Biological and Applied Environmental Research

Vol. 7(2): 170-177, 2023

https://doi.org/10.51304/baer.2023.7.2.170

ISSN: 2002-6153
Biol. Appl. Environ. Res.
www.baerj.com
editor@baerj.com

Climate Warming-Controlled Salinity Drives Toxicant Metals in Mesopotamian Wetlands

Mohammed J. Al-Haidarey[1*], Hiba Ibrahem Al-khalidy[1, 2] & Mohammed A. Hamdan[2]

[1] Department of Ecology, Faculty of Science, University of Kufa, Najaf, Iraq.
[2] Department of Biology, University of Baghdad, College of Science for Women, Baghdad, Iraq.

Corresponding author: mohammedj.alhayderi@uokufa.edu.iq

Abstract: Global warming is being accelerated because of anthropogenic reasons. This plays important role to change many aquatic ecosystems throughout the world. Warmer temperatures and reduced water level are the main two factors that influence greatly to increase salnity in fresh water ecosystems. In the wetland, the toxicant metals (e.g. Heavy metals) have increased dramatically over time because of human activities (anthropogenic) and natural-processes. At the same time, the climate change has affected salinization. Interesting, there are such studies about increasing of toxicant metals and salinity, while the role of elevated salinity in driving these metals needs more understood. Hence, this study comes out to evaluate the differentiation of some environmental toxicant metals in wetland ecosystems "Mesopotamian Marshes" that have elevated salinity levels. Salinity, water temperature, pH, DO, and turbidity were measures to investigate their effect on availability of toxicant metals which includes some heavy metals (Cd, Pb, Zn, Cr, As, Se, Hg, Cu, Ni, Fe, Mn), phenols, Oil and grease in these ecosystems. The concentrations of these toxicant metals were low in low salinity marshes and elevated in high salinity marshes. This study demonstrated that salinity drives environment of these metals. The acute and chronic concentrations of toxicants in all studied marshes were higher than the national recommended aquatic life criteria which means that the aquatic life at Mesopotamian marsh regions is threatened. Hence, we highly recommend studying this issue in more deeply.

Keywords: Climate warming, salinity, toxicant metals, Mesopotamian wetlands.

Introduction

Due to these unique properties of wetland production, they are known to sequester various forms of pollution through water and biological productivity. Marshland classified as a type of wetland (Mitsch & Gosselink, 2000). Depends on hydrological regime, three kinds of marshes are present (inland freshwater-marshes, tidal salt-marshes, and tidal freshwater-marshes). Salinization is the process of salinity increasing above than natural values (Nielsen et al., 2003). There are two sources could contribute salt to marshland: natural linked salinity and anthropogenic linked salinity, the natural are frequently related to saline marine water invasion, ground

Received: 12 March. 2023, Accepted: 26 June 2023.

water, or evaporation, while the anthropogenic linked salinity is due to anthropogenic activities such as pollution.

Mesopotamian marsh is a unique ecosystem in the world according to human culture (Ma'dan), provide a unique space for biodiversity and geographic location (Thesiger, 1964). The marshes were a critical component for the fisheries and water quality of the entire Arabian Gulf "Marshes act as filters and transport systems". This wetland has many challenges related to water shortage, climate change, and pollution (Alkam et al., 2014). The water discharge to these marshes, that comes mainly from the Tigris and Euphrates, decreased significantly over time (Pvalue= 0.04) (Figure 1, A). Conversely, salinity increased dramatically in those rivers (Fig: 1, B). The level of salinity in the Mesopotamian marshes also has been increased over time significantly (Tahir et al., 2008; Al-Kenzawi et al., 2010).

Increasing salinity affects the freshwater ecosystem structural and functional (2000; Erbert et al., 2015), and these salts could play a substantial role in: the organism metabolic functions (SalCon, 1997), biodiversity (Blinn, 1993), change the fish and macrophytes ecosystem community structure (Nielsen et al., 2003), change the attribution of major ions, and increase the effect of toxic component.

