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Environmental factors affect the geographic distribution of aquatic plants in Tigris River-Maysan Governorate /Iraq

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Abstract

An ecological survey was conducted during 2018-2019 to study the effect of environmental factors on the geographical distribution of aquatic plants in the four sites of the Tigris River in Maysan Province. Water and air temperature, electrical conductivity, and pH environmental factors were studied. This study recorded twelve aquatic plants species in the study stations, of which two were free-floating species, *Azolla filiculoides* (for the first time) and *Lemna minor*. Three submersible species, *Ceratophyllum demersum*, *Hydrilla verticillata*, *Ranunculus trichophyllus*, and two long emerged *Phragmites australis* and *Typha domingensis*. There are three short emerged plants: *Eclipta Alba*, *Persicaria salicifolia*, *Plantago lanceolata*, and two bank trees *Populous euphratica* and *Salix acmophylla*.

Keywords: Geographical distribution aquatic plants, Tigris River, *Azolla filiculoides*.

Introduction

The length of the Tigris River is about 1718 km, originating from eastern Turkey, and most of its flows inside the Iraqi territory about 1400 km. The Tigris River receives additional quantities because of the water inside the Iraqi territory through a group of important tributaries, namely Khabour, large Zab, small Zab, Adhim, and Diyala (Al-Khashab, 1983). The river distance between Amara (Maysan) and Basra at Qurna is estimated at 141 km and the river at the city of Amara branch to the streams of Petira, Al-Arid, Al-Mufrah, Al-Kahla, Al-Majar Al-Kabir and Majariya (Saad, 2014).

Aquatic plants are one of the keys to the aquatic ecosystem, and knowledge of the functional characteristics of the dominant plants enables researchers to know the characteristics of the ecosystem and use them as biological indicators to monitor the state of the environment in which they exist (Hatzenbeler *et al*., 2004).

The growth and distribution of aquatic plants in water bodies, especially freshwater, is influenced by various environmental factors, including light, temperature, water movement, nutrients, salinity, pH, or biological interactions such as competition, herbivores, productivity, and human intervention. (Tamire and Mengistou 2013). Due to the important environmental, social, and economic functions of aquatic plants. In Iraq, interest in studying aquatic plants began in the late seventies of the last century, including Al-Saadi *et al*. (1975) as concerned with the environmental aspect of aquatic plants found that the elements of potassium and sodium affect the presence and abundance of some aquatic plants in the Shatt al-Arab River and the Tigris and Euphrates.

AI-Mayah (1978) dealt with aquatic plants in the Shatt al-Arab River and southern Iraqi marshlands, where 59 species of floral aquatic plants were recorded, six of which were first diagnosed in Iraq and 11 new species in the southern regions.

Alwan (2006) studied the evaluation of aquatic plants in the southern marshes after drying, which reported that there were more than a hundred species of aquatic and amphibian plants known in Iraq historically and recorded 27 species, including two species of algae and pointed out that several species have disappeared completely such as water lilies (Kaiba).

Al-Asadi (2009) conducted an environmental and phenotypic study of *Hydrilla verticillata*, first recorded in Iraq by Al-Mayah in 2004, and showed that this plant could invade all water bodies because of its different vegetative reproduction strategies.

Al-Asadi (2014) examined the impact of some environmental factors on the abundance and distribution of submersible aquatic plants in marsh Al-Hammar and Shatt Al-Arab River. She explained that the community of the *Ceratophyllum demersum* L. and the community of *Hydrilla verticillata* and *Potamogeton* are the most frequent during the study period.

Al-Mayah *et al*. (2016) recorded the genus of *Azolla filiculoides* for the first time in Iraq, noting that *Azolla filiculoides* are associated with free-floating plants such as *Lemna*.

Al-Mayah and Al-Asadi (2018) estimated the status of aquatic plants in Shatt al-Arab River in southern Iraq and recorded 31 species. The effect of high salinity values leads to the disappearance or decline of aquatic plant species in Shatt al-Arab River.

Study sites

The study was carried out on the Tigris River within Amara (Maysan) southern of Iraq from Sep. 2018 Jun. 2019 seasonally. Four different sites in the Tigris River were selected (Table 1 and Figure 2). The first site is located on the main River Tigris in Ali AL-Sharqi. The river section is characterized by the proliferation of agricultural land and fish ponds on both sides and aquatic plants such as *Azolla filiculoides* and reeds *Phragmites australis*. The second site is located in the south of the Kumite district, characterized by the presence of aquatic plants such as *Typha domingensis*. The third site was chosen in the center of the city of Amara near the AL-Shohada Bridge. This river area is characterized by the right side groves and left houses and a clear spread of the plant *Persicaria salicifolia*.The fourth site is in the center of the district of Qalat Saleh, and it is characterized by the spread of aquatic plants such as the *Ceratophyllum demersum.*

Material and Methods

Water samples from a depth of 10 cm below the surface were collected in three replicates on both sides of the river. Several measurements were carried out directly in the field, and laboratory measurements, including air and water temperature, using a mercury thermometer of 0-100ºC. After calibrating, the multimeter (WTW- model 3110) was used for pH measurement and EC (mS/cm). Plant specimens were collected, diagnosed, and kept in the herbarium at the University of Basrah BSRA.

