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Review of limnological and oceanographic data base in Iraq during 1973-1977

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Abstract

This paper reviews the research activities of the author on Iraqi water bodies during his stay in Basrah University from 1973-1977 and after return to his main position in Alexandria University till 1988.

Because research facilities of limnology and oceanography in Basrah University at that time were not available, the author established a research laboratory in the Department of Biology for the first time and hired boats and vessels for sampling from the study areas.

Huge numbers of data and information have been collected during 1973-1977 from Iraqi water bodies, covering basic limnological and oceanographic parameters. The main compartments investigated were; 1) waters containing suspended matter; and 2) surfacial sediments. In addition, biota such as phytoplankton, bottom meiofauna have been also investigated mainly in the following points; 1) the influence of environmental parameters on the seasonal and regional distribution of phytoplankton; 2) the effects of pollution on the quality and density of phytoplankton; 3) the qualitative and quantitative distribution of the meiofauna in seasons and localities in relation to their environmental conditions and composition of the sediments.

The main parameters investigated were; 1) Environmental (limnological and hydrographic) characteristics of the water bodies, mainly temperature, transparency, suspended matter, total residue, fixed total residue, volatile matter, pH, total alkalinity, chlorosity or salinity, dissolved oxygen; and 2) Nutrient salts and organic matter (eutrophication). The data were concentrated on the vertical, regional and seasonal variations of the investigated parameters. Besides, the sediment characteristics and composition were also investigated.

The results obtained from those research projects were published in twenty- seven papers in several national and international journals. From these publications, the authors cooperated with Iraqi colleagues in nine papers and with German colleagues from Rostock University, who were in lateral agreement with Basrah University, in four papers. The rest fourteen papers were carried out by the author alone. The titles of all these papers are found in the personal web site of the authors www.drmassoud.net Some papers were published from 1975 to 1977 during the work of the author in Basrah University. The rest of

publications, however, were published from 1978 to 1988 after the author returned to his permanent position in Alexandria University. In addition to those publications, the author still reserves several sediment samples, which might be useful for comparison with relevant recent sediment samples in the future. This comparison will illustrate man's impact on these study areas after three decades following the expected increase in population and consequently the increase in their different wastes discharged into these study areas. Beside the expected environmental variations of the Iraqi water bodies resulted from the population increase with progress of time, the debris and wastes dumped into these water bodies from the war with Iran, as well as from the first and second Gulf war produced with no doubt a considerable impact on these water bodies.

The results obtained from those research projects were discussed and several conclusions were found among them are; 1) the canals crossing Basrah (Al-Ashar, Al-Khandak and Al-Rabat) were highly eutrophicated and heavily polluted mainly from the discharged untreated domestic wastes, affected Shatt al-Arab estuary at the areas of their connections with this estuary; 2) the water characteristics in the lower reaches of Tigris and Euphrates have determined the beginning of Shatt al-Arab, which was different from the previous location; 3) the huge amounts of the brownish mud transported by the River Qarun traversing Iran and discharged continuously into Shatt al-Arab at Abadan affected much the transparency and consequently the primary productivity, as well as the water characteristics of the lower reaches of this estuary till its opening into the Arab Gulf; 4) Shatt al-Arab transported annually to the North-West Arab Gulf huge amounts of suspended matter, which were partially deposited near the area of discharges and partially distributed by the action of waves and currents in the gulf.

Keywords: Shatt al-Arab, Tigris, Euphrates, Arab Gulf, limnology, oceanography.

Introduction

This paper reviews the research activities of the author on Iraqi water bodies during his stay in Basrah University from 1973-1977 and after return to his main position in Alexandria University till 1988.

Because Iraqi water bodies attracted the attention of the author and due to the unavailability of field and laboratory research facilities of limnology and oceanography in Basrah University at that time, the author has established a research laboratory in the Department of Biology for the first time and hired boats and vessels for sampling from the study areas; 1) lower stretch of the River Tigris within Iraq; 2) lower reaches of Tigris and Euphrates; 3) canals crossing Basrah and opening into Shatt al-Arab; 4) Shatt a-Arab; and 5) North-West region of the Arab Gulf.

The results obtained from those research projects were published in twenty-seven papers in several national and international journals. From these publications, the authors cooperated with Iraqi colleagues in nine papers and with German colleagues from Rostock University, who were in lateral agreement with Basrah University, in four papers. The rest fourteen papers were carried out by the author alone. The titles of all these papers are found in the personal web site of the authors www.drmassoud.net Eight papers were published from 1975 to 1977 during the work of the author in Basrah University. The rest of publications, however, were published from 1978 to 1988 after the author returned to his permanent position in Alexandria University. In addition to those publications, the author still reserves several sediment samples, which might be useful for comparison with relevant recent sediment samples in the future. This comparison will illustrate man's impact on these study areas after three decades following the expected increase in population

and consequently the increase in their different wastes discharged into these study areas. Beside the expected environmental variations of the Iraqi water bodies resulted from the population increase with progress of time, the debris and wastes dumped into these water bodies from the war with Iran, as well as from the first and second Gulf war produced with no doubt a considerable impact on these water bodies.

