi-arid central parts of the country. The quality of water in Karoun has demonstrated a degrading trend, because untreated urban and industrial sewage conveying household and hospital sewage as well as agricultural runoff carrying pesticides and fertilizers enter the River on its path to the Persian Gulf.

The aim of this paper is to illustrate in general how natural purification and filtration of Karoun will be disrupted during dry seasons particularly with intensification of drought. In this regard the health of the population living in the cities near this river utilizing the water for drinking purposes faces serious risks. Further reduction in the flow of Karoun River will certainly lead to increasing pollution, sedimentation and salinity of the River, and will have the impacts on the residents living along the banks of this river.

Keywords: Karoun River – Dams – Iran – Khuzestan province - Sedimentation - Water quality — Water transfer

1. Introduction

Population growth, increasing agricultural and industrial activities and urban demands in the past few decades have resulted in over-withdrawal of surface and ground water. High withdrawal rates have placed immense pressure on water resources in developing parts of the world.

To meet the increasing water demand, water resource managers are turning their attention to higher extraction of water from rivers, lakes and aquifers.

To utilize surface water, engineers are constructing reservoir dams, diversion dams and pump stations to reserve and transfer water to cities and agricultural fields.

Over extraction of ground water from aquifers has caused water tables to drop in the aquifers. Some regions in the world have completely depleted their groundwater resources because of over withdrawal. On the other hand, stress on surface waters such as rivers, has changed their hydraulic regimes, discharges, sedimentation and pollution buffering capacity.

At the present time, one of the most important problems of rivers is pollution by untreated urban and industrial sewage conveying household and hospital sewage as well as agricultural runoff carrying pesticides and fertilizers. In river systems, there are two factors that can intensify this problem: one is over withdrawal of water causing a drop in discharge, and second is pollution entering rivers with low flows.

In developing countries such as Iran, stress on surface and groundwater resources is more profound due to unsustainable development. The population of Iran has grown

from 30 million in 1970 to 72 million in 2008, and it is expected to reach 100 million by 2020

The aim of this paper is to demonstrate how the factors such a s growth of population, drought, and wastewater streams from urban areas near Karoun River, is gradually diminishing the quantity and degrading the quality of water in this river.

2. Karoun River characteristics

Karoun is Iran's most important river with the highest amount of flow located in western part of the country. Karoun originates from the Zagros Mountains and discharges into the Persian Gulf in Southwestern Iran (Figure 1).