Table 1: Geographical coordinates of study site using GPS

Site number	Name of site	Coordinates	
		N	E
St.1	Ali Al Sharqi sub – district	32°4′507″	46°52′389″
St.2	Kumait sub – district	31°58′948″	46°53′716″
St.3	The center of Amara district	31°49′018″	47°8′874″
St.4	Qal'at Salih district	31°30′99″	47°17′841″

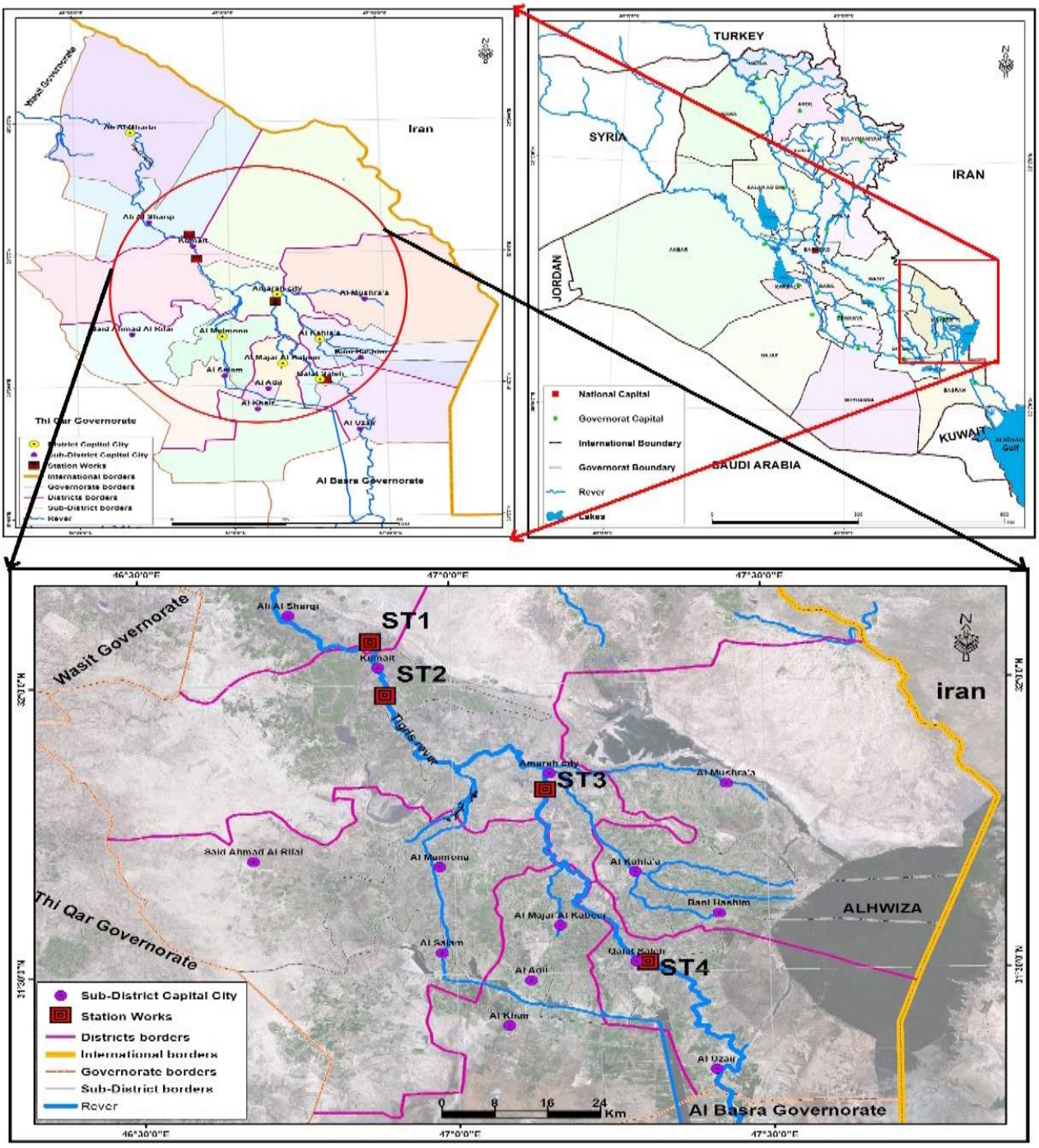


Figure 1: Map of Maysan province showing the study site.

Results and discussion

Environmental factors

Environmental factors play an important role in the distribution, abundance, and survival of plant communities in the aquatic environment. **(**Capers *et al*., 2010**).**

Fig. 2 and 3 show the seasonal and site variations in water and air temperature for the four selected study sites. The highest water temperature was 32.6º C during the summer of 2018. The lowest was 11.8º C during the winter, the highest air temperature was recorded at 44.3º C during the summer of 2018 and 2019, while the lowest value was 12 ºC during the winter. This is because the Tigris River is affected by the nature of the climate of Iraq in general, where it is hot, dry in summer, and cold rainy in winter (Fahd, 2006). Statistical analysis showed significant differences for both seasons and sites at a significant level ($p \leq 0.05$).

