African Journal of Hospitality, Tourism and Leisure, Volume 7 (4) - (2018) ISSN: 2223-814X


# Spatial variation of surface water contamination by heavy elements in Alhira relative to tourism

Safaa M. Almudhafar* and Hassan Allawi Abboud
Faculty of Arts
Department of Geography
University of Kufa
Najaf, Iraq
Email: almudhfars@gmail.com

Corresponding author*

**Abstract**

Tourism to Iraq requires far more political stability and security, and it is able to become a key growth sector. Today it is however underdeveloped and somewhat neglected, due to wars, and perceived and real volatility and uncertainty. The Ministry of Tourism has huge capacity constraints and there are numerous barriers to tourism such as water quality.

This study included the estimation of concentrations of heavy elements (Al, Fe, Ni, Cd, Zn, Cu, Pb) in water using the spectrophotometer (German, Model 2013). The study was based on the collection and analysis of 28 samples of surface water and 14 sites in the study area with 2 samples for each site and for two seasons. The study found that there is a spatial and temporal variation in concentrations of heavy elements, where concentrations increase in the summer and less in the winter. The study also showed that surface water in the study area is contaminated with heavy elements. For most of the studied sites and seasons, their concentrations surpassed each of the global determinants of WHO and Iraqi determinants of potable water and are not suitable for irrigation according to the FAO, Iraq and the Iraqi Determination of Irrigation. This water is unsuitable for animals to exceed permissible limits. Particular attention should be given to the Iraq rivers, which are supported the highest contamination levels among the studied rivers, but also concentrates on many important agricultural industries and includes areas of international tourist interest. The canal water has attracted millions of tourists, visitors and also local peoples of Najaf. The river water is the most important source of drinking and irrigation water located at the Najaf governorate. Water is critical to life and thus vital for tourism to succeed.

**Keywords:** surface water, FAO, WHO, heavy elements, contamination, spectrophotometer, tourism

## Introduction

Tourism development is a huge contributor to economic, social, cultural and political growth in a country like Iraq and investing in tourism ventures such as hotels, tourists villages and developing the existing infrastructure in order to create a new and attractive tourist environment is critical (Al-Gamre & Jabber, 2017).

New types of tourist centres can be established such as water parks and desert resorts but this will require a carefully crafted set of guidelines for the planning, designing and construction of such parks, and resorts that are suited to Iraq's desert climate. For example an integrated "water city", can be constructed providing special recreation and aqua-adventure facilities for water sports and swimming pools (Ali, 2018).

The southern parts of Iraq in particular have advantages which makes it possible for them to produce successful water parks for tourists but the private sector needs to become involved in such projects as water parks will attract the attention of local businesses and foreign investors and such initiatives will create jobs and alleviate poverty (Ali, 2018).

Iraq has the 74th-largest total renewable water resources in the world (89.86 $km^3$) and its water is a necessary requirement for every living being. About 70 percent of Iraq's water comes from rivers and marshes collectively used with its neighbours, especially the Tigris and the Euphrates rivers - both of which run through Turkey. A great responsibility falls on the shoulders of the Iraqi government to plan its water security (Ibrahim, 2018). Water is an essential element of life and water sources have witnessed a significant deterioration in recent periods, due to lack of attention to them. In fact the recent years have been characterized by a significant deterioration in the natural environment, especially pollution of the aquatic environment.

Water pollution is defined as any change in physical, chemical and biological properties occurring in water through the addition of substances that are foreign to its natural constituents. They may be dissolved or suspended solids, or dissolved organic or inorganic substances or live microorganisms such as bacteria, algae, parasites, chemical elements, heavy metals. Which makes the water unsuitable for drinking or household consumption, nor is it suitable for use in agriculture or industry (René, 1981) and certainly not for any tourists. Therefore, this pollution can cause water degradation, leaving the water untreated and without good management would be catastrophic for both locals and tourists from abroad.. So it will pose a great danger to humans and other living organisms. Figure. 1 shows the study area.