Description of study areas

Lower 630 km stretch of Tigris within Iraq

The Tigris rises in Turkey. It flows generally in a southeasterly direction through the mountains of Turkey and plains of Iraq and gradually converges on the Euphrates until **t**hese two rivers join at Qurna and open into Shatt al-Arab estuary. The whole length of the Tigris totals abou**t** 1950 km and its length in Iraq is 1360 km (Fig. 1)**.** The catchment area of the Tigris basin is ahout 166,155 km^2. From the Turkish- Iraqi border at Mosul, the river flows in a relatively wide valley, and the river width ranges front 120 to 200 m. forming sand pebble islands. The velocities are 8.0-1.0 m/s, and during high water, maximum velocities at some stretches was 5m/s. The stream gradient fluctuates within the limits of 70-80 cm/km. The stretch of the Tigris front Al-Fatha to Baghdad is characterized by a wide flow. The stream gradient of the stretch between Fatha and Samara reaches an average of 50 cm / km and it decreases near Baghdad to 7 cm/km.

Figure 1: Lower stretch of Tigris within Iraq

From Baghdad to Kut**,** the river is exceedingly tortuous, with an average slope of 6.7 cm / km. The width varies from 250 to 350 m. From Kut to Amarah, the river is less winding diminishings in

size. The slope is very much less than at points upstream being only 3.5 cm/ km. Between Qalat salih and Azair, the river is reduced to its smallest volume, then it begins to expand once more until it reaches the town of Qurna**.** The principal tributaries of the Tigris in Turkey are the Batman and the Botan. At the Iraqi borders, it is joined by Khahour River, and within Iraq by the Greater Zab, the Adhaim and the .Diyalah Rivers.

Lower reaches of Tigris and Euphrates

The river Euphrates divides at its lower reach in Iraq into two branches. One branch joins the river Tigris at the town Qurna forming Shatt al-Arab. The other branch traverses Hor Hammar, a large marsh enriched with aquatic plants, and then joins Shatt al-Arab at Sindibad Island (Fig. 2). Shatt al-Arab runs in a south-eastern direction to open into tile Arabian Gulf.

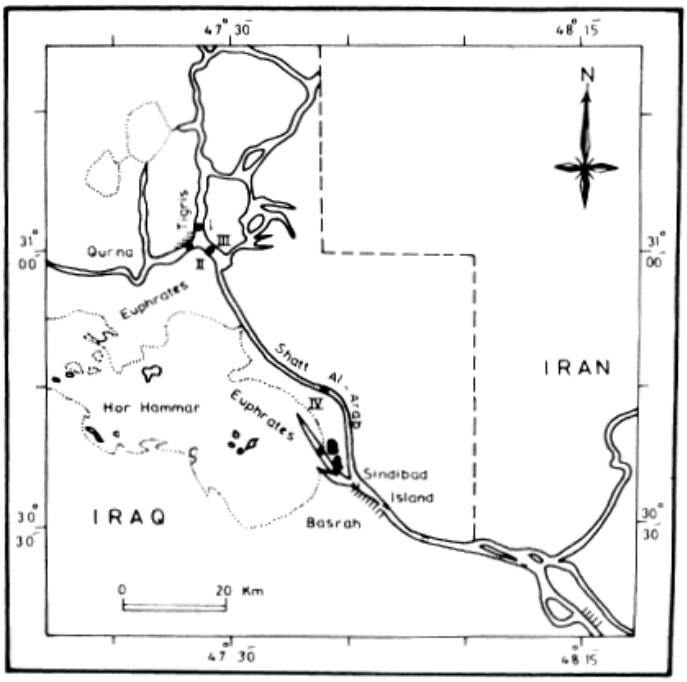

Figure 2: Lower reaches of Tigris and Euphrates

The width of this estuary ranges from 0.4-1.5 km along the 130 km reach from Basrah to the Gulf. The water of Shatt al-Arab may reach Hor Hammar during the high tide and the brackish water from this Hor may enter into Shatt al-Arab during tile ebb and affects its chlorosity. The levels of the Tigris and Euphrates rise in spring and this increases the level of Shatt al-Arab during this season. This rise of river levels follows the melting of snow in Turkey. The fresh flood water decreases the chlorosity of the three rivers during spring. The study area receives untreated sewage wastes, mainly from the town Qurna and the national paper factory, as well as agricultural runoff.

Canals crossing Basrah

Shatt al-Arab, the estuary of Tigris and Euphrates, begins at Ourna and opens into the Arabian Gulf (Fig. 3).Tigris and Euphrates transport continuously large amounts of fine sediments into Shatt al-

Arab. The width of this estuary ranges from 0.4-1.5 km along the 130 km reach from Basrah to the Arabian Gulf. The water depth of the river main channel fluctuates between 10 and I2 m, although deeper areas are found, where the river is narrow Shatt al-Arab has hundreds of lateral channels on both sides. Four of them, crossing the city Basrah, are highly polluted, mainly by sewage and agricultural wastes.