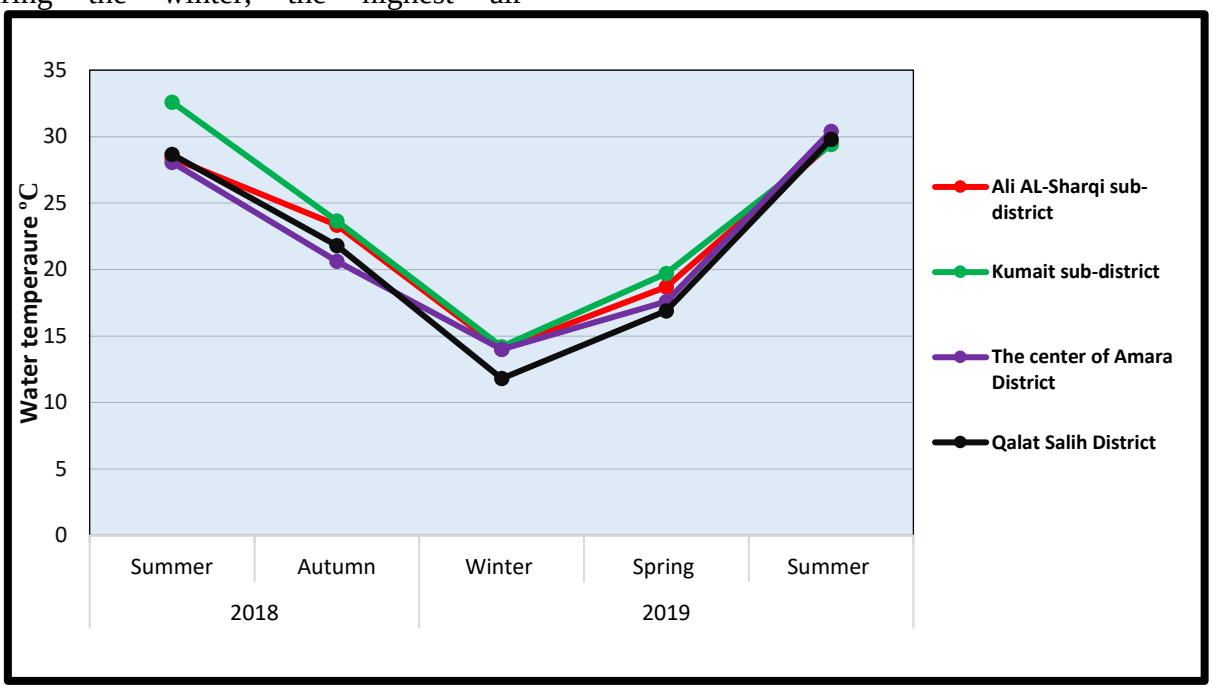


Figure 2: Seasonally and site changes in water temperature for the study site.

The results of pH (Fig.4) showed that most values were in the alkaline direction, and this result was agreed with most of the previous local studies such as Samir *et al*. (2011), Al-Zaidi (2017), and AL-Taher (2019). The statistical analysis showed significant differences ($p \leq 0.05$) among seasons and showed significant differences ($p \leq 0.05$)among the sites.

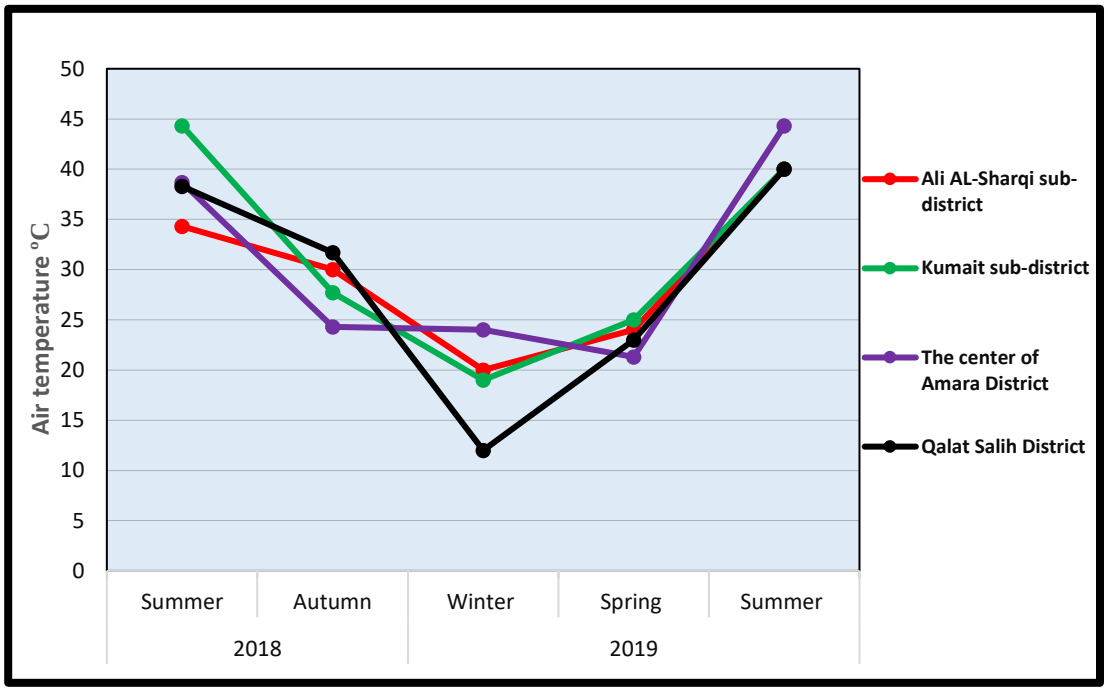


Figure 3: seasonally and Location Changes in Air Temperature of study sites.