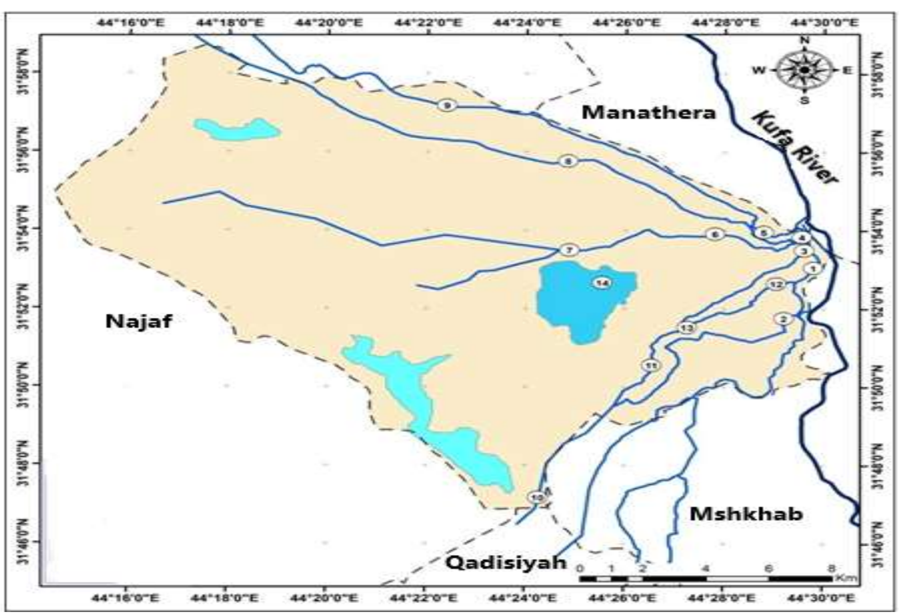


**Fig. 1.** Sampling sites in the study area

The rivers are essential to the population and is one of the important freshwater ecosystems in Najaf. Besides providing potable water for drinking purposes, the river supplies water for manufacturing and agriculture. It provides considerable sources of food and acts as a breeding ground and is a sanctuary for aquatic organisms.

The economic value posed by this ecosystem makes its suitable for aquaculture activities, the source of food, nature tourism, recreation, and genetic resources. The rivers, lakes, and marshlands are natural inland freshwater that originated from a meteorite impact, rains and floods, and serve many functions including water for drinking and domestic use, fishing, transportation, tourism and landscape entertainment. Therefore, safeguarding the quality of water in the rivers, lakes, and marshlands and its surroundings is a great responsibility of the government of Iraq, researchers, and environmentalist for the conservation of this important water resource and world heritage site.

## Materials and Methods

The importance of this research, which focuses on one of the water problems, is the pollution of surface water in Alhira by heavy elements, because the waters in the region lack such studies and their distribution, sources, spatial distribution and temporal changes need to be known, given the absence of a previous study. Therefore, this study was based on 13 field visits to the study area and it was based on the method of visual observation and direct personal interviews with purposively selected respondents in the study area. The study was based on the collection and analysis of 28 samples of surface water and 14 sites in the study area and 2 samples for each site and over two seasons. The total number of elements that were measured was 392 in July 23/7/2017, and the second analysis was in February 23/2/2018. Heavy elements (Al, Fe, Ni, Cd, Zn, Cu, and Pb) were analyzed. The chemical tests were conducted in the laboratory of the Department of Soil and Water Sciences at the Faculty of Agriculture University of Kufa, using the German Spectrophotometer, the model 2013, for the purpose of conducting measurements of heavy elements.

The spatial limits of the study area are the administrative boundaries of Alhira, one of the areas of Al-Manathera district in Najaf Governorate, which is located in the northeastern part of Najaf Governorate, making it an astronomical position between longitudes (44.16- 44.28) east and between two latitudes (31.48 - 32.00) north. The study area is characterized by a network of rivers and streams branching out of the Euphrates River, which are the six main sources, in addition to Shatt Jahat, which branches out of the water network in the region. However, the selected locations represent portions of the coastal zone where the main development, the maritime, industrial and tourism activities take place. Karbala and Najaf are the most popular tourist destinations in Iraq due to the religious sites in the country.

