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**Assessment of Water Quality of The
Euphrates River at Al-Musayyib City using
Water Quality Index**

A THESIS

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BABYLON AS A PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER IN ENGINEERING / ENVIRONMENTAL ENGINEERING**

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2023

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بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

رَبِّ اشْرَحْ لِي صَدْرِي * وَيَسِّرْ لِي

أَمْرِي * وَاحْلُلْ عُقْدَةً مِّن لِّسَانِي *

يَفْقَهُوا قَوْلِي *

صَدَقَ اللّٰهُ الْعَظِیْمُ

سورة طه الآيات ((25 - 28))

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Most importantly, I would like to thank my family, my father, my mother, my brother, my sisters who always offer their patience and prayers and for their unlimited encouragement and support during the period of preparing this work.

Nour Ali Hashim

2023

Dedication

To my happiness My father

To the source of love My Mother

To the source of love My Brothers And Sisters

To the source of knowledge My teachers

To those who give me the hope..... My friends

*And To Everyone Supported Me And Gave Me
Advice.*

Nour Ali Hashim

Abstract

The study was carried out in Euphrates/Al-Musayyib River. Water samples were collected for testing the physical, chemical once every month from Euphrates/Al-Musayyib River. The analysis was done for six months (July 2020 to Decembers 2020) from three sites during the dry and wet seasons. These samples have been chosen from three stations to help in understanding the variability of water quality due to seasonal differences. Wet and dry weather have been analyzed to better determine the river pollution rates. Thirteen parameters with their limits were considered in the present work according to the standard specifications, collected and analyzed from physical and chemical parameters (pH, DO, EC, TDS, NO₃, PO₄, SO₄, Mg, Na, Ca, K, TH, and TUR) were chosen parameter using water quality indices (WQI). Utilization of the WQI weighted arithmetic method of parameters showed that (WQIWA) was 62.174, 61.564, and 61.528 in station 1, 2, and 3 during the dry season, respectively, for $k = 1$ (for water without contamination), While the (WQIWA) was 59.959, 61.858 and 61.070 in these stations during the wet season, respectively.' The use of water quality index unweighted arithmetic method (WQIA) of the parameters indicated that (WQIA) was 69.538, 70.422, and 77.851 in station 1, 2, and 3 during the dry season, respectively, While, the (WQIA) was 66.440, 67.162 and 66.358 in these stations during the wet season, respectively, The results from Water Quality Index show that water quality was unsuitable to use in drinking in the dry and wet weather unless treat of it.

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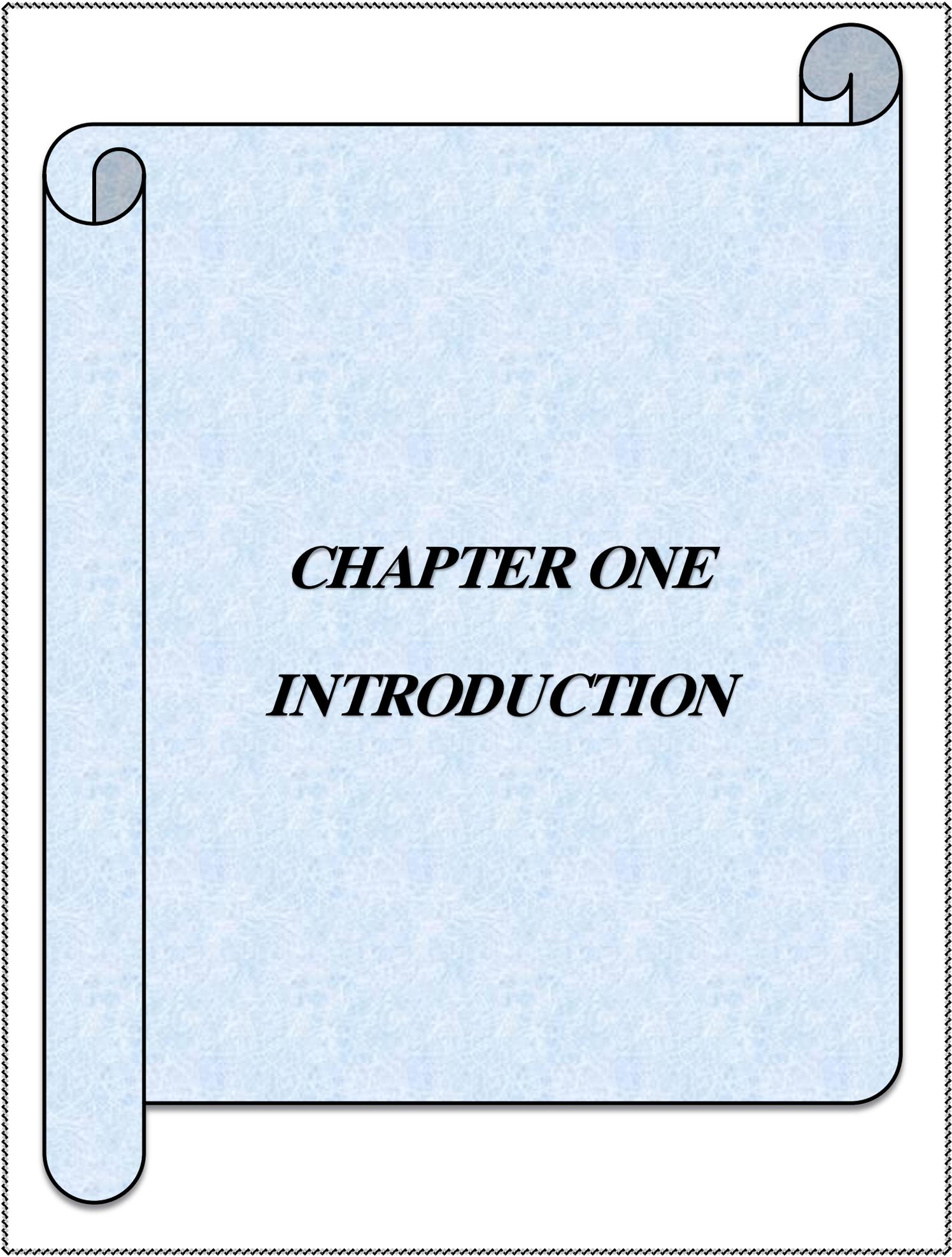
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CHAPTER ONE