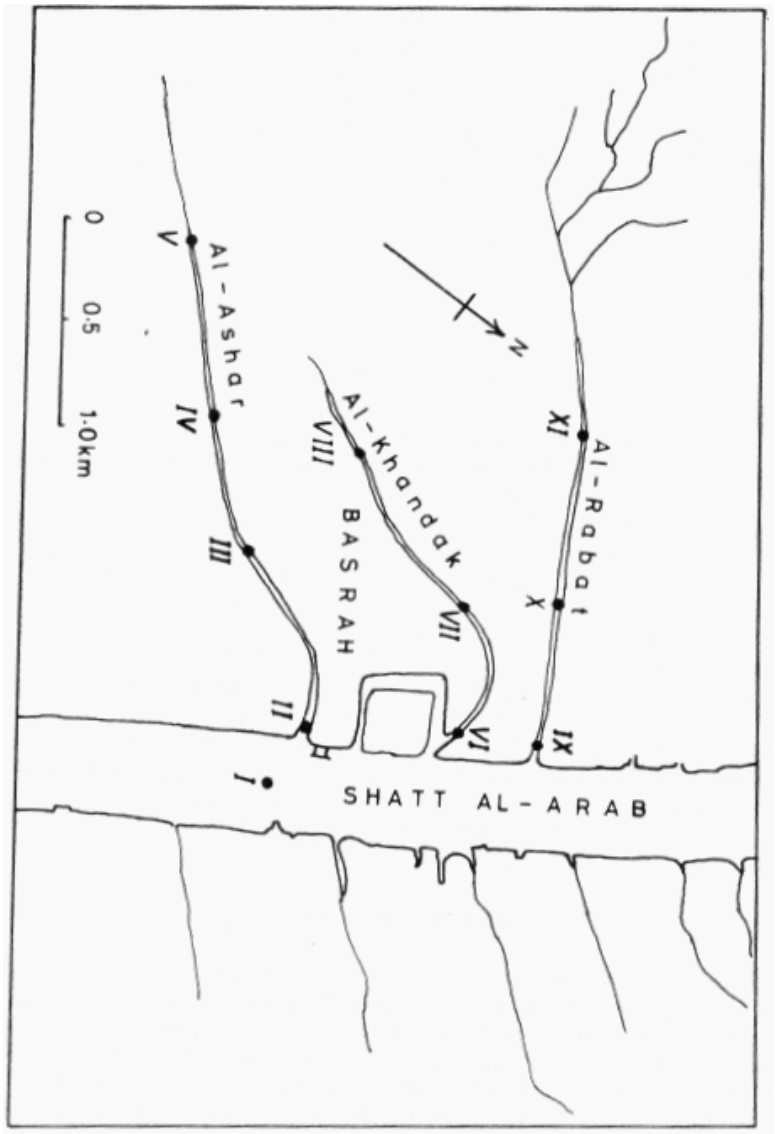

Figure 3: Canals crossing Basrah

Shatt al-Arab and the N-W Arab Gulf

The river Euphrates divides at its lower reaches in Iraq into two branches. One branch joins the river Tigris at the town Qurna forming Shatt-al-Arab. The other branch traverses Hor Hammar and then joins Shatt-al-Arab at Sindibad Island.

Shatt-al-Arab runs in a south eastern direction to open in the Arabian Gulf (Fig. 4). The water of its mouth may reach a distance of about 5 km inside the Gulf. Shatt-al-Arab transports annually to the Gulf about 35300 millions m^3 of water from the rivers Tigris, Euphrates and Karun. Karun

crosses the Persian lands and finally opens into Shatt-aI-Arab at about 20 km north of Abadan. In addition, huge quantities of fine sediments accumulate at the mouth of Shatt al-Arab. Most of these sediments enter this estuary from Karun. A considerable part of the accumulated sediments is distributed inside the Gulf, mainly by the influence of tidal currents. A long deep channel was dug inside the Gulf for the purpose of navigation.

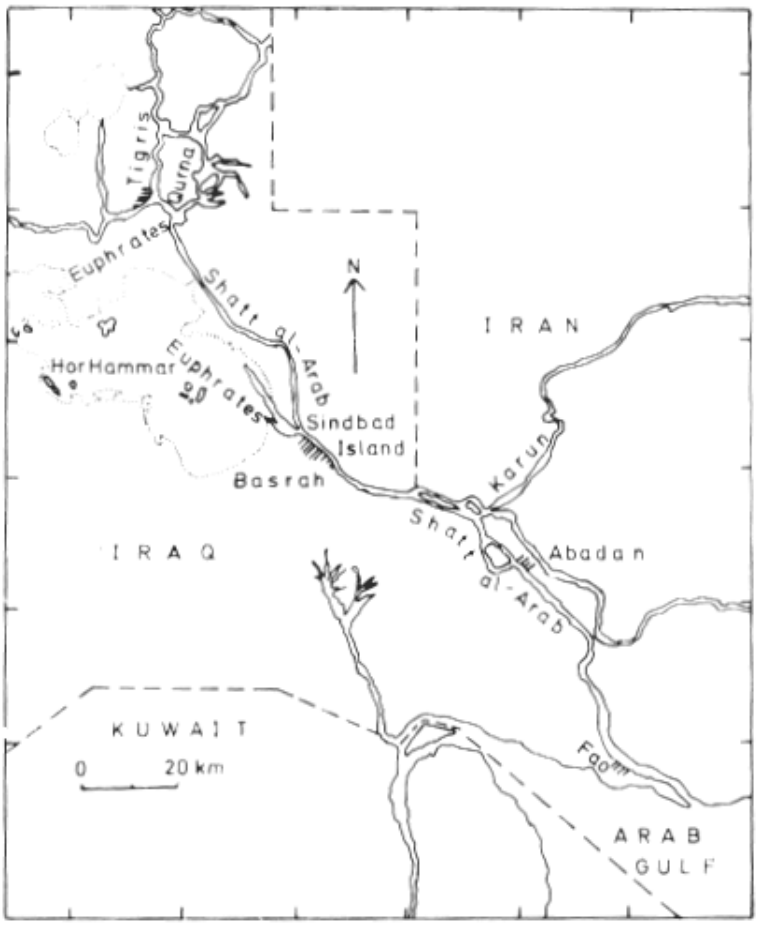

Figure 4: Shatt al-Arab and N-W Arab Gulf.