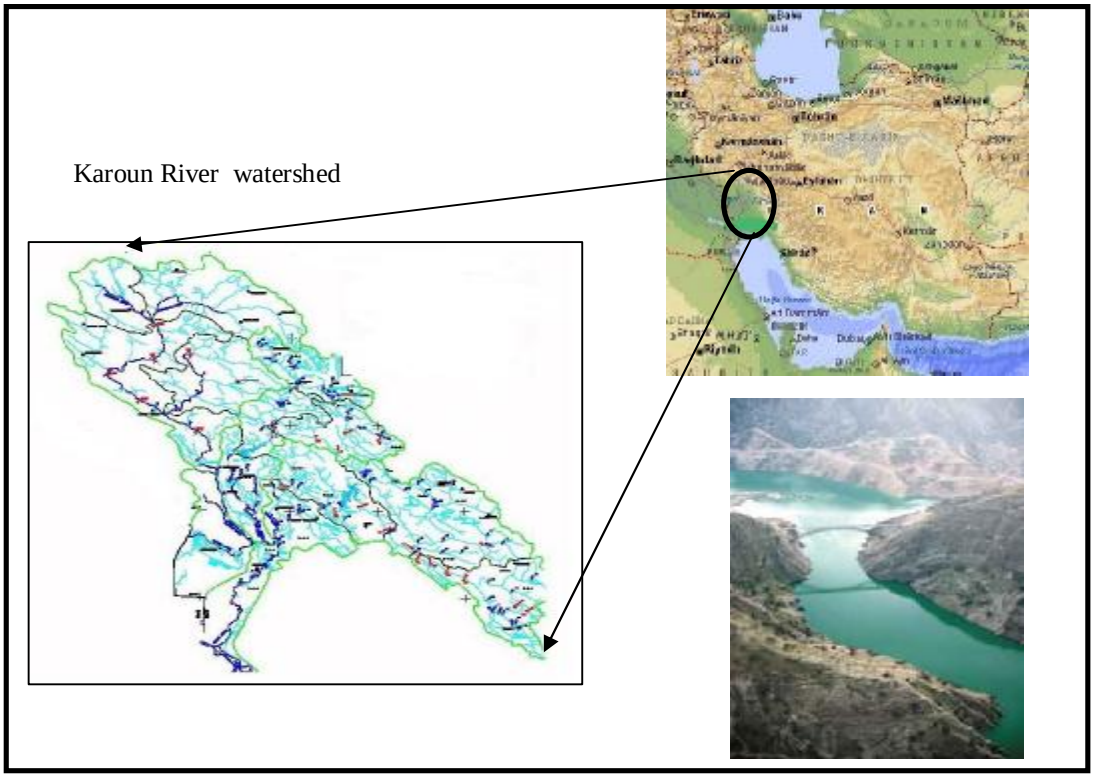

Figure 1 – Geographic Location of Karoun River watershed in sought west of Iran, with a photo in the Zagros Mountain(Right)

Karoun River has many tributaries in upstream sub watersheds, the largest tributary of Karoun is the Dez River. The total area of the river watershed is estimated at 66,930 km^2, of which 52,630 km^2 is covered with mountains and 14,300 km^2 is grass land and plain. The total area of its watershed in the Khuzestan Province is estimated at 21,600 km^2, with 75% in plain area. Khuzestan province is in south western part of Iran with high potential for surface water production.

Karoun plays a major role in developing the western provinces of Iran (Hassounizadeh et al.,2004). The total length of the Karoun River is about 1360 km, of which 900 km flows through the Khuzestan Province with an average annual flow of 450 m^3/sec (in Ahvaz city, southwestern part of the river). The Karoun River is the major source of water for 4.5 million people in the Khuzestan province. It should be mentioned that the total fresh water balance (surface and groundwater) in Iran is estimated at 100 to 130 × 10^9 m^3. The Karoun River alone accounts for 20 to 25 × 10^9 m^3 of this water balance which is nearly 1/6 of the total water balance in Iran (SalaviTabar, 2002).

Figure 2- Map of Iran and Khuzestan province in sought west(Google Earth, 2008)

The Karoun River alone accounts for about 30% of the total potential surface water resources of the country and supplies 70% of the domestic water demand to more than 2 million people in the Khuzestan province. It also supplies 70%, or about 9 billion m^3, of the irrigation water demand and 90%, or about 1 billion m^3 of the industrial demand of the province.

3. Dam projects on Karoun River:

A number of water projects such as large dams, and small diversion dams, pumping stations, etc are already commissioned and under construction/operation in different parts of the Karoun River, and its principal tributary (the Dez River) since 1960 (Figure 3).