Generally, the fresh water in Iraq, and the habitats of the Mesopotamian marshes in specific suffered from different kinds of toxicants, and a lot of studies were mentioned to (e.g. Al-Haidarey et al., 2010; Al-Khafaji & Al-awady, 2014; Balasim et al., 2013; Alkam et al., 2014). Recently, the toxicant concentrations in the marshes have changed substantially (Al-Imarah, et al., 2017). The presence of pollutant, even in trace concentrations, could affect the marsh ecosystem in general (Al-Haidarey et al., 2010; Al-kenzawi et al., 2010) and may affect human health directly or indirectly (EPA, 1986; Vineis et al., 2011)

An increase in salinity is important to saturate the cation exchange capacity of the sediment, which could decrease the sediments ability to store heavy metals and reduce the wetlands capacity to sequester heavy metals pollution from the surrounding catchment. These attributes would theoretically prevent the attraction of heavy metals into the sediment; increase the availability of heavy metals in the water. In the wetland, generally, the toxicants (e.g. heavy metals) has increased dramatically over the years because of human activities (anthropogenic) and natural-processes. At the same time, the climate change has affected salinization (Nielsen et al., 2003; Nielsen & Brock, 2015; Rahi & Halihan, 2010). There has been much research on the presence of heavy metals in the marshes, but not many studies on salt water intrusion effects on the behaviours of these metals in natural ecosystems in which they are present. The interesting thing, there are studies about increasing of toxicants and salinity separately, while there were less studies about the relationship between salinity and toxicants and how potential salinity drives toxicant viability. Therefore, this study came out to evaluating the differentiation of some environmental toxicants in two parts of the same marsh area once was fresh water and other was characterized with more salinity, to investigating the hypothesis that elevated salinity via warming over time drives controls toxicants availability.

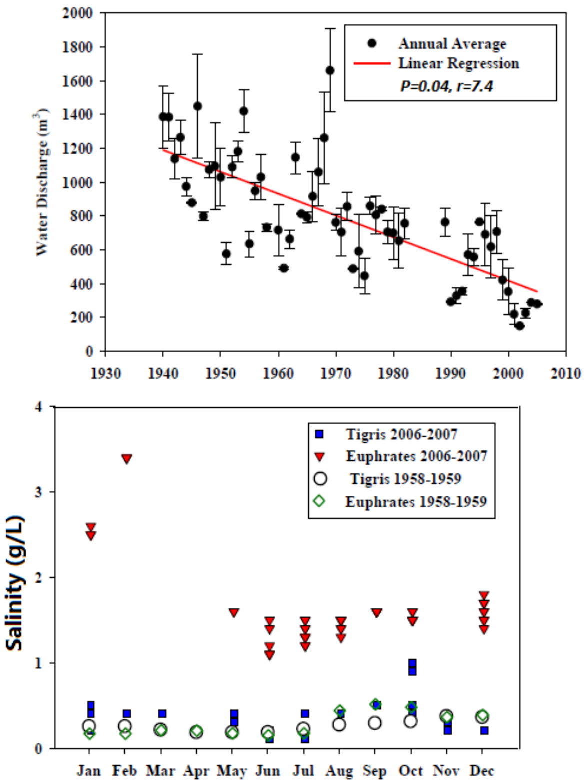

Figure 1. (A) The average of water discharge of Tigris and Euphrates rivers (±SE). (B) Salinity comparison of the Euphrates and Tigris rivers between their values between (1958 -1959) and (2006-2007) periods (Almaarofi, 2015).

Materials and methods

To investigation this study, twenty sampling sites were chosen in two different concentrations of salinity at the same wetland area which located southern of Iraq (Chibayish marshes) (Figure 2). Sub-surface water samples were collected by Van Dorn water sampler. In the field, five litters of water samples were immediately filtered through 0.45µ acid washed Millipore filters. Water temperature (WT), pH, dissolved oxygen (DO), salinity (Sal), and total dissolved (TDS) was measured by Multi 340i meter (WTW company/ made in Germany) and turbidity was measured by turbidity meter (Portable turbidity meter tube. 430). The filtrates were placed in glass tubes (for Oil, grease, and Phenol test) and plastic containers with acidification of heavy metals (Cd, Pb, Se, Cr, Zn, Cu, Ni, Fe, and Mn). All samples were frozen till the time of analysis. Standard methods (American Public Health Association - APHA 2005) were followed for the investigated the different studied parameters and toxicants. C≡CIL spectrophotometer (model C≡7200), and ICP-MS (In the Lab of SGS Lake field Research Limited / Lake field-Ontario; Model: ICPMS-Varian MS 820) were used for the sample analysis.