INTRODUCTION

Chapter One

1.1 General Introduction:

Particular goals were developed and tested the method for estimating water quality in watersheds where no or less data of water quality index available. Employing a statistical method, the relations between the watershed characteristics and water quality index within a particular area or topographical area were specified and utilized for predicting the likely WQ data of poor watersheds inside such an area [**Jeffery S. Horsburgh, 2001**]. Statistical analyses were conducted to obtain which of the important parameters were highly related with WQ, and predictive relations of WQ were evolved [**Fadhil Kassim Jabbar, 2019**].

The scientific public has raised its consideration upon the studies that deal with the land-use variation and WQ, and the stress upon them can be ascribed to the continual increase in the population of human raising the inhabitants and water demand, it's vital to be capable to evaluate its quality upon an actual-time foundation and for the predictive aims [**Harkiran Kaur, 2015**]. The Water-quality Indices (WQIs) give a means via which the WQ can be compared through the time and space founded upon a compound indicator. The values of index and sub-index can be utilized for flagging the concerned contaminants, guiding the administration labors arrangement, and for prognostic purposes [**Valeria Mijares, 2017**].

Shortly, after starting the launch of the initial Landsat satellite, the investigators started searching the utilization of Landsat images for monitoring the WQ of lakes and coastlines. The initial usage of Landsat images was for the simple qualitative observations including locating

and mapping the pollution and the plumes of pollution. Soon afterward, the WQ field measurements were related with the data of Landsat, and after that such relations were employed for the WQ quantitative evaluation (for instant, chlorophyll, water clearness, and turbidity) [**Leif Gordon Olmanson, 2012**].

The WQ of source takes a crucial part in the quality preserving and the drinking water supply; still it can be adversely influenced via human actions [Yuxin Wang, 2014]. The precise detection of WQ variations is a critical duty of the companies of water. The companies of the supply of water should offer a safe drinking water. [**Fitore Muharemi, Doina Logofătu and Florin Leon, 2019**].

The probability-based WQ surveys are being usually utilized for meeting the needs of the Section 305(b) of the Clean Water Act. The design of survey permits an effect to be made regarding the state of regional stream, but they cannot be employed for identifying the WQ damaged segments of stream. Thus, a fast and cost-effective technique is required for locating the possibly damaged segments of stream through big areas [**Erin E. Peterson and N. Scott Urquhart, 2006**].

The evaluation of the of river WQ is a vital procedure owing to the pollution and the changes of usual or anthropogenic source [**Zakaullah and Naeem Ejaz, 2020**]. The WQ of water resources is a subject of ongoing concern. The evaluation of the lasting WQ variations is also a challenging [**Vassilis Z. Antonopoulos, Dimitris M. Papamichail and Konstantina A. Mitsiou, 2001**].

Water is the major element that is responsible for the life upon the earth. The variation of climate is influencing the precipitation and eventually influences the available freshwater amount, while, raising the loads of

waste water from point and non-point sources deteriorates the surface WQ in addition to the resources of ground water [**Mrunmayee Manjari Sahoo, 2014**].

Data of water quality are frequently collected at various sites through the time for improving the management of WQ. WQ data typically display these characteristics: presence of outliers, non-normal distribution, serial dependency, values below detection limits (censored), and missing values.

It's necessary to implement proper statistical methodology to analyze the data of WQ for drawing useable inferences and therefore give beneficial advice in the management of water [**Liya Fu and You-GanWang, 2012**].

1.2The Aim of Study

1- The objective of the present study is to analyze and monitor the water quality of Euphrates /Al-Musayyib River supplied to the humans and agriculture areas alongside this river.

2- Assess the quality of water by the relevant statistical tools.

3- Using different water quality indices (WQIs) used for giving a total sight upon the spatial-temporal variations of the WQ will be employed in the present work of this thesis.