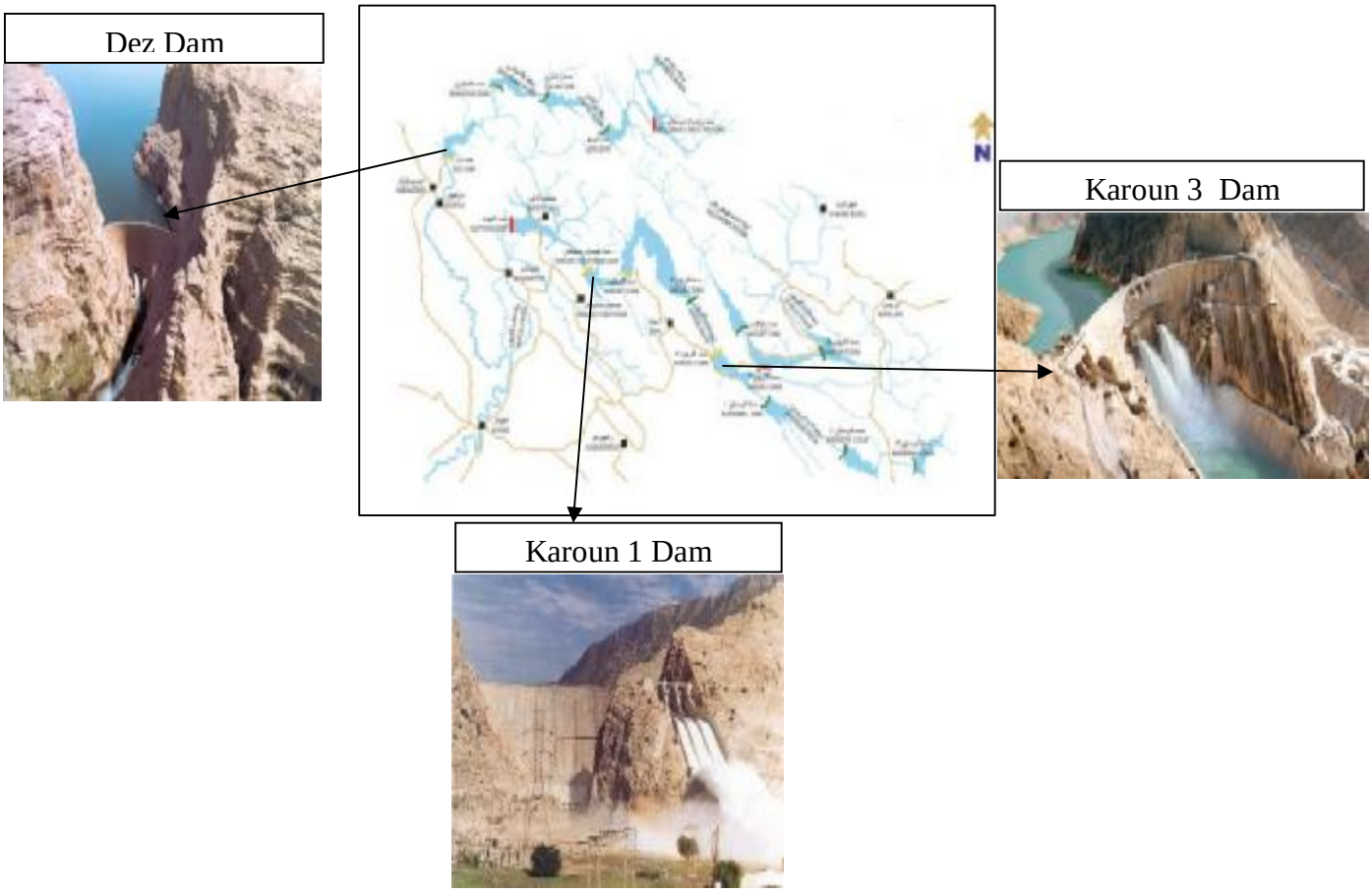

Figure 3 – Dams construction on Karoun River

Some hydraulic structures are constructed for hydropower plant, irrigation, and domestic industrial water supply. With this result, there are significant numbers of water projects which are either under construction, design or study.

Eleven large dams have been designed for the upstream tributaries of Karoun, among them 5 are either constructed or under construction. In 1977 the second largest dam in Iran was built on Karoun River. Karoun-1, with a height of 200 meter and a reservoir of 2.9 billion cubic meters, is one of the 7 large dams to be built within a cascade reservoir arrangement on Karoun River. Apart from water regulation, the main objective of these reservoirs construction is hydropower generation (installed capacity equal 620 MW in Dez and 1000 MW in K-I), (Motiee, 2000).

In 2005, in upstream section of Karoun-I dam, construction of Karoun-3 (another large concrete dam) was finished with a height of 205 meter and a reservoir of 2.75 billion cubic meter.

During the next decade, three large dam projects on the Dez river, as well five large dam projects in the upstream tributaries of Karoun River are planned. Each of these projects has an impact on the environment of the Karoun River watershed not only on its upstream but on its downstream sections as well.