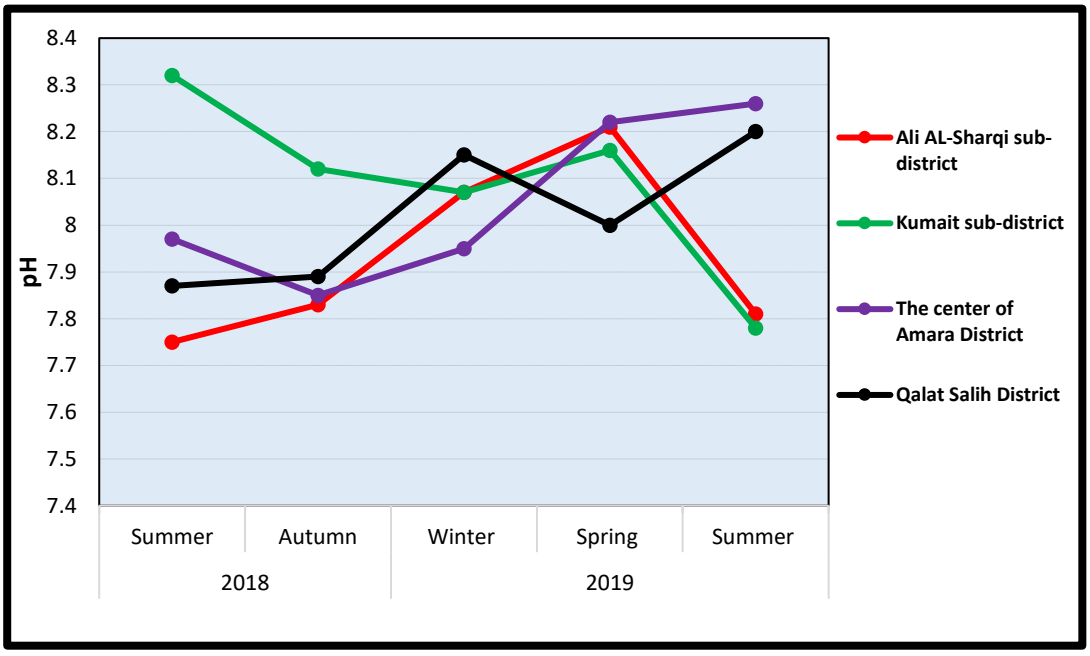


Figure 4: Seasonally and site changes in pH of study sites.

Also, the results showed an increase in electrical conductivity during summer 2019 compared to summer 2018 for all sites (Fig.5). This is due to the increase in the discharge of water levels because of sudden floods during the study, which led to washing of saline soils and the drift of dissolved salts to the river basin, in beside the exposure of the river column to household, waste that thrown in the river without treatment (Salman and Hassain, 2012). Statistically, we showed a significant difference ($p \leq 0.05$) among seasons and significant differences ($p \leq 0.05$) among all sites.