1.3 Thesis Structure

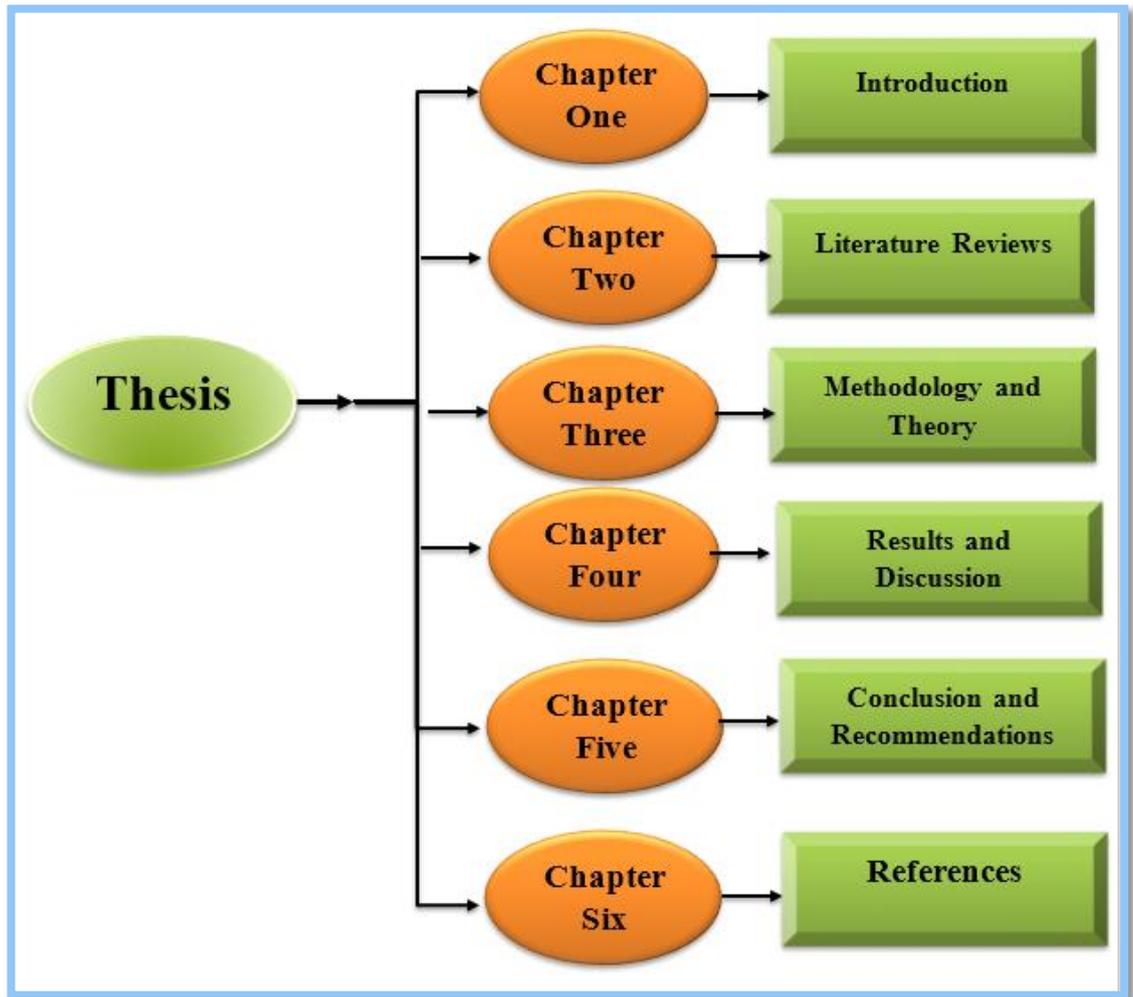
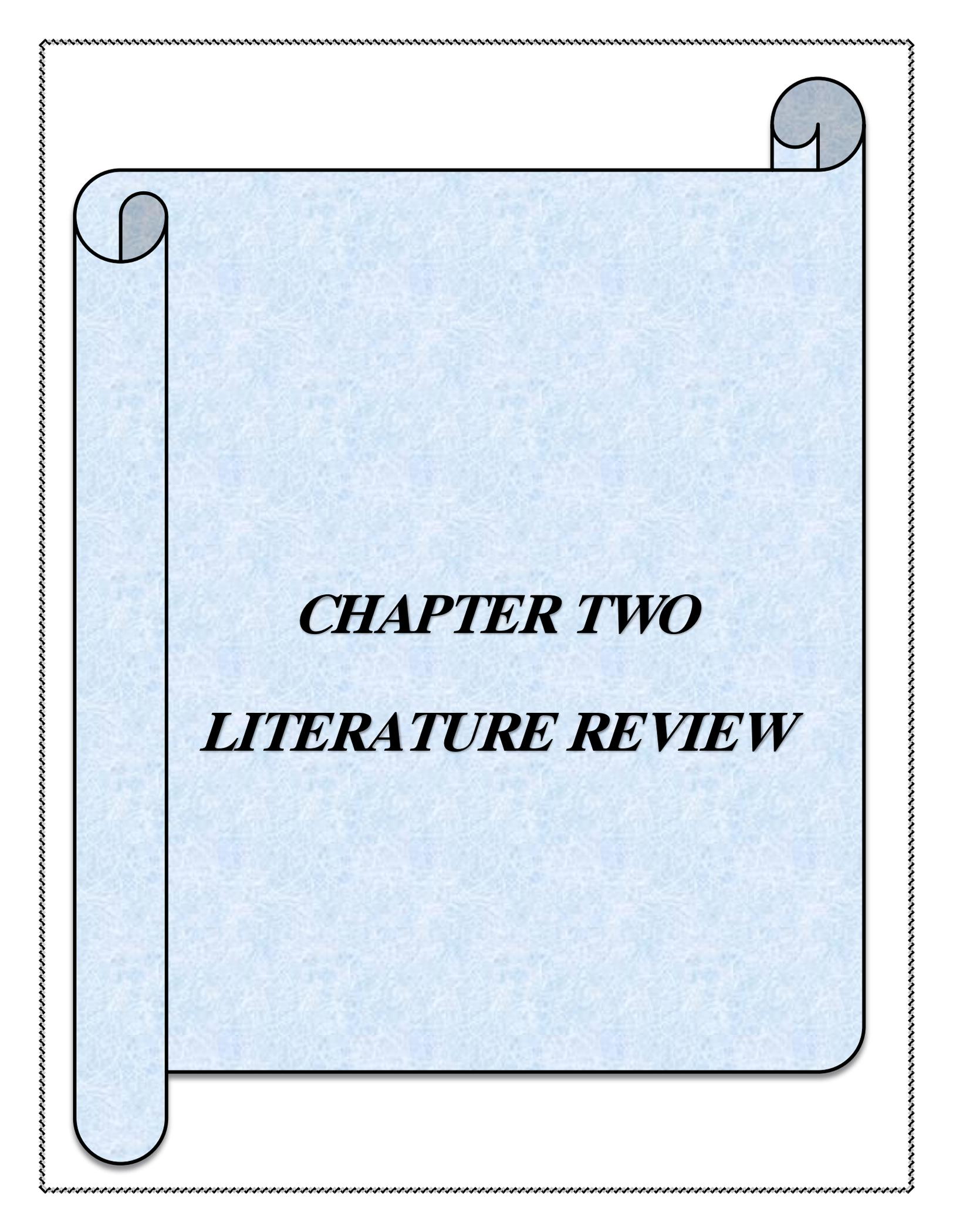