Moreover, the Dez river, which is the most important tributary of Karoun, 5 large dams are being studied. Dez concrete arch dam was the first large reservoir constructed on Dez river in 1962 with a reservoir volume of 3.0 billion cubic meter, and a hight of 203 meter(Figure 3).

4. Water transfer from Karoun River to central arid regions

Water deficit in some parts of the eastern and the central parts of Iran is so severe that water conveyance from other provinces, despite its high cost values, seems to be the only solution. The project of conveyance of surface water from upper Karoun River to Isfahan and Yazd provinces, in the central Iran, is a good example, which was fulfilled in 2000 (Motiee,2000)

In this regard, more and more, the Karoun River has become the source of water transfer to arid areas of central and southeastern Iran such as Yazd, Esfahan, Qom, Mahallat,, Kashan and Rafsanjan (Figure 4). Water transfer projects in recent years has caused serious concern for the people of Khouzestan province who mostly live in the south part of the Karoun River Delta.

Despite high demand for water transferring from Karoun tributaries to the central regions of Iran, Water resources experts believe that transfer of water from another water basin and from a long distance, in long term will have, different effects on the natural environment of the Karoun watershed (Abrishamchi et al, 1999).

In addition, planners have to pay careful attention to the impacts this solution may place on the environment. Water transfer from Karoun may be a proper solution for central regions of Iran with severe water shortage, provided that a comprehensive environmental impact study is carried out prior to the implementation of such plans.

Figure 4 – Transfer of water from upper of Karoun river to eastern cities

5. Impact on water quality of Karoun River:

As mentioned earlier, the Karoun River has been the source of civilization in Iran's southwest since 4000 years ago. Many historic cities have been built near this river and its tributaries and they still exist today. Rapid development and growing of the population has occurred in the watershed, particularly along the river, and has had significant pollution impacts on the river water quality.

There are three major causes of pollution in Karoun River;

I – drainage waters from agricultural lands

II – untreated urban wastewaters

III – untreated industrial wastewater

The irrigated lands within the watershed have been growing from 100,000 to more than 700,000 hectares within the last 10 years and further expansions are being planned

(Sarsang et al., 2008). Sugar cane and wheat are the major crops. An important increase in the number of industries related to sugar cane, paper mills, petrochemical and steel industries, have been built in the province of Khuzestan. About 90% of the industrial facilities of the province are located within the river watershed. The banks of the Karoun River have also experienced rapid development of the aquaculture. As a result, this development has created a rapid expansion of the population within the watershed.

All these activities that compete for the water resources discharge their untreated effluents and wastewaters into the river, thus significantly degrading Karoun's water quality.

According to Sangsar et al (2008) ' approximately 1.5 billion m^3 per year of drainage water from agricultural fields, about 200 million m^3 per year of industrial effluents, and 150 million m^3 per year of urban sewage are being discharged into the river".

There is estimated that industrial, municipal, and agricultural pollution sources contribute to approximately 19%, 26%, and 55% of the water quality of the river, respectively (Karamouz, 2004).

6. Impact of over withdrawal of water on Karoun River

Over withdrawing such as construction of large dams and water transfer from Karoun will have has many long-term negative impacts on this River. These impacts includes:

1- The level of contaminants in the river will increase. If the rate of water storage behind the large dams and water transfer increases, the entire River eco-system including aquatic organisms and plants in the north and south of the River will face major ecological stress. The quality of water in Karoun has demonstrated a degrading trend, due to discharge of untreated urban and industrial sewage conveying household and

hospital sewage as well as agricultural runoff carrying pesticides and fertilizers enter the River on its path to the Persian Gulf. Therefore, the environmental impact can be transfer to the Persian Gulf with entering of pollution from Karoun to Gulf's water. An estimated 1.6×10^9 m^3 of wastewater entering Karoun has turned the historical symbol of life and culture in Khouzestan to one of the most polluted rivers of Iran. If the natural flow of Karoun is not maintained, the amount of wastewater entering the river on a daily basis can swiftly increase the rate of the pollution in this River.