The length of Shatt-al-Arab from Sindibad Island to its mouth in the Gulf amounts to 139 km. Its width varies at different regions, ranging from 0.4 km at Basrah to 1.5 km at its mouth. The water depth increases, in general, in the direction of the Gulf, varying from 7,5 m at Sindibad Island to 12.5 m at the mouth. However, the water depth relatively decreases at the mouth of Karun in Shattal-Arab, due to the continuous accumulation of large amounts of sediments transported by Karun to this locality. The water level is mainly affected by the tides of the Gulf. Numerous big ships enter into Shatt-al-Arab from the Gulf and many of them reach Basrah. The wastes discharged from these ships and also from other smaller ones always found in Shatt-al-Arab can be considered as main pollutants in this estuary. Hundreds of outlets in the form of small rivers and canals are found on both sides of Shalt-al-Arab.

A large marsh, Hor Hammar, lies at the north western side of Sindibad Island and is enriched with aquatic plants. The water of Shatt-al-Arab may reach this Hor during the high tide. The brackish water of this Hor may enter into Shatt-al-Arab and affects its chlorosity.

Main compartments and parameters investigated

Huge numbers of data and information have been collected during 1973-1977 from the study areas covering basic limnological and oceanographic parameters. The main compartments investigated were; 1) waters containing suspended matter; and 2) surfacial sediments. In addition, biota such as phytoplankton, bottom meiofauna have been also investigated mainly in the following points; 1) the influence of environmental parameters on the seasonal and regional distribution of phytoplankton; 2) the effects of pollution on the quality and density of phytoplankton; 3) the qualitative and quantitative distribution of the meiofauna in seasons and localities in relation to their environmental conditions and composition of the sediments.

The main parameters investigated were; 1) Environmental (limnological and hydrographic) characteristics of the water bodies, mainly temperature, transparency, suspended matter, total residue, fixed total residue, volatile matter, pH, total alkalinity, chlorosity or salinity, dissolved oxygen; and 2) Nutrient salts and organic matter (eutrophication). The data were concentrated on the vertical, regional and seasonal variations of the investigated parameters. Besides, the sediment characteristics and composition were also investigated.

Results and discussion

Lower 630 km stretch of Tigris within Iraq

This study area was covered by five papers prepared from M.Sc. Thesis , which I have supervised in Basrah Universitry.

Local variations of some environmental characteristics [1]

The lowest air and average water temperatures were recorded in January. The highest average pH values, generally found in October and July, are due mainly to the abundance of phytoplankton. The remarkably low average chlorosity values found in the period of high water were correlated with the high discharge. The highest average values of dissolved oxygen were generally recorded in January and April and the lowest ones were observed in October and July.

Seasonal variations of nutrients [2]

The lowest average values for nitrate and phosphate found in July and October respectively, were correlated mainly with the high rates of uptake by phytoplankton. The lowest average concentrations of silicate recorded in July, can be related principally to considerable increase in diatom density. Additional nutrients entered into the River Tigris in January through land runoff and in April with the flood-water. The average concentrations of nitrate and phosphate showed an inverse relations. The average nitrate : nitrite ratio varied from 0.07 : 1 to 782.0 1 and the average nitrate:phosphate ratio ranged from 0.01:1 to 7.90 : 1.

Seasonal qualitative and quantitative variations of phytoplankton [3]

The Chlorophyceae generally contributed more genera to the phytoplankton community and the Bacillariophyceae and Cyanophyceae ranked second and third, respectively. The phytoplankton generally showed considerable local and seasonal variations at the surface of the sampling locations.

Seasonal variation of dissolved organic matter [4]

The relative increase in the values of dissolved organic mater (DOM) near the bottom of the river coincided mainly with the increase in the rate of decomposition of the descending plankton organisms and the release of organic mater from the bottom material to the overlying water. The average values of DOM generally showed noticeable local variations. The considerable high

average values of DOM found in April (varied from 13.69 to 21.49 mg O / l) and in July (ranged from 9.94 to 18.51mg O / l**)** originated in the main from the flood waters, which brought to the river large amounts of allochthonous organic matter. The DOM gave in October values at all stations (fluctuated between 0.33 and 1.57 mg O / l).This is mainly due to the great decrease in the supply of the allochthonous organic matter in that month, as well as the increase in the rate of decomposition of organic matter by elevation of water temperature. The average values of DOM in January, ranging from 2.86 to 5.89 mg O / l were markedly higher than those in October. This can be mainly attributed to the land runoff in the rainy season, as well as the decrease in the rate of decomposition of organic matter by the considerable drop of water temperature.

Water transparency, total suspended matter, total residue, fixed total residue and volatile matter [5]

Regional and seasonal variations of transparency, suspended matter (SM), total residue (TR) fixed total residue (FTR) and volatile matter (VM) were studied and discussed in the lower 630 km stretch of Tigris within Iraq. The Secchi values generally gave slight local variations. The minerogenic fraction was found to dominate in the suspended load. The increase in the values of SM, TR and FTR near the bottom of the river is mainly due to the stirring up of the sediments. The average values of SM,TR and FTR generally showed remarkable local and seasonal variations. The extremely lower average values of SM found in October and July are principally attributed to the great decrease in the discharge. The extremely high average values of TR and FTR found in January and April along the river stretch (Stations I-X) are principally related to the great increase in the amounts of SM, which was accompanied by extremely low Secchi values (3—10 cm) during the periods of high waters. The VM followed the same seasonal trend of TR and FTR.