Fig (1.1): Thesis Structure



CHAPTER TWO

LITERATURE REVIEW

Chapter Two Literature Review

2.1 Previous Studies

Ahaneku, & Animashaun et al., 2013. assess some physicochemical parameters (pH, Dissolved oxygen, Temperature, Turbidity, Total dissolved solid, Nitrate, Ammonia, Iron, Lead and Chromium) of river Asa and present the complex water quality data of the river in a form that can easily be understood by the technical and non-technical personnel. To achieve the aim, the Canadian Council of Ministers of the Environment Water Quality Index (CCME WQI) was applied on the analytical results of the parameters to obtain a single value that was used to rank the river at each of the sampling station.

Nor, Mohd, Shamila,, & Muhammad et al., (2013) study of Melana River, Johor. Malaysian Journal of Analytical Sciences, study of water quality in Melana River, Johor was carried out in three consecutive months (March - May 2012). This study aims to determine the comparative results through biological monitoring as well as conventional method (physical and chemical analysis). Assessment is carried out through collection and identification of the biological indicator which comprises of macrobenthos based on Biological Water Quality Index (BWQI). Comparison was done based on two methods namely invertebrate analysis and also laboratory analysis. For invertebrate analysis, Melana River consist of three types of Family groups namely Nymphs, Larvae and Molluscs. The result for Water Quality Index (WQI) and also Biological Water Quality Index (BWQI) analysis showed that the level of Melana River is polluted and classified in Class III. This study shows that even though different methods were used, the similar results were obtained for both rivers and can be applied to any river to identify their level of cleanliness.

Al-Janabi ,Al-ObaidyAl-Kubaisi, et al., 2015. Applied of CCME Water Quality Index for Protection of Aquatic Life in the Tigris River within Baghdad city. Al-Nahrain Journal of Science,study, Tigris River within Baghdad city was monitored for a variety of physical and chemical parameters to determine water quality during 2010. Water quality indices (WQIs) were calculated for protection of aquatic life, using the model of CCME WQI (Canadian Council of Ministers of the Environment Water Quality Index). Twelve parameters were selected namely: Lead, Iron, Zinc, Manganese, Turbidity, pH value, Dissolved Oxygen, Water Temperature, Phosphate, Ammonia, Nitrate and Nitrite. The results revealed that station 3 which was located in south of Baghdad was more polluted than the other stations. The WQI ranking was between marginal in station 1, 2 to poor in station 3. The highest deviation occurred in lead, Iron and Turbidity, this parameter made a big contribution in decreasing the value of WQI.

Parmar and Bhardwaj, et al., 2015 dealt with the management of water quality utilizing a statistical scrutiny as well as a time-series prediction model. The monthly changeon of WQ standards was utilized for comparing statistical average, median, standard deviation, mode, skewness, kurtosis, and the coefficient of variation at "Yamuna River". The model was confirmed employing the confidence limits, predicted value, Ljung-Box analysis, normalized Bayesian information criterion, maximum absolute error, mean absolute error, maximum absolute percentage error, mean absolute percentage error, root mean square error and R-squared. Utilizing the auto regressive integrated moving average model, the forthcoming values of WQ parameters were assessed. And, it was noted that the prognostic model being beneficial at the confidence levels of (95%), and that the predicted series being near to the original series, providing a perfect fitting.

Naubi, Zardari Shirazi, Ibrahim et al., 2016 study the spatial trend of water quality index (WQI) and its sub-indexes are important for determining the locations of major pollutant sources that contribute to water quality depletion in the Skudai and its tributaries. In this study developed WQI for eight sections of the Skudai watershed. Ammonia-nitrogen ($\text{NH}_3\text{-N}$) was identified as a major pollutant downstream from the Skudai, with the lowest WQI index (i.e. 38). WQI for the Skudai (natural) was 94, i.e., Class I (very clean) category of river water quality. The Senai River has WQI value of 85 and Class II category (slightly polluted). However, the Kempas River, which was in suburban parts of the Skudai watershed, had WQI of 53 (Class III, polluted). The Melana and Danga rivers were also polluted rivers with WQI of 69 and 57, respectively, in Class III (polluted). Overall water quality in the Skudai and its tributaries was downstream of the river. The study also assessed water quality of the Skudai and its tributaries from other water quality parameters such as conductivity, turbidity, temperature, total dissolved solids, total phosphorous, and nitrogen, which were not part of the WQI formula developed by the Department of the Environment (DOE), Malaysia. The study found that Department of Education (DOE) formula for WQI was not effective in water quality assessment as many important parameters such as nutrients, heavy metals, and fecal coliform (or *E. Coli*) were missing in the WQI formula.

Ewaid & Abed et al., 2017 asses quality of Al-Gharraf River, the main branch of the Tigris River in the south of Iraq. Water samples were collected monthly from five sampling stations during 2015–2016, and 11 parameters were analyzed: biological oxygen demand, total dissolved solids, the concentration of hydrogen ions, dissolved oxygen, turbidity, phos- phates, nitrates, chlorides, as well as turbidity, total hardness, electrical conductivity and alkalinity. The index classified the river water, without including turbidity as a parameter, as good for drinking at the first station, poor at stations 2, 3, 4 and very poor at station 5. When turbidity was included, the index classified the river water as unsuitable for drinking purposes in the entire river. The study highlights the importance of applying the water quality indices which indicate the

total effect of the ecological factors on surface water quality and which give a simple interpretation of the monitoring data to help local people in improving water quality.