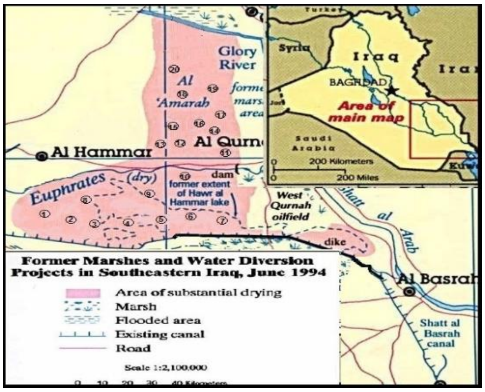

Figure 2. The wetland study sites southern of Iraq.

Results and Discussion

Table 1 shows the mean (± standard deviation) of all studied variables and toxicants in low and high salinity groups. During this work, the results showed that salinity was ranged between 0.62(±0.26) to 1.39(±0.22); pH was natural to slightly alkaline; DO was < 6 ppm in both groups; turbidity was < 30NTU in both groups; concentration of Cd, Pb, Zn, Cr, As, Se, Cu, Ni, Fe, Mn, and oil & grease were higher in high salinity group (Pt-test<0.05); while there were no different in Hg in highest salinity group compared with less salinity (Figure 3).

Climate change strongly affects wetlands, which are important ecosystems. Wetlands provide important services in water filtering, removing pollutants, and carbon sequestration. In the wetland, the toxicants have increased dramatically over time because of climate change and human activities. The climate change has affected salinization (Erbert et al., 2015). In Iraqi wetlands, climate change, dams building and mismanagement of water are the main reason of a sharp drought and increasing of salinity over time (Figure 4).

In this study, we compared between two different salinity parts ($P_{\text{t-test}} < 0.05$) in the same lagoon marsh, one part was still feeding from Euphrates river, while the other had shortage in water due to climate change. The salinity was ranged between 0.62(±0.26) to 1.39(±0.22) (fresh – brackish; EPA, 1986) that means if the shortage of water discharge to that wetland continue, the wetland classification will conversion from freshwater wetland to brackish or maybe a saline wetland in closed future. The results showed that the increasing of salinity affects all of environmental studied toxicants except mercury (Table 1, Figure 3; $P_{\text{regression}} < 0.05$). During this work, the toxicant concentrations were more than that registered by Al-Haidarey (2009) and Salman (2011). In addition, the results showed that the increasing of salinity not affected pH, DO, and turbidity. Although the concentration of toxicants was lower in low salinity group than high salinity group, the acute and chronic concentration of toxicants in both salinity groups were higher than the national recommended aquatic life criteria (Table 1), and that means the aquatic life at that region in dangerous and we recommended to study that issue in more deeply. Which means the salinity could be play as a key to drives the viability of these toxicants.

Therefore, the low water levels and increased salinity have reduced aquatic life in the Southern Marshes of Iraq.

Finally, this work suggested that the salinity could play as the main key driver to marshland toxicants, but the danger of bioaccumulation of these toxicants still wants more deeply studies. The results of this study suggested that the salinity could play as the main key driver to marshland toxicants.

Table 1. Mean (± standard deviation) and p-value (P< 0.05) of t-test to low and high salinity groups, and p-value (P< 0.05) of regression correlation between studied variables, Salinity and national recommended aquatic life criteria.