Lower reaches of Tigris and Euphrates

This study area was covered by five papers, including one paper in Arabic

Environmental conditions and phytoplankton blooms [6]

Some parameters, Secchi disc readings, temperature, dissolved oxygen and chlorosity were studied during spring in the lower reaches of Tigris and Euphrates, as well as in the upper reaches of Shatt al-Arab. Qualitative and quantitative investigations were also carried out on the phytoplankton of these rivers.

A slight thermal stratification was found at most stations. On the basis of Secchi disc readings, the photosynthetic zone reached a maximum depth of 2.31 m in Euphrates and a minimum depth of 1.65 m in Tigris and Shatt al-Arab. The vertical samples of all stations were well oxygenated, due to the abundance of phytoplankton blooms which flourish in the spring. The relatively higher values of chlorosity found in all samples of stations II and IV are principally attributed to the influence of the brackish-water from Hor Hammar, which reached these localities.

138 phytoplankton species were identified from the three rivers. Higher percentages of halophil diatoms were found. There were significant differences in the composition of phytoplankton species in the samples of Tigris and Euphrates. Also, significant quantitative variations of phytoplankton groups were found between all stations.

Bottom deposits [7]

Sediment samples were col1ected from the lower reaches of Tigris and Euphrates, as well as from the upper reaches of Shatt al-Arab in order to study the nature and composition of these sediments. These samples were subjected to some physical and chemical investigations.

The maximum density of wet mud found in the sediments of Tigris was associated with the minimum density of dry mud. On other hand, the minimum density of wet mud recorded from the sediments of Euphrates at Qurna, was associated with the maximum density of dry mud.

The organic matter, the calcareous substances, the allochthonous material and diatom-silica were deposited in variable amounts on the bottom of the studied region. However, similar amounts of diatomaceous silica were recorded from the sediments of two different localities. The quantitative distribution of these components at various localities of the investigated region was found to depend principally upon certain factors which were discussed.

Comparison of the results obtained from the sediments of Euphrates after leaving Hor Hammar gave considerable variations. The data obtained suggest that this Hor supplied Euphrates sediments with additional amounts of organic, calcareous and allochthonous material.

Limnololgical studies [8]

The transparency showed local and seasonal variations. The Secchi values were markedly low, due to the relative turbidity of Tigris and the maximum Secchi values observed coincided with more sedimentation in Euphrates. The slight decrease in water temperature with depth is related to the mixing processes. The lowest temperatures were recorded in January (winter) and the highest in August (summer).The temperatures gave considerably high readings in April and October, since the region lies within the arid climate.

Seasonal variations of pH were recorded and attributed to physical and biological changes. The relatively high average pH in August and October give a good evidence for the phytoplankton abundance under better environmental conditions. The increase in chlorosity content at certain locations is mainly due to the effect of the brackish-water from Hor Hammar on these locations.. DO showed remarkable seasonal variations, giving the highest averages values in January and the lowest in August. It was concluded that the sources of DO in the regions was more related to the atmosphere rather than the photosynthetic activity, and the mixing processes as well as water temperatures were the main factors affecting its concentrations and distribution. The data showed that the water characteristics at the three selected stations were different, confirming that Tigris joins Euphrates at Qurna, and not at Sindibad Island as was previously thought, forming Shatt al-Arab.

Nutrient salts [9]

The seasonal distribution of nutrients, as well as the social and environmental impacts on their concentrations we studied. Depletion of nitrate, especially in April, is due mainly to adsorption of considerable amounts of nitrate on the suspended particles, which increased during the flood period, as well as the increase in nitrate reduction and uptake by phytoplankton. The increase in nitrate content is attributed principally to agricultural runoff, discharge of sewage wastes, increase in decomposition of organic matter and release of the adsorbed nitrate.

Nitrite was detected in all samples. The increase in nitrite concentrations with depth is mainly due to the increase in reduction of nitrate to nitrite and nitrification of free ammonium to nitrite, as well as the discharge of sewage wastes. The relatively lower average values of nitrite obtained in April and August are probably related to the rise of temperature, which enhanced the bacterial transformation of nitrite to nitrate or ammonium, as well as the consumption of nitrite by phytoplankton.

Similar to nitrate, the depletion of phosphate in April is attributed mainly to adsorption of large amounts of phosphate on the suspended particles and the increased in uptake by phytoplankton. The high phosphate concentrations found in some bottom samples coincided mainly with the decay of phytoplankton and the release of considerable amounts of phosphate from the sediments, as well as the allochthonous phosphate from agricultural lands and sewage wastes.

The decrease in silicate content is related principally to uptake by diatoms. However, the increase, especially near the bottom of some stations, is due mainly to the decline of diatoms and the increase in the rate of dissolution of diatom frustules in the sediments. In general, the average values of silicate, similar to those of the other nutrients, gave local variations in each season. Some controls should be done in order to prevent or at least minimize the effect of present and future pollution on the receiving water bodies.

Canals crossing Basrah

These study areas were covered by 8 papers including one published as abstract only.

Effect of pollution on phytoplankton in two canals [10]

Variations of some environmental characteristics and phytoplankton in Shatt al-Arab and in two of its polluted outlet canals at Basrah were studied and discussed. Air and water temperatures were lower in March. Transparency was lower in the canals, mainly due to phytoplankton abundance. Decay of accumulated organic matter in the canals reduced the pH values. Swage and agricultural wastes increased the chlorosity in the canals. The oxygen content in the estuary is mainly affected by physical factors and in the canals by chemical and biological factors. Bacillariophyceae contributed more genera and species and formed the main bulk of phytoplankton, followed by Chlorophyceae and then by the Cynophyceae. The high numbers of the blue greens in June might be correlated with high temperature and organic matter.