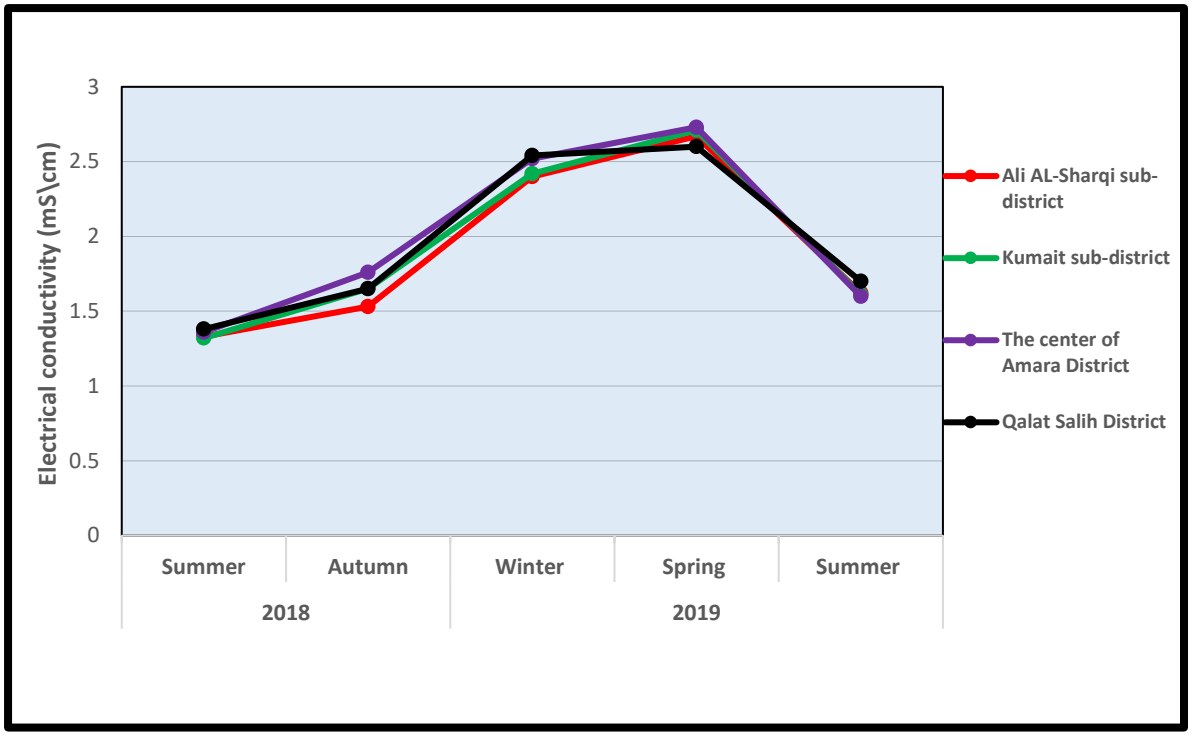


Figure 5: Seasonally and Location Changes of Electrical Conductivity of Study Sites.

The presence of aquatic plants in the studied sites

Table 2 showed that *Azolla filiculoides*, having coexisted with the *Lemna minor* species throughout the study period and at all sites, because of the process of eutrophication due to increased nutrients resulting from the displacement of functional groups responsible for the initial production of submersible aquatic plants to floating aquatic plants that encouraged the invasion of invasive species into freshwater bodies (Szabo *et al*. 2010; Espinar *et al*., 2015).

Ceratophyllum demersum was recorded throughout the study period and in all sites. Its presence refers to the state of eutrophication in rivers and thrives when nutrients increase their natural growth is determined by the transparency of water. Then the reduction of light, because of the low depth of water, leads to increased penetration of light in submersible aquatic plants that affect photosynthesis (Pełechaty *et al*., 2014).

Ranunculus trichophyllus was limited to the second site during the spring. The local name of this plant is Zhair Al-Batt is an annual plant rapidly growing in the form of aquatic weeds with finely divided submersible leaves and are found in predominant communities in canals, swamps, and shallow trenches. *Hydrilla verticillata* is also present in the first site, and it is a global submersible aquatic plant found in shallow and deep freshwater or saline (AL-Mayah *et al*., 2016).

The presence of emerged aquatic plants in all study sites, and in varying proportions in numbers and density, the most emerged aquatic plants that prevailed in all stations was *Phragmites australis*, It has been recorded throughout the current study period, and it is a worldwide plant with the ability to tolerate levels of salinity and availability of nutrients in water and sediments (Li *et al*., 2014).

The presence of species *Typha domingensis* in the form of small groups confined to a specific location in the second

and third stations is because the papyrus plant prefers to be in shallow and stagnant brackish water, and is characterized by its ability to adapt within certain increases of salinity concentrations (Al-Mayah and Al-Asadi, 2018).

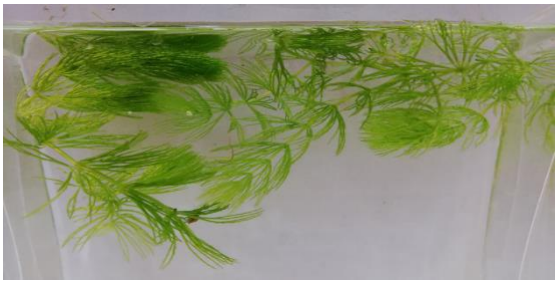
Table2: List of aquatic plant species in the Tigris River during the study period.

No.	Botanical name	Family	Site			
			1	2	3	4
1	***Azolla filiculoides***	**Salviniaceae**	+	+	+	+
2	***Ceratophyllum demersum***	**Ceratophyllaceae**	+	+	+	+
3	***Eclipta alba***	**Asteraceae**	+	-	-	-
4	***Hydrilla verticillata***	**Hydrocharitaceae**	+	-	-	-
5	***Lemna minor***	**Lemnaceae**	+	+	+	+
6	***Persicaria salicifolia***	**Polygonaceae**	-	-	+	-
7	***Phragmites australis***	**Poaceae**	+	+	+	+
8	***Plantago lanceolata***	**plantaginaceae**	+	-	+	-
9	***Populous euphratica***	**Salicaceae**	+	+	+	+
10	***Ranunculus trichophyllus***	**Ranunculaceae**	-	+	-	-
11	***Salix acmophylla***	**Salicaceae**	+	+	+	+
12	***Typha domingensis***	**Typhaceae**	-	+	+	-

+ presence
- Absence

Azolla filiculoides

Lemna minor



Ceratophyllum demersum

Ranunculus trichophyllus

Phragmites australis

Hydrilla verticillata

Persicaria salicifolia

Typha domingensis

Figure 6: Digital photographs of some aquatic Macrophytes presence in study sites. (Photo: by Author)

Geographical distribution of aquatic plants in the Tigris River

Azolla filiculoides was recorded in the Tigris River for the first time in all sites in the current study. It extends along the Tigris River column starting from Ali Al-Gharbi district north of Maysan governorate to Al-Uzir area south of Maysan governorate. (Fig. 7).