## Results and Discussion

The results of laboratory analysis of concentrations of lead (Pb) in surface water show that there is temporal and spatial variation in lead concentrations (Table 1). Lead concentrations exceeded the WHO standard and Iraqi standard of 0.01 mg/l (WHO, 2017). So water is not drinkable in all the studied sites and this was the case for the two seasons. Concentrations ranged between

0.448-5.406 mg/l during July and ranged from 0.023-3.932 mg/l during February. Water is not suitable for irrigation either according to the FAO standard of 0.01 mg/l (FAO, 1999) and the Iraqi standard of 1 mg/l (Central Agency for Standardization and Quality, 2014). Water is not suitable for drinking animals to exceed the permissible limit of 0.1 mg/l, according to the classification of Ayrs and Westco (Ayres & Westcot, 1989). Note that surface water in the study area is also highly polluted by lead. The maximum contaminant level goal for lead in drinking water is zero as lead is a highly toxic metal that is harmful to human health even at low exposure levels. Once it's consumed, lead competes with calcium to be absorbed by the body and several studies in lab animals have found that exposure to lead compounds by either swallowing or any other means, can cause cancer (American Cancer Society, 2018).

The results of the concentrations of Cadmium (Cd) in surface water show that there is temporal and spatial variation in Cadmium concentrations (Table 1). Cadmium was exceeded the WHO standard and Iraqi standard of 0.0001 mg/l. Concentrations ranged between 0.24-4.592 mg/l during July and ranged from 0.190-4.062 mg/l during February. It is not drinkable in all the studied sites and for the two seasons. Water is not suitable for irrigation according to the FAO standard and the Iraqi standard of 0.01 mg/l. Water is not suitable for drinking animals to exceed the permissible limit of 0.05 mg/l, according to the classification of Ayrs and Westcot (Ayres & Westcot, 1989). It was found that the water is not suitable for aquatic life because it exceeded the permissible limits of 0.0002 mg/l. Note that surface water in the study area is highly polluted by Cadmium. The results of the Iron in surface water show that there is temporal and spatial variation in Iron concentrations (Table 1). Iron was exceeded the WHO standard (0.3 mg/l) and Iraqi standard (0.5 mg/l). It is not drinkable in all the studied sites and for the two seasons. Water is suitable for irrigation according to the FAO standard and the Iraqi standard of 5 mg/l, except the sites S14, S10, S8, S7, and S6. The water assessment for industrial purposes according to Fe concentrations is considered to be unsuitable for use in the textile and paper industries because it exceeds the allowable limits of (0.01,0.3) mg/l each of them, excluding sites S12, S4, S3, S2, S1 during the months of July and February. The water is not suitable for use in the cement industry and for most of the covered sites and for the two seasons that it exceeds the permissible limit of 1.8 mg/l, excluding sites S4, S3, S2 and S1 during July and February and S12 during February only. The results of surface water show that there is temporal and spatial variation in Copper concentrations (Table 1).

Copper did not exceed the WHO standard (2 mg/l), except at sites S5 and S14. Water is not suitable for irrigation according to the FAO standard and the Iraqi standard of 0.2 mg/l, except the sites S1, S3, S4, S12, S13. Water is not suitable for drinking animals to exceed the permissible limit of 0.5 mg/l, according to the classification of Ayrs and Westcot (1989), except the sites S13, S12, S4, S3, S2, S1. The water assessment for industrial purposes is considered to be unsuitable for use in the paper industries because it exceeds the allowable limits of 0.5 mg/l (Hem,1989), excluding sites S13, S12, S4, S3, S2, S1 during July and February. The results of surface water analysis show that there is temporal and spatial variation in Zinc (Zn) concentrations (Table 1). It also exceeded the WHO standard (0.1 mg/l) and Iraqi standard of 3 mg/l, except sites S12, S6, S4, S2, S1. So water is not drinkable at all in all the studied sites. Water is suitable for irrigation according to the FAO standard (20 mg/l). Water is suitable for drinking animals as it agrees with the permissible limit of 24 mg/l, according to Ayrs and Westcot (1989).