Variables (unit)	Low Salinity Group	High Salinity Group	$P_{(T\text{-}Test)}$	$P_{(Regression)}$	National recommended freshwater life criteria. **	
	Mean (±SD)	Mean (±SD)			Acute (µg/l)	Chronic (µg/l)
Salinity (ppt)	0.62 (±0.26)	1.39 (0.22)	<0.001*	-	-	-
WT (˚C)	27 (±1.11)	28 (0.17)	0.193	0.081	-	-
pH	7.86 (±0.18)	7.76 (±0.16)	0.112	0.095	-	6.5-9
DO (mg.l^{-1})	5.46 (±1.16)	4.54 (±1.08)	0.077	0.104	-	-
Tur (NTU)	27.4 (±16)	29 (±22)	0.835	0.172	-	-
Cd (µg.l^{-1})	0.08 (±0.05)	0.14 (±0.02)	0.015*	<0.001*	0.042	0.042
Pb (µg.l^{-1})	0.80 (±0.68)	1.48 (±0.48)	0.047*	<0.001*	0.145	0.145
Zn (µg.l^{-1})	8.76 (±1.36)	11.14 (±3.60)	0.038*	<0.001*	0.978	0.986
Cr (µg.l^{-1})	0.06 (±0.06)	0.12 (±0.04)	0.014*	<0.001*	0.316	0.86
As (µg.l^{-1})	2.04 (±0.24)	3.30 (±0.84)	0.002*	<0.001*	1	1
Se (µg.l^{-1})	0.26 (±0.24)	1.03 (±0.29)	<0.001*	<0.001*	0	0
Hg (µg.l^{-1})	0.02 (±0.03)	0.04 (±0.03)	0.24	0.073	0.85	0.85
Cu (µg.l^{-1})	3.09 (±0.62)	4.47 (±0.47)	<0.001*	<0.001*	0.96	0.96
Ni (µg.l^{-1})	3.02 (±0.76)	4.16 (±0.51)	0.013*	<0.001*	0.998	0.997
Fe (µg.l^{-1})	6.38 (±0.38)	8.45 (±0.42)	<0.001*	<0.001*	0	1000
Mn (µg.l^{-1})	4.19 (±0.44)	5.30 (±1.06)	0.002*	<0.001*	-	-
Oil and grease (mg.l^{-1})	5.84 (±1.43)	8.85 (±1.19)	0.004*	<0.001*	0	0
Phenol (mg.l^{-1})	0.032 (0.03)	0.07 (0.01)	0.002*	<0.001*	0.028	0.66

*Significant (p-value less than 0.05), ** according to (EPA 1986), (EPA, 1995a), (EPA, 1995b).