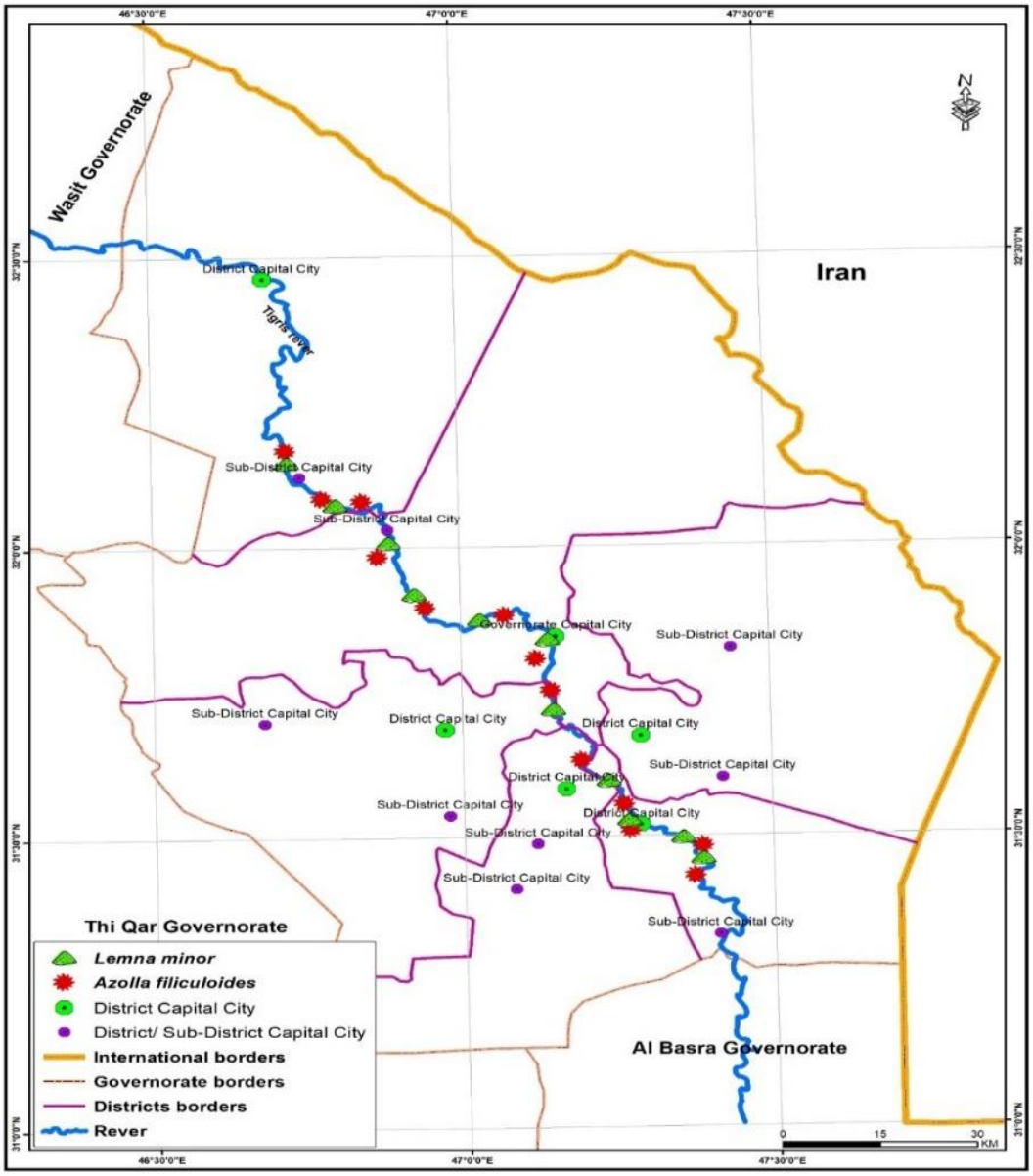


Figure 7: Map of the distribution of floating aquatic plants in the Tigris River in Maysan Province

Hydrilla verticillata was observed only in the eastern part of Ali AL-Sharqi in the village of al-Adala and the absence in the southern part of the Tigris River. At the same time, *R.trichophyllus* was characterized by its presence in Kumit and was characterized by its white flowers spread over the water surface. Figure 8.

The Ceratophyllaceae family represented by *Ceratophyllum demersum*, which was distinguished throughout the study period and along the Tigris River column. It extends from the district of Ali AL-Sharqi west of Maysan province and down to the Uzir district south of Maysan province, passing through the villages on the banks of the Tigris River. (Figure 8).