Effect of pollution on phytoplankton in one canal [11]

The effect of pollution on phytoplankton in the Ashar Canal was studied during March and June 1976. Higher temperatures were recorded in June. The canal water was more turbid than that of the adjoining Shatt al-Arab estuary, due to high algal populations and sewage disposal. The chlorosity values were high in the canal, due to sewage disposal. The flood waters in June lowered the chlorosity in both estuary and the canal. Sewage disposal into the canal decreased its dissolved oxygen content. The lower oxygen values in the estuary in June were accompanied with higher temperatures. The pH values were generally higher in the estuary and were also higher in June than in March.

Eighty-six algal taxa were recorded, 45 of which were diatoms. The phytoplankton in the estuary was more abundant in March, due to the increase in currents and turbidity in June. The Chlorophyta, Conjugatophyta, Myxophyta and Bacillariophyta in the estuary showed reverse seasonal trends from those of the total phytoplankton. These algae seemed to flourish during periods of high temperatures. The dense blue-green algae recorded in June is attributed to the high temperature and dissolved organic matter. The Chrysophyta recorded high populations in the estuary in March and were totally absent in June. Lower temperatures and high transparency in March might have led to their relative abundance.

The total phytoplankton in the Ashar Canal followed two different seasonal trends, one resembling and the other differing from those in the estuary. The disposal of domestic sewage and agricultural wastes in the canal seemed to lead to such adverse seasonal variations. The diatoms only dominated the phytoplankton at one station in both months. The sewage and agricultural wastes disposal seemed to favor the abundance of other phyla than the diatoms. Increased organic load in the canal has led to a considerable increase in the Myxophyta in June.

Effect of pollution on the bottom sediments in three canals [12]

Sediment samples were collected from three water channels crossing Basrah and opening into Shatt al-Arab estuary in order to illustrate the effect of pollution on these sediments by comparing the

results with those obtained from one station selected in this estuary near the areas of connection. The density of wet mud in Shatt al-Arab was relatively higher than the average wet density for each channel. The amount of dry matter in the Shatt al-Arab sediment samples was relatively higher than the maximum amounts found in the channels. Also, the quantity of water in that sample was relatively lower than the minimum quantities in the channels.

The high average amount of organic matter found in one m^2 in Al-Khandak sediments suggests that the organic pollution in this channel was higher than that in the other two channels. The high organic matter content was found at locations in the vicinity of the waste outfalls. The amount of calcareous substances deposited on one m^2 in Shalt al-Arab was markedly higher than the average amounts found in the sediments of the channels. This is due to the scarcity of calcareous shells in the sediments of the polluted channels. The amount of allochthonous material obtained from Shatt al-Arab sediments was remarkably high, due mainly to the nature of this estuarine water, which is enriched with silt and clay. The amount of silica found in Shatt al-Arab sediments was considerably high, suggesting the enrichment of this estuarine water with silica, which increased the density of diatoms. The high values of diatomaceous silica found in some sediment samples reflect the richness of these samples with diatom frustules.

Organic pollution in three canals [13]

Water samples were collected in different seasons from three canals traversing Basrah and opening into Shatt al-Arab estuary in order to show the influence of organic pollution on these canals. The values of dissolved organic matter (DOM) gave in each canal a considerable wide range of variations during the study. The progressive increase in DOM concentrations from September through December and March to June, following the corresponding increase in population, indicates that the major portion of DOM originated from the allochthonous supply of organic matter, mainly from untreated sewage and agricultural runoff. The remarkable high organic matter content in the canals consumes considerable amounts of dissolved oxygen during decomposition, leading sometimes to oxygen depletion,

Effect of pollution on the water characteristics in three canals [14]

Water samples were collected in different seasons during 1975-1976 from three heavily polluted canals of the Shatt al-Arab estuary crossing the city of Basrah, in order to illustrate the influence of pol1ution on the water characteristics of these canals. The air and water temperatures showed a wide variation during the study period. They were higher in September and June than in December and March. Turbidity of the canals is related principally to the algal populations and sewage disposal, whereas that in Shatt al-Arab is due mainly to the minerogenic suspended particles. The increase in turbidity of each canal is due in the main to the effect of the estuarine water in increasing the transparency at the junction of the canals.

The highest seasonal average pH values in the three canals and the maximum pH in the estuary were found in June. The low concentrations of dissolved oxygen in the canals are related mainly to sewage disposal, whereas those in the estuary were associated with elevation of temperature. The irregular variations of the regional average values of pH and dissolved oxygen observed along each canal might be related to the prevailing local conditions at each station.

The average values of Secchi disc, pH and dissolved oxygen calculated for each canal during the investigation were lower than corresponding regional averages for Shatt al-Arab, due mainly to the direct effect of pollution on the canals**.**

Effect of pollution on nutrient salts in three canals [15]

Water samples were collected in different seasons during 1975-1976 from three highly eutrophicated canals of the Shatt al-Arab estuary traversing Basrah, in order to show the effect of

pollution on their nutrient contents. The high nitrate, nitrite and phosphate concentrations in the three canals coincided in the main with the continuous discharge of untreated sewage and agricultural runoff. The increase in silicate content in these canals can be attributed mainly to dissolution of diatom frustules, runoff and domestic detergent in the sewage wastes.