The results of laboratory analysis of Nickel (Ni) in surface water show that there is temporal and spatial variation in Ni concentrations (Table 1). It exceeded the WHO standard of 0.07 mg/l and

Iraqi standard of 0.02 mg/l. So it is not drinkable in all the studied sites and for the two seasons. Water is not suitable for irrigation according to the FAO standard of 0.02 mg/l. The results show that there is temporal and spatial variation in Aluminum (Al) concentrations (Table 1). Water exceeded the WHO standard (0.1 to 0.2 mg/l) and Iraqi standard of 0.2 mg/l, except sites S3, S1. Water is however suitable for irrigation according to the FAO standard (5 mg/l).

**Table 1** Heavy elements (mg/l) in the water of the study area for 2017-2018.

| location | SC | Pb | | Cd | | Fe | | Cu | | Zn | | Ni | | Al | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jul | Feb | Jul | Feb | Jul | Feb | Jul | Feb | Jul | Feb | Jul | Feb | Jul | Feb |
| Center of old Juhat river | S1 | 0.45 | 0.02 | 0.24 | 0.19 | 0.22 | 0.19 | 0.34 | 0.12 | 5.07 | 3.00 | 1.31 | 0.21 | 0.27 | 0.02 |
| Beginning of old Jehat river | S2 | 0.88 | 0.11 | 0.79 | 0.51 | 0.27 | 0.20 | 0.86 | 0.35 | 2.73 | 1.09 | 0.96 | 0.71 | 0.94 | 0.52 |
| Beginning of Hashemi river | S3 | 0.91 | 0.32 | 0.12 | 0.10 | 0.41 | 0.29 | 0.10 | ND | 5.46 | 3.34 | 0.44 | 0.29 | 0.25 | 0.10 |
| Beginning of Badriya river | S4 | 1.53 | 0.81 | 0.58 | 0.23 | 0.31 | 0.17 | 0.15 | 0.10 | 3.97 | 3.00 | 0.22 | ND | 1.40 | 0.85 |
| Middle of river Abu Idoua | S5 | 3.98 | 1.54 | 2.90 | 2.52 | 2.95 | 2.04 | 2.86 | 2.42 | 8.90 | 8.00 | 5.87 | 3.26 | 1.37 | 1.01 |
| Midway of Badriya river | S6 | 2.92 | 2.20 | 2.69 | 2.01 | 5.3 | 5.03 | 0.82 | 0.54 | 4.29 | 2.36 | 1.78 | 0.41 | 1.40 | 1.12 |
| End of Badriya river | S7 | 2.61 | 2.00 | 1.34 | 1.00 | 7.82 | 5.09 | 1.10 | 1.06 | 5.51 | 4.88 | 2.70 | 2.05 | 1.72 | 1.22 |
| Beginning of Abu Idoua river | S8 | 3.53 | 1.68 | 3.14 | 1.95 | 8.22 | 7.44 | 1.15 | 0.70 | 6.63 | 4.87 | 6.13 | 4.85 | 1.09 | 0.76 |
| Sudair river near control of strategic line | S9 | 2.34 | 1.81 | 2.24 | 2.01 | 4.50 | 4.09 | 1.63 | 1.25 | 5.85 | 5.01 | 1.04 | 0.11 | 1.56 | 0.67 |
| End of Hashemi river | S10 | 2.14 | 1.48 | 4.03 | 2.38 | 5.95 | 3.15 | 1.54 | 1.04 | 4.42 | 3.52 | 4.96 | 2.05 | 1.84 | 1.31 |
| center of the Hashemi River | S11 | 1.92 | 0.91 | 1.14 | 1.01 | 2.09 | 1.15 | 1.73 | 1.29 | 4.68 | 4.00 | 2.13 | 2 | 1.56 | 0.65 |
| Beginning of Shahriya River | S12 | 0.86 | 0.19 | 1.79 | 0.52 | 1.44 | 0.35 | 1.88 | 0.14 | 3.90 | 2.99 | 0.04 | ND | 1.87 | 1.30 |
| End of the Shahriya River | S13 | 4.39 | 2.01 | 4.26 | 2.77 | 3.42 | 1.28 | 1.91 | 0.9 | 4.62 | 4.27 | 1.02 | 0.59 | 0.91 | 0.49 |
| Hor Aaljhbsa near Zahjhra | S14 | 5.41 | 3.93 | 4.59 | 4.06 | 8.10 | 8.01 | 4.93 | 4.75 | 8.45 | 8.01 | 7.06 | 5.81 | 2.94 | 2.09 |
| **Average** | | **2.42** | **1.36** | **2.13** | **1.52** | **3.64** | **2.75** | **1.50** | **1.13** | **5.32** | **4.17** | **2.55** | **1.86** | **1.37** | **0.86** |