Mijares et al., 2017 evolved and improved sub-index formulations for the key factors of the quality of water for incorporating the targets and criteria of the quality of water. The improved sub-index formulations were constructed into the Unweighted Multiplicative Water Quality Index (UMWQI) as well as verified for appropriateness, besides a concentration upon the Western Lake Erie Basin (WLEB). This suggested model of UMWQI incorporates the targets and criteria of the quality of water fixed onward via the USEPA and the ecological agencies of state, to enhance the WQ grade of the WLEB Rivers.

Hamdan, Dawood, Naeem, et al., 2018 uses the Water Quality Index (WQI) to describe the pollution level of the Shatt Al-Arab river and by using Geographic Information System (GIS) to create WQI map, also determines the critical pollutants affecting the river water quality throughout its course. WQI has been formulated making use of several water quality parameters such as pH, temperature, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Nitrate (NO₃⁻²), Phosphate (PO₄⁻³), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity (Tur), and Electrical Conductivity (E.C) which were measured at 37 sites along the river. Bad water quality was observed at the sites of the river branches, near the center of Basrah governorate.

Muharemi et al., 2019 described some methods to identify the variations or the anomalies taking place upon WQ time series data. Also, such investigation debated as well as suggested a solution to certain defies if treating with the time series data. The models that were applied to the data of the WQ were Deep Neural Network (DNN), Long Short-Term Memory (LSTM), Artificial Neural Network (ANN), Artificial Recurrent Neural Network (ARNN), logistic regression, Support Vector Machines (SVM), and linear discriminant analysis. The assessment of performance was performed utilizing the F-Score metric. And, a simulation work was carried out for checking every algorithm performance employing F-Score. The solving unbalanced data was essentially deliberately biasing the data for getting the remarkable findings in place of the accurate ones. Results showed that the whole algorithms are susceptible despite that the logistic regressions of ANN and SVM models have a tendency to be slightly less susceptible, whereas the LSTM, RNN, and DNN models being too susceptible.

Leong et al., 2019 stated that the present computations of the WQI occasionally are highly time-consuming as well as intricate which includes the computation of sub-index, such as (COD) and (BOD); nevertheless by using the models of Least Squares Support Vector Machine (LS-SVM) and Support Vector Machine (SVM), the water quality index can be foreseen straight utilizing straightly the measured physical data via employing similar predictors utilized in the numerical method without any sub-index computation. And, there existed 3 chief factors controlling the (SVM) model performance, nevertheless merely the type of kernel function being studied; they're Radial Basis Function (RBF), linear, and Polynomial kernel functions. Then, the model's findings were scrutinized via utilizing the Determination Coefficient (R^2), Mean of Sum Squares Error (MSSE), and Sum Squares Error (SSE). And, it was obtained that the best kernel function for the SVM model being the

polynomial kernel function with ($R^2 = 0.8796$). Moreover, the LS-SVM model trained with the precise predictors possessed a greater accurateness with ($R^2 = 0.9227$) in comparison with the SVM model trained with the whole predictors with ($R^2 = 0.9184$). And, the SSE as well as the MSSE was 74.78 and 1.5594, and (1.6454) for the LS-SVM and the SVM, correspondingly.

Prasad M. Pujar et al., 2020 attempted to evolve a statistical model founded upon Internet of Things (IoT) for the WQ analysis of river Krishna utilizing various factors of water quality, like the total dissolved solids biochemical oxygen demand, temperature, dissolved oxygen, conductivity, and pH. Such factors are too significant for assessing the quality of the water of the river. The data of water quality were gathered from (6) stations of river Krishna in Karnataka state. In this investigation, the stretch of the river Krishna that flows in the Karnataka state was only regarded; that means around 483 km length. IoT is one way by which the real-time observing of the WQ of the river Krishna can be conducted in a rapid period. Thus, such study focused upon the IoT-based WQ observing via implementing a statistical analysis for a gathered data from river Krishna. And, one-way Analysis of Variance (ANOVA) as well as two-way ANOVA was employed for the gathered data, and it was obtained that the one-way ANOVA being highly active in performing the analysis of WQ.