The lowest seasonal average nitrate values in the three canals were found in June and the highest in September. At Shatt al-Arab station, nitrate gave a maximum value in September and was depleted in June. The lowest seasonal average silicate values in the three canals were obtained in March and the highest in September. In Shatt al-Arab, the minimum and maximum silicate values were also found in March and September, respectively. This might be related to the effect of the canal waters entering into Shatt al-Arab during the low tide periods. The relationships of the seasonal average phosphate concentrations were opposite to those of nitrate content.

The low regional average values of nitrite, phosphate and silicate at and near the mouth of each canal reflect the influence of the estuarine water. The irregular variations of the regional average values of nitrate and phosphate along each canal might be related to the prevailing local conditions at each station.

The average values of nitrate, nitrite, phosphate and silicate calculated for each canal during the study were remarkably higher than the corresponding regional averages for Shatt al-Arab, due mainly to the direct influence of pollution on the three canals. It was concluded that the allochthonous supply of nutrients, mainly from sewage and agricultural wastes, represents the major portion of nutrient contents in these canals.

Total suspended matter, total residue, fixed total residue and volatile matter in three canals[16]

Water samples were collected in different seasons during 1975-1976 from three heavily polluted Canals of the Shatt al-Arab estuary traversing Basrah, in order to show the influence of pollution on their content of suspended matter (SM), total residue (TR), fixed total residue (FTR) and volatile matter (VM). In the three Canals, the maximum seasonal average values of SM in March are attributed mainly to phytoplankton abundance, whereas TR, FTR and VM in December are due principally to the increase in the concentrations of dissolved salts from washing of the agricultural land in the rainy season. At the Shatt al-Arab station, the increase in the values of SM in March, as well as TR, FTR and VM in December coincided mainly with the effect of the canal waters entering into this estuary during the low tide periods.

Shatt al-Arab and the Arabian Gulf

These study areas were covered by ten papers including one paper in Arabic**.**

Phytoplankton and environmental parameters [17]

Samples of phytoplankton were taken from the Euphrates and Tigris Estuary (Shat al-Arab) in April 1974 and investigated by means of inverted microscope. Among 226 species identified in the samples, 95 were of marine origin. The share of diatoms in the total number of cells from all stations amounted to 68%. The abundance of planktonic green algae amounted to 19%, of blue green algae to 13%. The number of marine species continuously increased in the longitudinal axis of the 139 km section considered. The data of the phytoplankton were compared with the gradation of some environmental variables (temperature, transparency, dissolved oxygen, chloride). Regular longitudinal or vertical differences of these parameters were not observed

Diatom silica in the sediments of Shatt al-Arab and Arabian Gulf [18]

Bottom deposits were collected from different localities of Shatt-al-Arab and the entrance of the Arabian Gulf in order to study the quantitative distribution of diatom-silica in these sediments. The diatomaceous silica of the sediments was determined by means of a chemical method.

The carbonate-soluble diatom - silica of the sediments gave different amounts, with an observed wide range of variations. However, similar amounts were found at some stations. The higher and lower amounts of diatomaceous silica recorded from the sediments were found to depend mainly upon certain factors which were discussed.

Problems of pollution in Shatt al-Arab [19]

The rivers Tigris and Euphrates join at their lower reaches forming Shatt al-Arab. The river Karun and several hundreds of outlets in the form of small rivers and canals also open into Shatt al-Arab, which receives various kinds of pollutants resulting from different sources. The amounts of untreated sewage wastes discharged into the outlets crossing the city Basrah greatly increased in the last years, due to the successive increase in human population which reached about 0.8 million in Basrah. The result is that sludge beds have covered the bottom of these outlets, which have changed into a markedly eutrophic state. These sewage wastes caused bacterial contamination in the aquatic environment and created a public health danger. Untreated industrial wastes discharging into Shatt al-Arab directly or indirectly through the rivers Tigris, Euphrates and Karun introduce considerable amounts of different substances toxic for aquatic organisms. Pesticides and fertilizers used by agriculture and entering into Shatt al-Arab add more pollutants to it. Oil and oily wastes represent the most important pollutants in Shatt al-Arab. These are discharged from hundreds of ships continuously entering this river. Oil pollution mainly occurs during the process of filling the oil tankers. Floating masses of crude oil sometimes cover the river water and most of the rooted plants. Oil pollution causes the biggest damages to the life of aquatic organisms.

Bottom deposits and meiofauna of Shatt al-Arab and Arabia Gulf [20]

Sediment samples were collected from the Euphrates and Tigris Estuary (Shatt al-Arab), and from the entrance of the Arabian Gulf in January 1974 and subjected to some physico-chemical investigations. The qualitative and quantitative distribution of the meiofauna was also studied. The external events had a remarkable effect on the nature and composition of the sediments. The different components of the sediments (organic matter, calcareous and allochthonous material) were deposited in variable amounts on the bottom, mainly due to certain factors which were discussed. The meiofauna were sorted into 13 groups, some were represented by few numbers of individuals and only at few stations, whereas others (Nematoda and benthic Copepoda) were found at all stations and in exceedingly greater numbers. The total number of animals was irregular at all stations. Regarding the salinity, the studied region was differentiated into three different water bodies, the fresh, the mixed and the marine. The total number of animals found in the region of mixed waters was remarkably lower than that in the fresh and marine waters, mainly due to the unstable environmental conditions caused by the tidal currents. The high abundances of Nematoda and benthic Copepoda in the marine region were found to depend mainly upon certain factors which were discussed. The distribution of meiofauna in the investigated region was related to local environmental conditions (mainly temperature, dissolved oxygen, food and currents) more than to the nature and composition of the sediments.