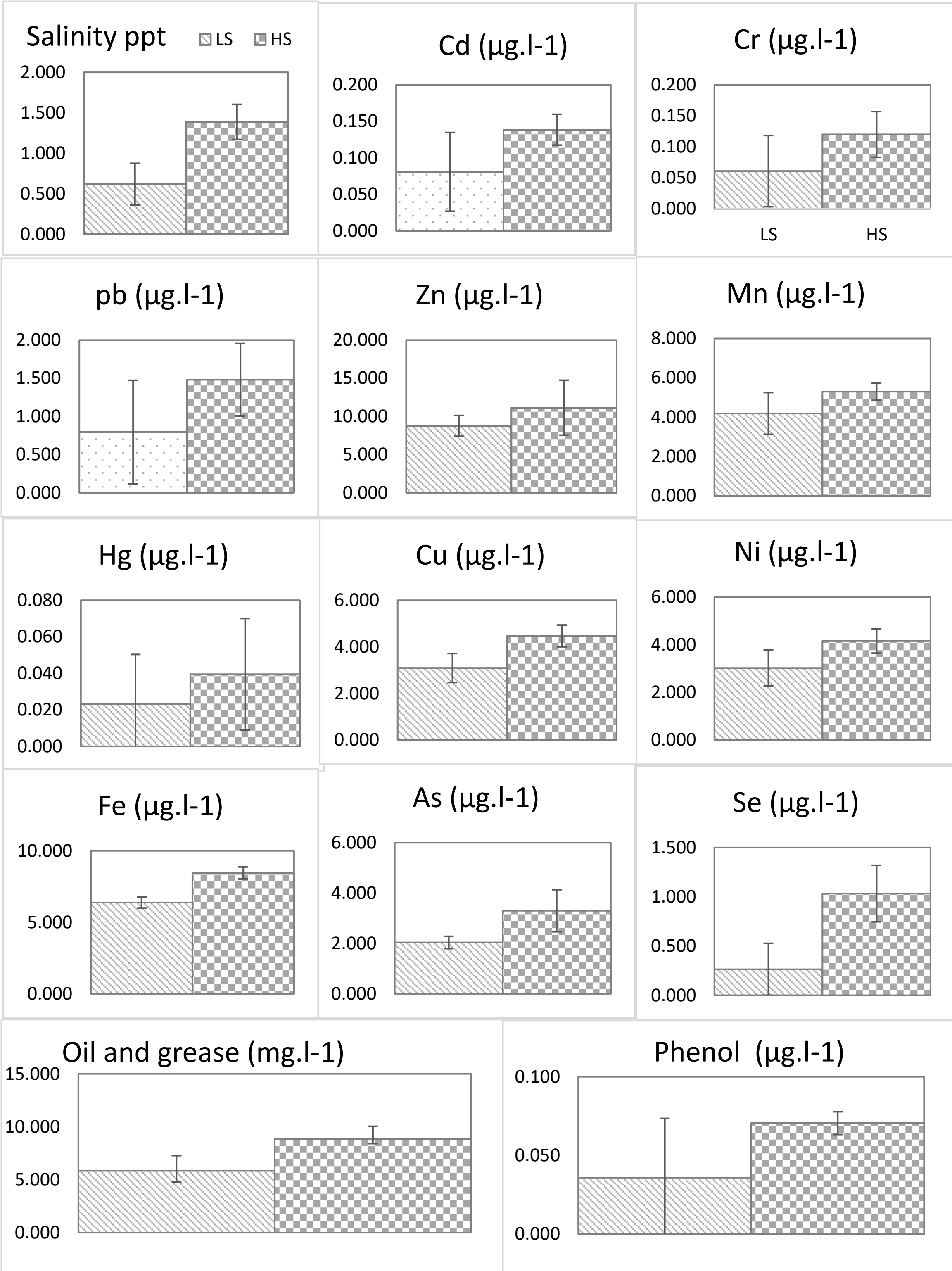

Figure 3. The mean of salinity and mean of environmental toxicants (with standard deviation bar) in the low salinity group sites and high salinity group sites.

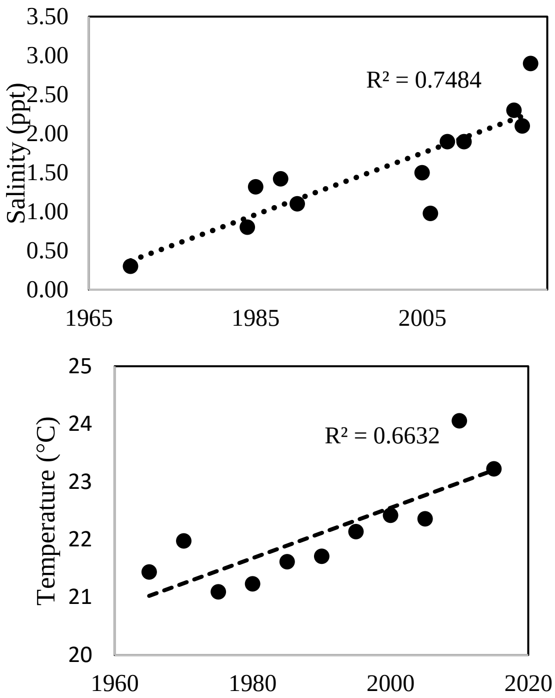

Figure 4. The Mesopotamian marshes salinity (b) and temperature (b) with timeline.

Acknowledgements
I would like to thank all staff of Marine Science Center in University of Basrah and Department of Ecology in University of Kufa for helping in the field and the lab. Also, I thank Canadian Iraq Marshlands Initiative (CIMI) for funding this study.

