Studying the Diversity of Freshwater Ecosystems in Iraq. Do We Need Different Approaches?

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Abstract

Freshwater ecosystems have been studied across the world as an effective tool for better understanding of the relationship between biotic and abiotic factors; however, no much attention to ecological studies has been given to reveal biodiversity of Iraqi freshwaters. All of which is due to relying on classical methods of assessment of freshwaters, such as water pollution assessment, toxicity studies, and few and other studies on the freshwater microbiology, hence, these kinds of studies are still crucial. Other new approaches should be given into consideration when studying the biodiversity of the freshwater ecosystems and taxa in Iraq. Studies such as food webs, as well as stream hydrological studies, functional biodiversity, and other approaches are still necessary to be tackled as different prospective. Such new approaches can help to understand various conditions threaten aquatic biota and their habitat, and to mitigate the effect of the climate change, and then to contribute in paving the way toward better management of water resources and human services.

Keywords: biodiversity, climate change, ecosystem services, food webs, freshwater, Iraq.

Introduction:

Freshwaters bolster probably the most organically rich and assorted living spaces yet incorporate the absolute most compromised biological systems at a worldwide scale (Dudgeon et al., 2006; Goria et al., 2010). The threats to freshwater biodiversity have been perceived at an arrangement level, including the over-use of their abiotic and biotic resources, including the threatened and conservation concern species and their habitats (Kadhim et al., 2019). Accordingly, and based on their environmental importance, the freshwater environment has been a key protection need in
the course of the most recent decade following the reception of goals 58/217 by the United Nations deciding 2005–2015 as the universal decade for activity on ‘water for life’ (Dudgeon et al., 2006).

Over the past two decades, especially after the restoration of the marshes of southern Iraq, the studies in Iraq have focused on the taxonomic studies of aquatic macroinvertebrates on water bodies of Iraqi rivers, hence, the Iraqi freshwater environments have wide range of aquatic diversity. Among many studies, Jaweir and Ibrahim (2004) have found that oligochaetes (Tubificidae family) and are more divers in Diwaniyah river and it is good for bioassessment of pollutants in the river. Additionally, it has been found that crustaceans represent high diversity in Dalmaj wetlands in Iraq, compared with other benthic invertebrates and the percentage is 29% (Jaweir and Al-Seria, 2015; Ala Allah et al., 2015). Furthermore, (Nashaat et al., (2017), pointed out that Tigris River has good diversity of aquatic macroinvertebrates which are Annelida, Oligochaeta, Arthropoda, Mollusca and Nematoda. Oligochaeta have been recorded to be the highest among benthic invertebrate communities and its percentage is 73%. In addition, Jaweir and Hassan (2017) have studied community of meiobenthic invertebrates that associate with Ceratophyllum demersum aquatic plant in Al-Salamiyat irrigation canal/ north Baghdad. The researchers pointed out that river canal is well diversities of benthic meiobetic which are Cnidaria, Platyhelminthes, Nematoda, Rotifera, aquatic Oligochaeta, Crustacea, chironomid. Several Iraqi studies have focused on taxonomic diversity of benthic invertebrates and especially on Aquatic Oligochaeta (Jaweir et al., 2014; Al-Abbad., 2010; Al-Abbad and AL-mayah., 2012; Al-Abbad., 2015).

To our knowledge no more attention has been brought to study biodiversity of aquatic invertebrates and threats to the environmental factors that contribute to declining the micro and macro-fauna in Iraqi water bodies. This review would like to highlight some ecological aspects that can be considered in the study of biodiversity of aquatic macro-invertebrates, especially biodiversity of aquatic insects in streams in the future ecological studies in Iraq, and highlight, to some extent the need for adopting new approaches in studying the different components of the freshwater ecosystems of which Iraq is rich with this kind of habitat.