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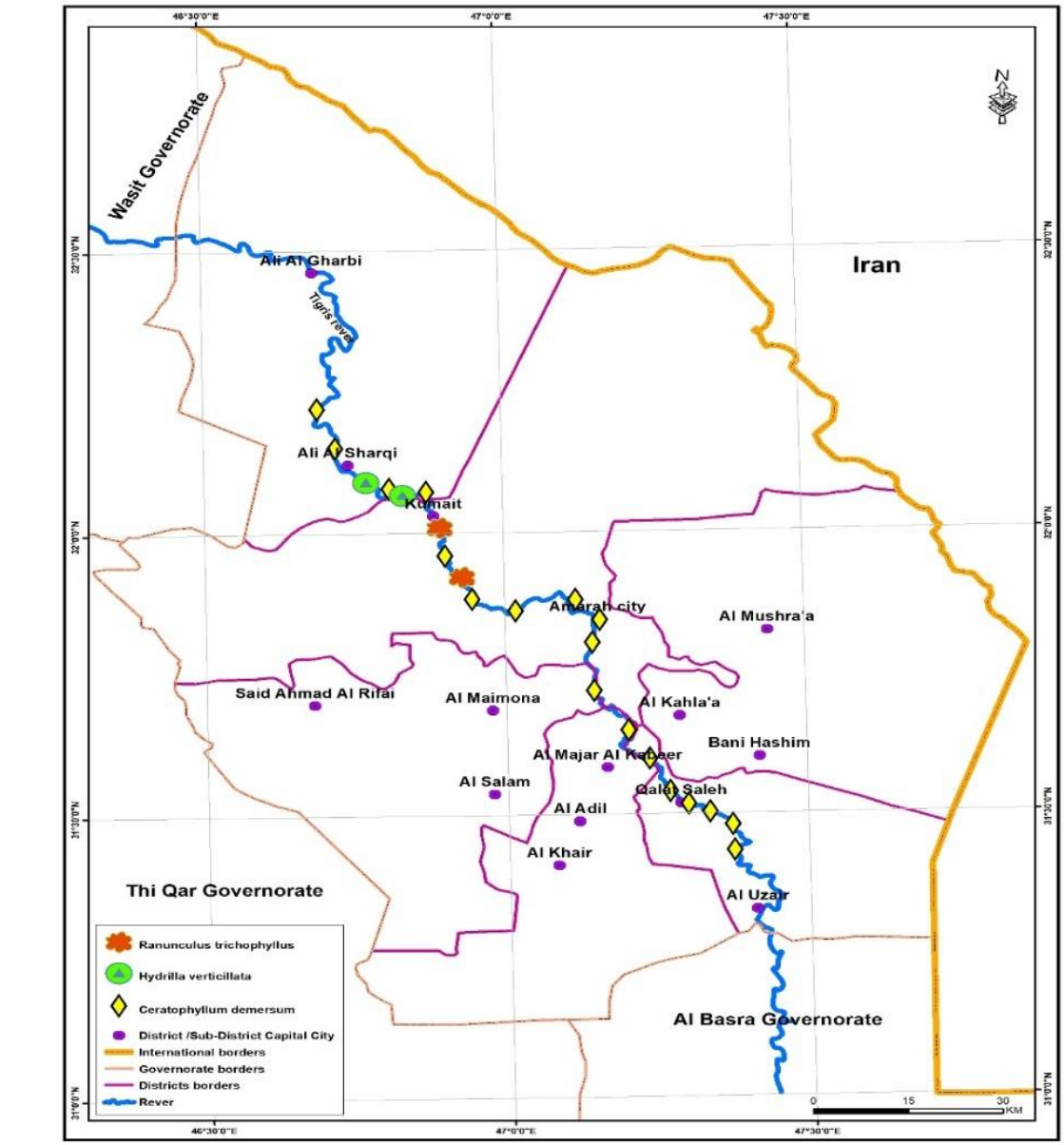

Figure 8: Map distribution of submersible aquatic plants in the Tigris River in Maysan province.

Phragmites australis is one of the most widely distributed plants in the form of dense plant communities. It is distributed along the column of the Tigris River, the sub-rivers and ponds, which extends from the district of the western north of the province of Maysan and down to the Uzir district south of the province of Maysan . Its spread extends from the western district of Ali-AL-Sharqi and through villages south on the banks of the Tigris River, and its height is not exceeding 3m.

The species *Typha domingensis* belonging to the family Typhaceae was limited in the district of Kumait and in the center of the district of Amara and was not recorded in the rest of the regions. Its height was about 1m. The species *P.salicifolia* is

concentrated mainly in the center of the district of Amara and the form of dense plant groups. While the species *P.lanceolata* was recorded in the wet places of the Tigris River and sites on the eastern district and the center of Amara district. As for *E.alba* was observed only in the east region of Ali-AL-Sharqi and was not found in other areas. (Fig. 9).