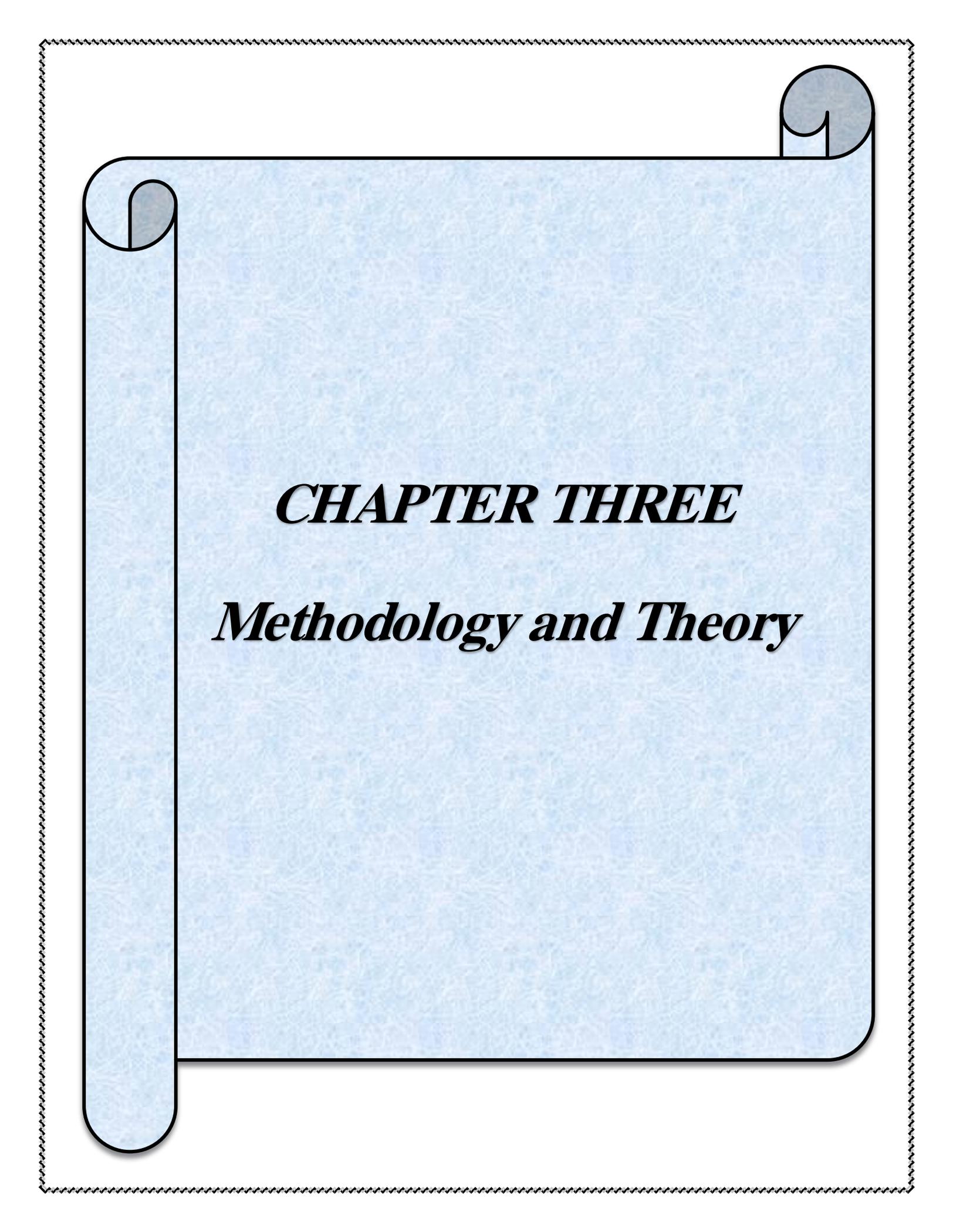
Costa et al., 2020 collected fifty-four water samples during the July and December of 2019 at 9 monitoring stations, and 15 factors were scrutinized for providing an updated diagnosis of the quality of water of the Piabanha River. Additionally, 40 years of monitoring were scrutinized, comprising the data of government and the preceding investigation projects. Also, a georeferenced database was constructed comprising the management data of water. The Water Quality Index from the National Sanitation Foundation (WQINSF) was computed utilizing 2 datasets and illustrated an enhancement in the general quality of water, in spite of yet giving systematic violations to Brazilian

standards. Principal Components Analysis (PCA) evinced the majority of the participating factors to the quality of water and assisted its relationship with the chief pollution sources that are identified in the geodatabase.

Othman et al., 2020 created an input method utilizing the Artificial Neural Networks (ANNs) for computing the Water Quality Index (WQI) from the input factors in place of utilizing the factors indices if one factor being none exist. Data were gathered from 9 stations of the monitoring of the quality of water at the basin of Klang River, Malaysia. Additionally, a complete analysis of sensitivity analysis was done for identifying the highly effective input factors. The model was founded upon the frequency spreading of the important parameters revealed an excellent capability for replicating the (WQI) and reaching the highest correlation (98.78%). Moreover, the sensitivity scrutiny depicted that the highly effective factor that influences the (WQI) is the Dissolved Oxygen (DO), whereas the (pH) being the least factor. In addition, the models performance showed that the lost values of (DO) resulted in a accuracy deterioration.

Venkataramana, et al., 2022 explored numerous deep learning algorithms for estimating the Water Quality Index (WQI), which is a singular index for describing the overall water quality, and the Water Quality Class (WQC), which is a typical class defined upon the the (WQI) basis. Samples of water were gathered from Korattur Lake in the city of Chennai. The factors of the quality of water, like pH, iron, Total Dissolved Salts (TDS), nitrate, phosphate, chemical oxygen demand, sodium, chloride and turbidity, were measured from the gathered samples of water. The utilized models to train and test comprise models of Deep Learning (DL), like Long-Short Term Memory (LSTM), Recurrent Neural Network (RNN), and Artificial Neural Network (ANN), for the two binary and multi-class classifications. The used metrics to evaluate the models were the models precision, accuracy, and implementation time, which were utilized to compare and analyze the overhead stated models. From

determined findings, it was noticed that the (LSTM) produced the highest accurateness of about (94%) and also consumed the least implementation time if compared to the else models of (DL).