On-going studies in Iraq:

1. Toxicity of pesticides studies:

Considerable amount of ecological studies on freshwater biota in Iraq have focused on studying the effect of pesticides on macroinvertebrates such as (Farid and Farid., 2002; Farid, 2005; AL-Jasimee et al., 2019). According to Dudley and Alexander, (2017), pesticides such as fungicides, herbicides and insecticides have been used in order to control pests. However, insecticides are more toxic chemicals to aquatic biota than fungicides or herbicides and then loss their biodiversity (Sánchez-Bayo and Goka, 2014; Mulé et al., 2017). For example, the abundance of arthropods such as crustaceans and insects have been declined because of applying pyrethroid insecticides (Kasai et al., 2016), or declining dragonflies in Japan (Nakanishi et al., 2018). Kadhim et al., 2019, have also referred to considerable list of threats that affects the aquatic ecosystems of which the pesticides were among this list.
2. **Water quality assessment studies:**

Physico-chemical parameters and heavy metal studies have been conducted to assess freshwater water quality in ecological Iraqi studies such as (Al-Obaidy et al., 2014; AL-Fanharaw and AL-Jasimee 2018; Ewaid, 2016). Although the importance of these studies to evaluate water quality of Iraqi water bodies, other ecological disturbance should be taken into account.

3. **Baseline studies on the biodiversity**

Following the restoration of the marshes of southern Iraq (the Ahwar), many studies have tackled the aspect of studying the biodiversity of the marshes, and these studies have been crowned by submitting the nomination file to the UNESCO at 2014 where the Ahwar have been inscribed as World Heritage property based on the outstanding universal value (OUV) that it have (IME, 2014). Highlighting the outstanding universal values of the Ahwar was based on the intensive studies that have been conducted in this area for more than a decade (Kadhim et al., 2019).

Following to the inscription of the Ahwar, the bulk of the scientific effort should be addressed towards monitoring of the attributes of the OUV at the four natural components (Huwaiza, Central Marshes, East, and West Hammar). The results of the field surveys have contributed to better understanding of the fauna and flora of the freshwater ecosystems and have added new species to the Iraqi taxa list (Salim, 2006; Salim et.al. 2009; Kadum, et.al., 2018; Salim and Abed, 2017).

Other ecological topics (approaches) to study the freshwater ecosystems in Iraq

Other ecological topics and approaches might worth to be taken into account when conducting ecological research in the Iraqi water bodies:

A. **The effect of urbanisation, land use, and other threats and factors**

Considerable harm to the Iraqi environment has been witnessed during the past decades (IME, 2013); additionally, dams building in would affect greatly on freshwater life (Ramierz et al., 2008) like the case with Turkey on Tigris and Euphrates issues. Channelization and removal of vegetative canopy cover can have adverse effect on community structure of aquatic biota (Burdon et al., 2013; Niyogi et al., 2007; Olson et al., 2016). Sánchez-bayo and Wyckhuys (2019) have pointed out that the majority of entomofauna declining in the world has been due to deforestation and urbanisation. Additionally, the authors have listed a number of factors such as pesticides and urbanisation, which can be clearly found in Iraq, have negative effect on aquatic fauna. Degradation was not only found in aquatic plant cover, but also in other animal taxa such as in birds, reptiles, fish, and mammals (Kingsford et al., 2009).

Sánchez-Bayo and Wyckhuys (2019) have pointed out that habitat change due to agricultures and urbanisation is a major a biological factor in declining diversity of freshwater insects (e.g. Coleoptera), and water bodies may need several years to recover (Suren, 1996). Additionally, deformation has a negative effect on freshwaters in Iraq, especially after war of 2003. The absence of awareness among farmers, agricultural lands and green zones has become less due to different drivers that requires wider circles of research to tackle.
B. Invasive and alien species

Invasive species of exotic animals such as fish and birds that affects natural habitats of native species (the World Bank, 2017). After 2003, some alien species have been found in Iraqi waters such as fishes in shat al-Arab and other habitats. The alien fish species Tilapia zilli has been found intensively in the Iraqi freshwater since the early surveys at 2005 (Nature Iraq, 2017). Also, some other bird species of recent range-expansion have been found in Iraq such as Common Myna, Namaqua Dove, Black-shouldered Kite, (Salim, 1998; Salwan and Salim, 2018; Salim, 2002; Abed and Salim, 2019), in addition to some other taxa that belong to the freshwater ecosystems in Iraq. Being open issue, and linked to the potential effect of the climate change in Iraq, the issue of the invasive and alien species should be taken as priority when studying the freshwater ecosystems in Iraq.