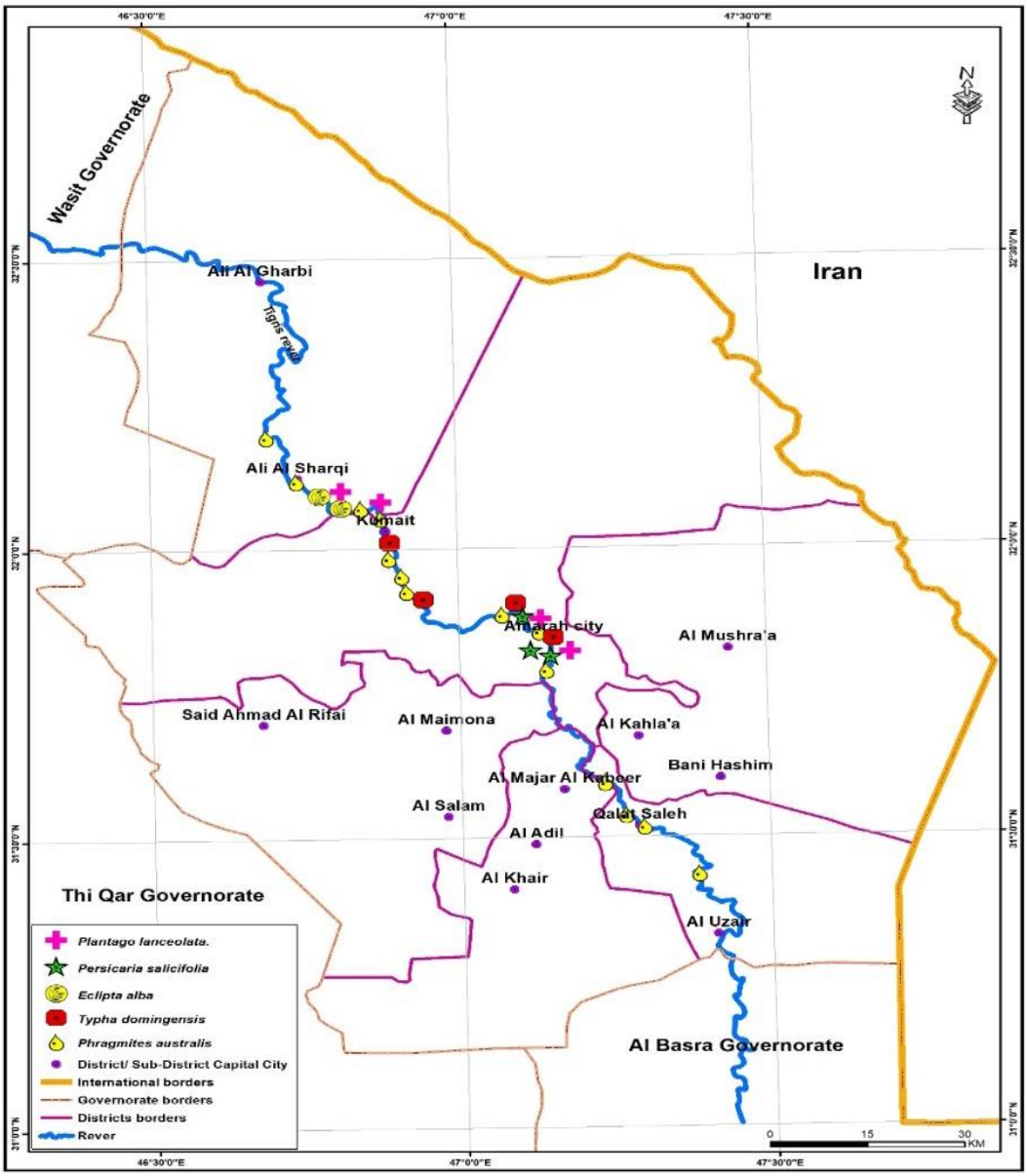

Figure 9: Map distribution of Long and Short emerged Aquatic Plants in the Tigris River in Maysan Province

It can be concluded that the continuation of the process of eutrophication leads to an increase in the density of *Azolla filiculoides* and *Lemna minor*, leading to decreasing in biodiversity in addition to pollution status. The study included the geographic distribution of the aquatic plants in the Tigris River, maps for geographical distribution were graphed. Canonical Correspondence Analysis (CCA) was depended on to estimate the relationships among the different

environmental factors and the existence of the aquatic plants by using the programmer of Canoco.

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تأثير العوامل البيئية على التوزيع الجغرافي للنباتات المائية في نهر دجلة في محافظة ميسان

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المستخلص

تم اجراء مسح بيئي خلال عامي 2018-2019 لدراسة تأثير العوامل البيئية على التوزيع الجغرافي للنباتات المائية في المواقع الأربعة في نهر دجلة في محافظة ميسان. وجرى قياس درجة الحرارة الماء والهواء والتوصيلية الكهربائية والاس الهيدروجيني كعوامل بيئية لعينات الماء وسُجل 12 نوعاً نباتيا مائياً في محطات الدراسة، كانت منها نوعين طافية طليقة هما *Azolla filiculoides* و*Lemna minor* وسجل النوع *Azolla filiculoides* لأول مرة في هذه الدراسة في نهر دجلة و وثلاثة أنواع غاطسة هي *Ceratophyllum demersum* و *Hydrilla verticillata* و *Ranunculus trichophyllus* ونوعان بارزان طويلان هما *Phragmites australis* و*Typha domingensis* وثلاثة أنواع من لنباتات البارزة القصيرة *Eclipta alba* و *Persicaria salicifolia* و*Plantago lanceolata* ونوعان من أشجار الضفاف هما *Populous euphratica* و *Salix acmophylla* .

الكلمات المفتاحية: التوزيع الجغرافي للنباتات المائية، نهر دجلة، نبات الازولا