**SC:** Sample Code**; ND:** Not Detect

The above rivers act as the chief artery to river-borne traffic wishing to go to upstream. The water itself is being utilized for various recreational activities and tourism. An increase in population and tourism, settling around Najaf has shown a gradual but small increase.

Iraq is considered to be an important potential site for ecotourism (https://www.telegraph.co.uk/travel/news/Iraq). The study area is very important for tourism, transportation, and fisheries, but there is limited information on heavy metal concentrations in the rivers of Najaf. There are many literature studies which examined the heavy metals contamination of different samples such as the soil, air, meat, and home water filters (Almayahi et al., 2014; Alduhaidahawi et al., 2015; Almayahi et al., 2016; Alduhaidahawi et al., 2017; Almayahi et al., 2018a, b). More than $400 million was invested in Iraq in 2011 alone, with most projects located in Erbil, Mosul, Basra, and Najaf and there is scope for growth if challenges are met

> "Religious tourism is booming in Iraq, especially in Najaf and Karbala, where millions of Shia pilgrims visit the holy sites every year," analysts at Euromonitor said. "The number of pilgrims to these areas is expected to rise to 7 million to 10 million visitors annually, partly boosted by the introduction of more flights. "As soon as the old regime ended, Shiite travellers were able to practice their faith in two holy Shiite cities, Najaf and Karbala; these two continue to welcome many Shiite arrivals every year, mainly from Iran and the Lebanon." (Bundhun, 2010).

Domestic religious tourism plays a role in boosting travel and tourism in Iraq. However, the issue of potable water, is still neglected and requires restoration in soon in order to fully benefit the travel and tourism industry and the country in general.

## Conclusions

The sustainable development of tourism will not be possible without concerted efforts to mitigate water pollution. The results show that there is a temporal and spatial variation in concentrations of the studied heavy chemical elements (AL, Ni, Zn, Cu, Fe, Cd, and Pb). They vary spatially between sites as concentrations increase in sites affected by human waste (civil, industrial, agricultural). As for the temporal, it varies between the seasons of the year. The water deteriorates in quality characteristics as we reach the areas of the tail of the rivers because of the impact of human waste and increased concentrations of pollutants in them.

As the water was not potable according to concentrations of heavy elements in it at the beginning of the branch and before entering the study area, this led to a discrepancy in the possibility of using it in most human activities, especially for drinking, in agriculture, industry and especially aquaculture. The study showed that there is a temporal and spatial variation in concentrations of the studied heavy chemical elements that exceeded the permissible environmental limits in most uses in most of the studied sites and for the two seasons in a row. Given that Najaf has the highest record of visitors in the few last years, urgent steps are needed to mitigate problems of water pollution. Water pollution is one of the key factors is an obstacle in the development of the tourism sector in Iraq and this problem has momentous impacts on the ecological, economic and social segments, and predominantly on the tourism sector which is an avenue to economic growth.