C. Water flow and droughts effect

It is well-known that the diversity of aquatic biota can be influenced by water level at each habitat, like the streams that receive water from either precipitation, or groundwater and runoff (Tonetta et al. 2017). High level of water in stream can decrease light density that is used by aquatic plants while low level of water might be of negative effect on diversity of benthic invertebrates (Bunn and Arthington 2002; Rolls et al., 2012; Spitale et al. 2015; Luiza and Mello, 2018). For example, Rolls et al. (2012) have stated that streams with low flow will affect physical structures of habitats of aquatic invertebrates and then their composition. Additionally, the authors found that low flow affects diversity and connectivity of habitats and finally low flow affects riverine energy. All these concepts are working together to formulate diversity of aquatic invertebrates at their habitats as one of the key components of this ecosystem. Garcia et al., (2016), have stated that aquatic insects of caddisfly, stonefly and mayfly are very sensitive and be less abundant in water reduction streams and this can lead to threating biodiversity of aquatic biota in temporary streams across the world.

Stream composition such as organic matter, chemistry of water habitat of organisms and nutrients can be varied by water flow and the diversity of aquatic macro-invertebrates (Crowder and Diplas 2000; Hart and Finelli 1999). Factors such as wetted width, depth and Velocity would be decreased based on decreasing water flow in streams (Gordon et al. 2004; Dewson et al., 2007; Szkokan-emilso et al., 2017). Contraction of aquatic ecosystem depends on losing water flow and stream habitat of aquatic biota, then reducing habitat diversity (Demars et al., 2012). Water flow is a key factor in shaping community stricture of aquatic organisms (Dewson et al., 2007; Stubbington et al. 2009; Webb et al., 2012). It would be valuable if hydrological regimes have been given a special attention by scientific institutions when conducting new studies relating to freshwaters in Iraq, especially Iraq might face continuous fluctuations in the water resources.

D. The effects of the global climate changes

Over the years the concerns of climate change effects has risen among developed countries, especially within the communities of the freshwater biologists and their fear of losing biodiversity and supporting streams of the rivers, all of which is due to drought and floods. Silveira et al., (2019) have conducted a research to assess the effects of global changes on
Brazilian freshwater ecosystems for a long time span at Serra do Cipó. The data has been obtained from elevational gradient, soil, biodiversity and climate. The authors pointed out that the long-term ecological research at Serra do Cipó (LTER-CRSC) was on how climate change affects diversity and function of Serra do Cipó ecosystem. Kakouei et al., (2018), have studied the effect of flow alterations that is induced by climate change on the abundance of stream macro-invertebrates in Germany highlighting considerable results regarding this kind of effect. The authors in the late research showed that climate change robustly affect flow conditions, and causes decreasing species abundance of aquatic invertebrates down to −42% of freshwater taxa in the Treene catchment in lowland and the Kinzig catchment in Germany. In addition, finally, the authors assessed that water flow analysis can be conducted in any others areas to assess the response of aquatic biota to climate change or any regions that have ecological stress. Domisch et al., (2013), pointed out that changes in species richness reached up to −100%, or even extinctions of species caused by abiotic factors of streams such as temperature and water flow (Pyne and Poff, 2017). Ecological stresses based on climate change such as the influence of drought on vegetation, urbanisation and flooding would largely affect macroinvertebrate biodiversity at their habitats (Kunapoa et al., 2018).

Based on the above-mentioned researches, an addition to many recent research work, it became obvious that it would be quite important to conduct similar scientific work on the climate change effects of the (including the potential effect) on the freshwater ecosystems in Iraq.