2- Decreasing flow in Karoun has led to the intrusion of brackish and saline waters from the Persian Gulf (Figure 5). To avoid this negative impact, the minimum discharge of Karoun must not be less than 131 m3/s or 4142 million m3 per year (Salemi et al.,2004). If the amount of water flowing in Karoun drops below this level, the highly saline water of the Persian Gulf enters the River and reaches the rich soils of date palm orchards and destroys orchards and the agricultural lands (Emamzadeh & Khosronehad,2004).

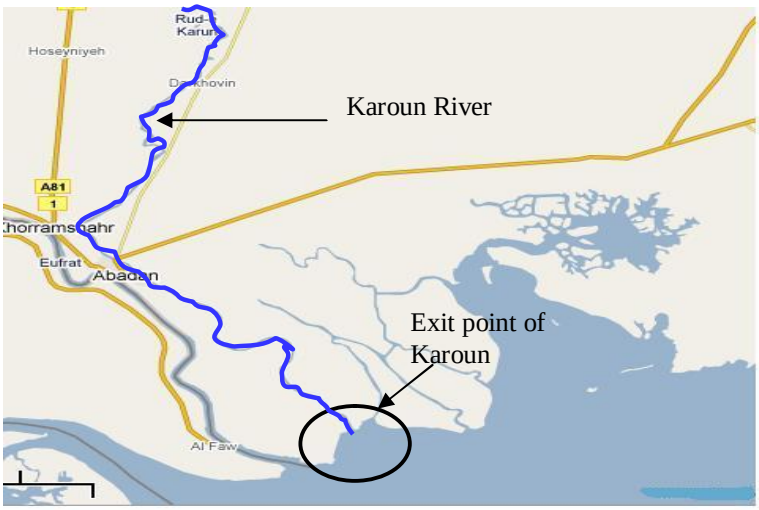

Figure 5 –Entering point of Karoun River to Persian Gulf

3- Increasing sedimentation in the southern part of the River, due to decrease in average annual discharge (Zahiri & Kordestni, 2004).

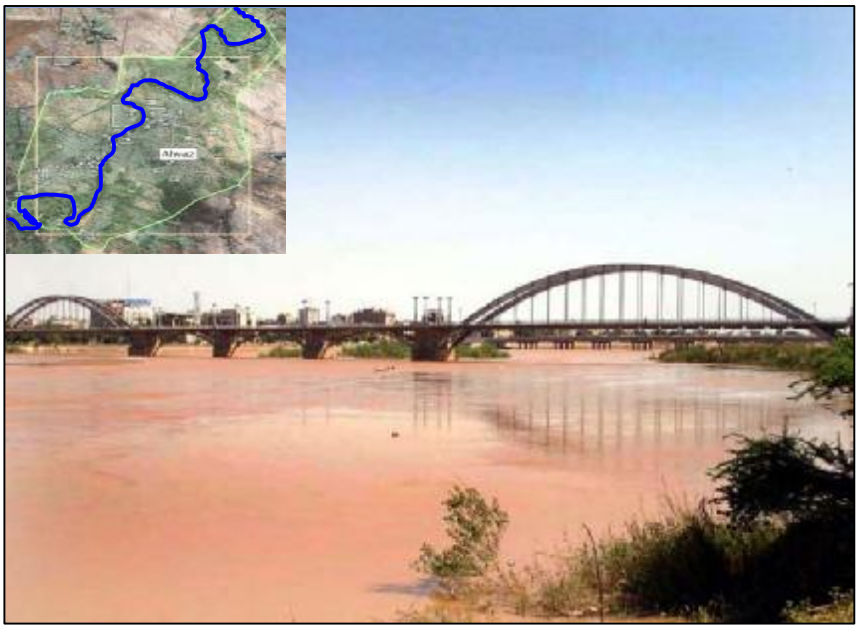

Figure 6. Picture of Karoun River in Ahvaz city, capital of Khozestan province with a water sediment flow

4- Moreover, 2.5 million m^3 of water from the Karoun River as well as $1.6 billion of investment has been allocated for development of sugar cane fields in the Khouzestan province. Fish farming in a surface area of 25,000 hectares on the banks of Karoun, presence of hundreds of large and small-scale agricultural farms, more than 2,000 traditional pumps and 4 million hectares of arable land within the flood plains of Karoun all point to the fact that water transfer from upstream reaches of Karoun is unjustifiable (Ghomeyshi,2004)

According to. Ghomeyshi (2004) : " Karoun irrigates more than 1/4 of all agricultural lands in Khouseztan and the budget that has been allocated for water transfer from

upstream sections of Karoun to central regions of Iran can be used to build irrigation and drainage system for 1.4 million hectare additional agricultural fields. On the other hand, people in Khouzestan suffer form water shortage due to water transfer from Karoun to central regions of Iran.