**Acknowledgment**

The authors acknowledge the financial support of the Kufa University, Iraq. The author is grateful to Dr. Basim Almayahi, University of Kufa (basimnajaf@yahoo.com) for assisting us throughout conducting the present research.

## References

Alduhaidahawi, F. J., Almayahi, B. A. & Abed, H. N. (2017). Environmental Assessment of Some Air Pollutants in the City of Hilla in Iraq. Prensa Med Argent, 103: 4.

Alduhaidahawi, F. J., Almayahi, B. A., Alasadi K. S. & Alasadi K. (2015). Gases Pollutants and Trace Element Concentrations in the Air of Najaf City, Iraq. International Journal of Environmental Monitoring and Protection; 2(4): 47-51.

Al-Gamre, N.A.A.& Jabber, M.A.A. (2017). The Management of the Marshes of Thigar Governorate in the South of Iraq and their Importance in Improving the Process of Tourist Development. *Arabian Journal of Business Management Review* , 7, 324.

Ali, A.H. (2018). Incentivising the private sector to develop domestic tourism in Iraq, *Al-Bayan Centre for Planning and Strategies,* Available online at http://www.bayancenter.org/en/2018/04/1501/

Almayahi B. A., Aseel F. A. & Ayad R. (2018a). Radionuclides and heavy elements in water deposits of Reverse Osmosis system filters in Iraqi houses. Medical Physics Journal Articles in Press, Accepted Manuscript, Available Online from 24 May.

Almayahi B.A., Hakeem, E., Alduhaidahawi, F.J. & Aqeela H. (2014). Heavy Metals Concentration in Different Soil Samples in Najaf City, Iraq. *International Journal of Engineering Trends and Technology* (IJETT), 16: 69-71.

Almayahi B.A., Laith, S. & Asmaa H. A. (2018b). Determination of Alpha particles and heavy metal contamination in meat consumption from Najaf, Iraq. Articles in Press, Accepted Manuscript, Available Online from 25 July.

Almayahi, B.A., Alduhaidahawi, F.J. & Kasim, K.A. (2016). Hydrocarbon and trace elements concentrations in Najaf city, Iraq. *Research Pharmaceutical, Biological Chemical Sciences*, 7 (1): 2127-2135.

American Cancer Society (2018). Lead. Available online at https://www.cancer.org/cancer/cancer-causes/lead.html
Ayres, R.S. & Westcot, D.W. (1989). Water quality for Agriculture. Irrigation and Drainage paper 29, Rev1, FAO, Rome, Italy, p.174.

Bundhun, R. (2010). Iraqi city's religious tourism set to grow - August 28, 2010, *The National*. Available online at:https://www.thenational.ae/business/travel-and-tourism/iraqi-city-s-religious-tourism-set-to-grow-1.511578

Central Agency for Standardization and Quality Control, Iraq. (2014). Drinking water standers, cent al organization for standardization and Quality, control, min, of planning.

Dunia Frontier Consultants. (2012). 2011 Foreign Commercial Activity in Iraq-February 2012. Iraq's Tourism Potential, Number 87 (4).

FAO. (1999). Guidelines for Irrigation Water Quality, ministry of environment human resource development and employment development of environment. U.S.A.

Hem, J.P. (1989). Study and interpretation of the chemical characteristics of natural water, *Geological survey, water supply paper*, p.258.

Ibrahim, A. (2018). Declining levels in Iraq's Tigris raise fear of water crisis, *News Grid*, Available online at https://www.aljazeera.com/news/2018/06/declining-levels-iraq-tigris-raise-fear-water-crisis-180607072317966.html

https://www.telegraph.co.uk/travel/news/Iraq-the-worlds-next-big-eco-tourism-destination/, Iraq: the world's next big eco-tourism destination?". (2015). Telegraph. Retrieved 2015-11-18.

René C. (1981), Water Pollution, Oweidat Publications, Beirut, p. 8.

WHO. (2017). Guidelines for drinking - water quality - 4th Edition.