E. Hydrological regimes

Studies on hydrological factors affecting benthic macroinvertebrate communities have been increasingly conducted worldwide (Chang, et al, 2008; Mesa, 2012; Belmar et al., 2012). Globally, quite large amount of studies have focused on studying diversity of freshwater biota at their habitats (riffle, run and pool) based on hydrological events. For example, Vimos-Lojano et al., (2019), have evaluated the effects of hydrological events on aquatic communities at the mesohabitat scale (e.g. pool, run, and riffle) in the high Andean region in Ecuador. The author showed that 14 hydrological indices were significantly related to the aquatic community. Hydrological flow conditions that affect habitats of aquatic biota have been studied (Kennen et al., 2010; Poff et al., 1997; Rolls et al., 2012). Variations in discharge event such as floods were studied in various regions including the temperate regions (Calapez et al., 2014; Leigh, 2013; Rolls et al., 2012).

The hydrological regimes might be one of the absent factors within the current studies of the freshwater ecosystems in Iraq, and this might be suitable opportunity to call for more focused efforts on studying the hydrological regimes of the freshwater environments either in the northern, middle, southern, or the estuaries regions in Iraq.

F. Stream food webs

Studying the food web of an ecosystem would very much help to understand energy fluxes of freshwater ecosystem (Power and Dietrich 2002; Shurin et al. 2006). Additionally, spatial and temporal changes can be showed by food web studies (Hall and Raffaelli 1991; Ings et al. 2009; Baiser et al. 2013). For example, the dynamics of resource of an ecosystem and macroinvertebrate community structure can be reviled by food web analysis (Polis and Strong
Erdozain et al. (2019) have studied food resources of stream macroinvertebrates in New Brunswick (Canada); the study pointed out that algae contribute 25-75% of macroinvertebrates than terrestrial food sources such as leave litter decomposition. Windsor et al. (2019) have studied the effect of contaminant loads of urban areas in rivers on aquatic invertebrates. This study pointed out that highly polluted food web communities tend to show less functional and taxonomic diversity, and abundance of their species. Deterioration of food web of aquatic ecosystem by xenobiotic contamination can cause reduction in trophic level effect on population and community of that ecosystem. In tropical ecosystems, the Amazon River floodplain, Arantes et al. (2019), have studied spatial variation of food webs. The authors showed that energy flow of organic matter is differ among food webs of floodplain ecosystems. Other studies can be reviewed (Moran et al., 2019; Sampson et al., 2019).

Just like the case with the other unstudied components above, the stream food webs in the freshwater environments is one of the areas of scientific work that should be covered by adequate scientific research in Iraq.

G. Ecosystem Services

Posten & Carpenter (1997) have indicated to the wide range of the services that the freshwater ecosystems supply for both: the local communities and the visiting communities as well. They have categorized the various types of the services in details where their study have covered the water supply, the fresh air, the food; in addition to other services that exceeds the local communities, like the recreation and the beauty of the landscape (Cretchen, 1997). More in-depth research efforts have been made on the freshwater ecosystems specifically showed that a freshwater ecosystem might be the highest is providing long list of ecological services to the local communities and in the development sectors especially in the increasing ecotourism field of tourism (Bárbara et.al., 2012).

Among the very few research effort made in this field in Iraq, Kadhim et al., 2019, have studied this area of work regarding the freshwater ecosystems in Iraq when they highlighted the importance of the serviced that the freshwater environment provide along with preliminary assessment of the different types of the services that these ecosystems provide in Iraq; nevertheless, we think that more efforts are to be addressed in this field in Iraq.

Conclusion:

The current review study has highlighted the importance of the freshwater ecosystems on the global and national levels, and focused on tackling the various, and indicated to the necessity of studying this important environmental component from none-classic prospective. Studying floral and faunal communities within their habitat scale based on temporal and spatial changes can open the door to more perspective studies. In addition, help to understand clearly, to large extent, the relationships among the environmental components, including the biotic and abiotic factors, and the way they behave in each type of freshwater system in Iraq. Such studies might exceed the present framework on the current studies to increase the focus on the climate change and its direct and indirect effects on these vulnerable habitats and their species. Furthermore, studying the services that the freshwater systems provide for the local communities and to other related communities might lead to essential foundation for any further development in the infra-structure
of the locations where the freshwater habitats are. Lastly, adopting an approach to study (and regularly monitor) the threats and other factors that affect this kind of vulnerable ecosystem would be of great value for future monitoring programs that cover the freshwater ecosystems and the other habitats (and human communities) relying on them in Iraq.

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