Meiofauna and sediments of Shatt al-Arab near Basrah [21]

Sediment quality and meiofauna distribution were investigated in the Shatt Al-Arab near Basrah (Iraq). Four stations were fixed in a transect reaching from the eulittoral to the main channel of the river. The sediment was investigated with respect to wet mud density, dry mud density, water

content, organic matter, calcareous substances, and allochthonous inorganic material. There were no major differences between the sediments taken at the different stations. Sediment quality was not a limiting factor for the distribution of meiofauna; important factors were water current, light penetration and temperature. The current has a great influence on sediment structure, the main channel of the river had harder sediment consisting of clay. Because of high turbidity, light can reach the bottom only in shallow water at stations I and II; macrophytes were present only at these two stations. The highest numbers of invertebrates were found at station II (0.5 m depth). As water depth increased, the abundance of meiofauna decreased. Nevertheless, the number of individuals at station I (0.05 m) in the tidal zone was lower than at station II. This fact can he explained by the magnitude of changes of the environmental conditions, especially temperature and insolation. There were very large diurnal temperature fluctuations, fluctuating between 10 and 25°C on a single day. Many meiofauna species cannot tolerate such fluctuations and colonize mainly the deeper reaches of the river, which are continuously covered by water. Stronger currents in the middle of the river prevent the settlement of large numbers of animals in this area.

Physico-chemical conditions of Shatt al-Arab [22]

Some physical and chemical investigations of Shatt al-Arab estuary were studied. The transparency as well as the average values of suspended matter generally showed local and seasonal variations. The upstream stations gave high Secchi values and low average values of suspended matter, mainly due to their position relatively further away from the effect of turbidity caused by the tidal currents and the river Karun. The slight decrease in water temperature with depth is related to the mixing processes. The lowest values of air and water temperatures were recorded in January (winter) and the highest in August (summer). The relatively high average pH values found in August and October give a good evidence for the phytoplankton abundance in better environmental conditions. The highest average values of dissolved oxygen were recorded in January and April, whereas the lowest in August and October. The exceedingly high average values of chlorosity found at station VII in January, August and October are attributed to the effect of the Gulf water.

Nutrients in Shatt al-Arab [23]

The seasonal distribution of nutrients in the Euphrates and Tigris Estuary (Shatt al-Arab) was investigated and discussed. The increase in nitrate and nitrite concentrations is due principally to the discharge of sewage and industrial wastes, as well as the waters of the feeding rivers mainly Karun. Very high phosphate concentrations found in some bottom samples coincided with the decay of phytoplankton and the release of phosphate from the sediments, sewage wastes and runoff from cultivated lands. The increase in silicate content, especially in the bottom samples at some locations, is due mainly to the decline of diatoms and the increase in the rate of dissolution of diatom frustules in the sediments. Nonbiological factors seem to greatly affect the content of nutrients in Shatt al-Arab.

Environmental characteristics of N-W Arab Gulf [24]

Several environmental factors are considered to be the most important for the biomass of the area were studied. Water samples were collected at eleven stations from different water depths in the months of October 1974 (autumn), January (winter), and March 1975 (spring). Transparency increased further away from the mouth of Shatt al-Arab. Thermal stratification was absent, and only slight temperature variations occurred throughout the whole water column of each station in a given season. Salinity gradient was much more pronounced at stations I—V, due to the direct effect of Shatt al-Arab on these localities. The pH values were found to lie on the alkaline side, ranging from 7.30 to 8.39. The highest oxygen values were found in spring.

Major ions in N-W Areas [25]

Water samples were collected at 11 stations in the North-West Arab Gulf from different water depths in the months October 1974 (autumn), January (winter) and March 1975 (spring) for studying the distribution of the major cations (sodium, magnesium, calcium and potassium). The values of these major cations found in the upper samples of stations I-V, affected by the estuarine water, were in general, relatively lower than those obtained from the upper samples of the other stations, especially in January and March. In general, the values of these cations were markedly higher in January than in October and March. Sodium had the highest concentration followed by magnesium, calcium, and then potassium. In a very few samples, however, potassium was equal in concentration to calcium or slightly higher than it. The relative increase in calcium generally found in the bottom samples of most stations reflects the solution of calcareous deposits and the relative decrease observed in the upper water layers is due to its utilization by organisms. The relatively lower values of calcium found in October coincided with the rise of water temperature in this month. The relative increase in potassium generally found in the bottom samples of most stations suggests its possible release from the bottom sediments and the relative decrease observed in the upper water layers is attributed to its concentration by some organisms, especially the large algae.

Conclusions and recommendation

The numerous data obtained from these research projects gave information on the fertility of study areas with regard to fish production. They were also of significant scientific interest on the national and international levels. Besides, the data determined eutrophication as a significant pollution problem resulting from discharges of untreated sewage and industrial wastes. These discharges produced major pollution problems in some study areas.

The published data and information bring to public notice and policy makers the understanding of significant environmental conditions in the study areas, which are of most scientific interest and of economical concern, due to their main use as water supply for drinking, agriculture, fisheries and recreation. Accordingly, it is highly recommended that the decision makers should respond, giving much interest in treating the existed pollution and preventing the new one, by following up the man’s impact on Iraqi aquatic water bodies and by proposing the suitable means for fighting aquatic pollution at the best possible rate of cost/efficiency. Besides, the contributions of the results in aquatic pollution problems assist the concerned authorities to force the Environmental Impact Assessment as a requirement for every new development and/or investment project likely to affect water quality.

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