The 1998-99 and 2008 drought experience in Khouzestan showed that diversion of more than one billion m^3 of water from upstream branches of the Karoun River has severe negative impacts on downstream reaches of this vital and important river in southwestern Iran.

There is no doubt that one of the factors urging the implementation of water diversion of the Karoun River in upstream reaches was the large depth of the River. The decisions to transfer water from the Karoun River to locations other than the downstream regions have completely ignored the ecological and environmental realities of this river system.

7. Conclusions

The fact has been accepted that based on world's defined standards, Iran with a population around 72 million is heading towards a major water crisis and will soon find itself facing serious problems to provide sufficient water for the population in need.

As demonstrated earlier, with fast growth of population, economic activities, and long period of droughts in central regions of Iran, there is an intense pressure to over use Karoun River for different purposes. This means that the water managers in the country are trying to use the energy of this river not only in its watershed but also in the other parts of the country for electricity and water transfer purposes. This over use of water is certainly beyond the capacity and environmental demands of Karoun..

As a result, natural purification and filtration of Karoun will be disrupted during dry seasons, as well the health of the population living on the banks of this river utilizing the water for drinking purposes. The risk of the people's health in Khuzestan province is in high level particularly in drought periods such the summer of 2008. Further reduction in the flow of Karoun River will certainly lead to more pollution, sedimentation and salinity of the River.

A detailed environmental impact study in the Karoun's drainage basin can provide sound information for the feasibility of further expansion of the existing water project systems in its watershed. If such studies conclude that no additional water can be diverted from Karoun, then other plans such as water management should be provided for protection of its life. Water management schemes including water conservation, installation of advanced irrigation systems, and construction of wastewater treatment facilities can substantially reduce the amount of water that is usually lost under improper management schemes.

References:

- Abrishamchi,A, Sarghami,M., Tajrishi,M., Elahipanah,N.(1999), " Interbasin Water transferring and necessity to respect the standards", Proceeding of the ", Tehran, Iransecond Asian Water and Wastewater conference

- Ghomeyshi, M. (2004), " Effects of the Karoun River water transforming ", Interbasin water transferring workshop, PWUT, Tehran, Iran.

- Hassounizadeh,H., Hemmadi,K., Golabkesh, S.., (2004), " Assessement of salinitation of Karoun river after water transferring to central part of Iran",

- Karamooz, M. (1998). Water Resources Management in Iran, Asian Conference on Water and Wastewater Management, Tehran, Iran.

-Karamouz M (2004) Assessment of water quality management in the province of Khuzestan in Iran. Khuzestan Department of Environment. The cooperation of World Bank Institute and Iran's Department of Environment

- Motiee, H. and Darakhani, J. (2000). Dam Construction Development in Iran During the 90's. Third Canadian Dam Assocaiation, Regina, Canada.

-Salemi S.,Firouzbakht,A. (2004) , ", Impact of water transferring projects to the water resources of Karoun watershed", Interbasin water transferring workshop, PWUT, Tehran, Iran

- SarangA., Vahedi, A., Shamsai, A. , (2008), How to Quantify Sustainable Development: A Risk-Based Approach to Water Quality Management, Environmental Management (2008) 41:200–220),

- Salavitabar, A., (2002). Integrated water resources management and inter basin water Transfers, Mahab Ghods consulting engineering, Tehran

-- Zahiri, A., kordestai, S.M..(2004), " Influence of water transferring of Karoun River on the sedimentation of the River", Interbasin water transferring workshop, PWUT, Tehran, Iran.