References:

Al-Haidarey, M. J. S.; Hassan, F. M.; Al-Kubaisey, A. R. A. & Douabul, A. A. Z. (2010). The Geoaccumulation Index of Some Heavy Metals in Al-Hawizeh Marsh. Iraq E-J. Chem., 7: S157-S162.

Al-Imarah, F. J. M.; Al-Mahmood, H. K. H.; Al- Shawy, I. J. M. & Hmood, A. Y. (2017). Study of Some Physical and Chemical Characterizations of Water from Southern Iraqi Marshlands after Rehabilitation/2003. Marsh Bull., 1(1): 82-91.

Al-Kenzawi, Mohammed A H, Adil H Talib, Mohammed J S Al-Haidary, and Mushtak F Karomi. (2010). Environmental Study of Some Water Characteristics at Um-Naaj Marsh, South of Iraq. Baghdad Sci. J., 8(1): 531-38. http://www.iasj.net/iasj?func=fulltext&aId=3854.

Al-Khafaji, B. Y. & Al-Awady, A.M.K. (2014). Concentration and Accumulation of Some Trace Elements in Water. Sediment, 8(2): 19-27.

Al-Maarofi, S. S. (2015). Ecological Assessment of Re-Flooded Mesopotamian Marshes, Iraq PhD. Thesis, Waterloo University.

American Public Health Association - APHA. (2005). Standard Methods for Examination of Water and Wastewater (21st ed.). Washington, DC: American Public Health Association.

Balasim, H. M.; Al-Azzawi, M.N. & Rabee, A.M. (2013). Assessment of Pollution with Some Heavy Metals in Water, Sediments and Barbus Xanthopterin Fish of the Tigris River – Iraq. Iraqi J. Sci., 54(4): 813-22.

Blinn, D. W. (1993). Diatom Community Structure Change the Physiochemical Gradients in Saline Lakes. Ecology, 74(4): 1246-1263.

Erbert, E. & Llen, R. H. (2015). A Global Perspective on Wetland Salinization: Ecological Consequences of a Growing Threat to Freshwater Wetlands. Ecosphere, 10:1-43.

Foad, M.; Alkam, Al-Haidarey, M. J. S.; Alasedi, K. K. (2014). A Study of Some Physicochemical Parameters and Heavy Metals in the Diwaniyah River/ Euphrates, Iraq. Int. J. Sci. Res. 3(7): 1915 K. K. 1918.

Nielsen, D. L. A., Brock, M. A. B.; Rees, G. N. A. & Baldwin, D. S. A. (2003). Effect of Increasing Salinity on Freshwater Ecosystems in Australia Effects of Increasing Salinity on Freshwater Ecosystems in Australia. Aust. J. Bot., 51(6): 655-665.

Nielsen, D. L. & Brock, M. A. (2015). Modified Water Regime and Salinity as a Consequence of Climate Change: Prospects for Wetlands of Southern Australia Modified Water Regime and Salinity as a Consequence of Climate Change: Prospects for Wetlands of Southern Australia. Clim. Change, 95(3-4): 523-533.

Rahi, K. A. & Todd, H. (2010). Changes in the Salinity of the Euphrates River System in Iraq. Reg. Environ. Change, 10(1): 27-35.

SalCon. (Salinity and Contaminant Hydrology Group) (1997). The Salinity Management Handbook. Brisbane. Department of Natural Resources, pp 214.

Tahir, M.A.; Risen, A.K. & Hussain, N.A. (2008). Monthly Variations in the Physical and Chemical Properties of the Restored Southern Iraqi Marshes. Marsh Bull. 3(1): 81-94.

Thesiger, W. 1964. The Marsh Arabs. Green Co. Butler and Tanner, London, pp 241.

Vineis, P.; Queenie C. & Aneire, K. (2011). Climate Change Impacts on Water Salinity and Health. J. Epidem. Glob. Health, 1(1): 5-10. http://dx.doi.org/10.1016/j.jegh.2011.09.001.