CHAPTER THREE

Methodology and Theory

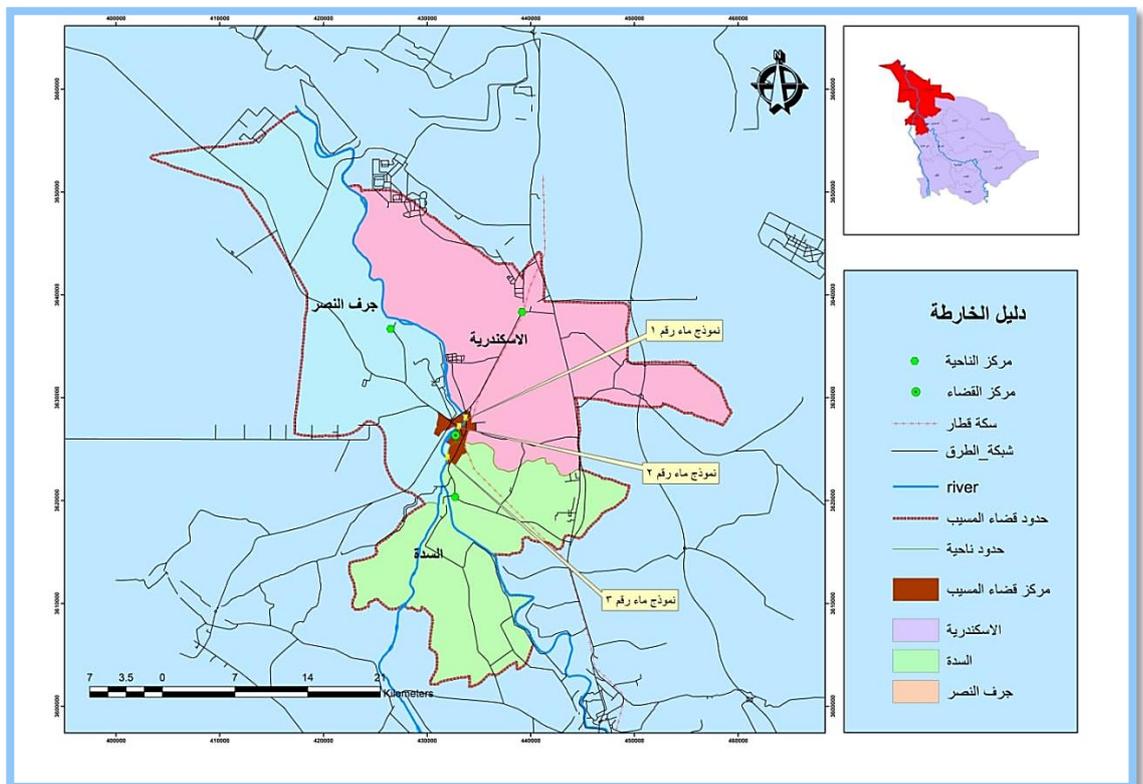
Chapter Three

Methodology and Theory

3.1 Study Area

It is located in Babil province, situated in the Iraqi central zone, occupying the northern part of the province. The case study was the river passing through the north of Hilla city at Euphrates River/Al-Musayyib located between latitude ($32^{\circ}47'14.95752- 32^{\circ}45' 9.36573$ N) and longitude ($44^{\circ}17' 32.37432- 44^{\circ}16' 25.59445$ E), as shown in Table (3-1). Three stations were taken on the river namely and measured the monthly environmental parameters, which were equal to thirteen parameters. These stations are depicted in figure (3.1) showing the map of the three water sampling stations. Agriculture farms and villages with moderately sized populations are distributed in the surrounding areas of study area.

Figure (3.1): Location of the Study Area



3.2 Water Sampling

Water samples were collected at each site from the middle of the river (0.5 m) below the surface of water; it is unlikely that the sediments will be disturbed by a 250 ml white plastic pot at the middle. Samples were put in bottles with a volume of 1L. The container was rinsed three times with the water to be sampled before sampling. The bottle was flooded in water with ensure that the water still stable with the lack of sediment and do not disturb anything in the direction of bottles in the area of taking samples. Samples have been transferred and put at 4°C in the refrigerator into the laboratory until examination, since after sampling from the source; the chemical characteristics of the water begin to change.

Water Samples of the Euphrates river/Al-Musayyib were collected once every month (during a period of six months). Samples were taken in the dry and wet seasons. The dry season included (July 2020, August 2020, September 2020, and October 2020) consider October in dry seasons because there in no rain in this month, while the wet seasons was at (November 2020 and December 2020). Samples were preserved and analyzed according to Iraqi standards. Velocity of flow was measured and was approximately close and constant for most months and sites where it ranged between (0.6 and 0.8 m/s). Table (3-2) presents the monitored water quality parameters.

Table (3-2): Water Quality Parameters

No	Parameters	Unit
1	pH	pH units
2	DO	mg/l
3	EC	μs/cm
4	TDS	mg/l
5	NO₃	mg/l
6	PO₄	mg/l
7	SO₄	mg/l
8	Mg	mg/l
9	Na	mg/l
10	Ca	mg/l
11	K	mg/l
12	TH	mg/l
13	TUR	NTU

3.3 Measurements of Water Quality Parameters

3.3.1 pH

This is standard process. Before beginning the measurement process, KCL was prepared as 3M, and then 5.592 gm of KCL material was weighted and dissolved in water. In a tiny clean beaker, the water sample was inverted multiple times from a 250 ml bottle of sample. The pH sample was then placed, and the calibrated pH meter's digital reading was taken.

3.3.2 Dissolved Oxygen (DO)

The DO meter was used to determine the amount of dissolved oxygen in the air. A pole was submerged in distilled water to calibrate the instrument, after which the dissolved oxygen content was determined and the device reading was recorded.

3.3.3 Electrical Conductivity (EC)

The reagent, which is a solution of KCL, must be prepared in advance before the device can measure electrical conductivity. Fill a 1 L bottle halfway with purified water devoid of salt and dissolve 0.7456 gram of anhydrous potassium chloride. The conductivity equipment, like the dissolved oxygen apparatus, was established on a potassium chloride solution and includes an electrode. A potassium chloride detector was attached to the electrode, and the reading was collected.

3.3.4 Total Dissolved Solids (TDS)

TDS is caused by natural or added solutes in water. Water can be "saline" when TDS is high, thus the term "salinity" might be used (Environmental protection Agency, 2001). Total dissolved solids were estimated using a weighting approach that took into account evaporation after filtering a given sample volume.

Initially, a small amount of filtered sample (50 ml) or less is taken based on the sample's salt concentration, and the eyelid is placed into a known weight and positioned into a water bath until it evaporates, then placed in an electric oven at (103-105°C) for (1 hr), then cooled into a drier and weighed, and the weight is taken.

The total dissolved solids were calculated using the following equation:

$$\text{mg Dissolved Solids/L} = ((A-B)*100)/\text{mL sample} \quad \dots\dots(3- 1)$$

Where:

A: The weight of dried residue + dish, (in mg)

B: The weight of dish (in mg)

3.3.5 Nitrate (NO_3^-)

While the reagents were being produced, nitrates were measured utilizing UV radiation having the wavelengths of (220 nm) and (275 nm) using a spectrophotometer. The first reagent was made by dissolving 0.7218 grams of Anhydrous Potassium Nitrate in 1 L of water, with a nitrate concentration of 100 parts per million and diluting it to 10 parts per million, whereas the second reagent was hydrochloric acid. Standard solutions were made from the nitrogen sample at concentrations of (0-350) micrograms by diluting numerous amounts to (50 ml) with distilled water (0, 1, 35) ml as well as supplementing (1 ml) of (1 N) HCL, with a (220 nm) predicted absorbance. 1 ml of filtered samples or any quantity diluted to 25 ml were taken, and 25 ml of filtered samples or any amount diluted to 25 ml were taken. 1 ml of hydrochloric acid was administered to 25 ml of filtered materials or any amount diluted to 25 ml, and the concentration was measured. Planck was created with 25 milliliters of pure water and 1 milliliter of hydrochloric acid. The samples were then read using a device with a wavelength of 220 nm, then 275 nm.

The nitrate was computed using the following formula:

$$\text{p.p.m (N)} = (\text{CONC.of N at 220} - \text{CONC at 275}) * F * \text{Dilution} \quad \dots (3- 2)$$

Where, $F=4.43$

3.3.6 Phosphate (PO_4^{3-})

The same apparatus used to measure nitrates was employed to detect phosphorus, and numerous reagents were made. Initially, a basic phosphate standard solution was made by dissolving 0.2195 g of KH_2PO_4 (dried at 105°C) in 1 liter of water. The second step involved diluting 70 ml of sulfuric acid with 1 liter of water to make 1.25 M sulfuric acid. Finally, the

unique reagent contains 6 gm ammonium molb, 0.14 gm anitomy pot.Tartarate, and 5.3 gram ascorbic acid. These materials were combined and ground thoroughly in a mortar. A reagent solution was made by dissolving one gram of the ground mixture in 100 mL sulfuric acid, as follows:

1) Take 25 mL from the candidate form and mix it with 5 mL of examination reagent.

2) Planck was made in the same way, with 25 mL of water and the reagent added to it.

3) To make the standard solution, take 1 mL of standard solution and dilute it to 100 mL, resulting in a concentration of 0.5 parts per million.

4) After fixing the device at a concentration of 0.5 parts per million, 25 ml was collected and added the special reagent in the same way as the model and plank, leave for 10 minutes after adding, and read the concentration along the wavelength of 700 nanometers.

after the sample was deposited and the device was fastened, the amount of phosphates read by mg per liter immediately from the device.

3.3.7 Sulfate (SO_4^{2-})

The conditioned solution reagent is made up of 30 grams of magnesium chloride, 1 gram of sodium, 1 gram of KNO_3 , and 20 milliliters of glacial acetic acid, all magnetically dissolved in 500 milliliters of water and diluted to 1 liter.

The other reagent was 2030 mesh barium chloride (BaCl_2), and the standard sulfate solution was made by dissolving 0.1479gm of Na_2SO_4 in 1L of distilled water. The following approach was used to quantify sulfate using a Spectrophotometer:

1) 10 mL of the sample was taken and 100 mL of distilled water was added to it.

- 2) Added 20 mL of the sulfate reagent, which is an active solution, and mixed with the magnetic motor at a constant speed.
- 3) After 30 minutes, the material was treated with 0.1 g of barium chloride (BaCl_2). The sample was coated with 0.1 g of barium chloride (BaCl_2) and left for one minute before being read by the test cell.
- 4) Before estimating the sample, the spectrophotometer was calibrated with normal sulfate solution and a blank.

3.3.8 Total Hardness (TDS)

Because there are several chemicals utilized, the hardness was estimated using the titration method:

- 1) Prepare a buffer solution by dissolving 16 g of NH_4Cl in 1.43 mL NH_4OH , adding 1.25 g Mg-EDTA, and diluting to 250 mL with water.
- 2) A concentration of 0.01 M EDTA
- 3) The advice 0.5 g (Erichrome Black T) was heated and placed in a sterile container with 100 g NaCl.
- 4) Normal calcium solution, as prepared with 1 g CaCO_3 and placed in a 400 ml beaker, slowly add HCl solution, then add 800 ml distilled water with a filet for several minutes, add red methyl guidance to give the orange color, and then move the solution to the beaker and finish the volume of water. This is a normal solution in which 1 mg of calcium carbonate is equal to 1 mL of calcium carbonate. The procedure was as follows: a 50 ml sample and a 2 ml buffer solution were used to raise the pH to 10, a little proof was added to make the color red, then the mix was washed with the (EDTA) till its color turns blue, and finally the reaction was completed.

The following formula was used to determine total hardness:

mg/l as $\text{CaCO}_3 = A * B * 1000 * \text{equivalent weight of } \text{CaCO}_3 / \text{volume of sample (ml)} \dots\dots(3-3)$

Where:

A: The EDTA volume used in titration

B: The weight of EDTA

3.3.9 Calcium (Ca⁺)

Titration with EDTA was used to calculate the amount of calcium concentration. The following reagents were used: Sodium hydroxide solution (40 g per liter of water) and meroxide guide (0.2 g of it mixed with 100 g of salt), with adequate heating and EDTA solutions of (0.02) N. The procedure was as follows:

- 1) 50 ml of the sample or any volume diluted to 50 ml were taken from the sample.
- 2) Combine 2 mL NaOH with a quantity of evidence indicating a pink color change.
- 3) The solution was titrated with EDTA until it turned purple, indicating the reaction's end point. The following equation can be used to calculate calcium:

$$\text{Ca (mg/L)} = A * B * \text{equivalent weight} * 1000 / \text{sample volume (ml)} \dots (3-4)$$

Where:

A: The EDTA volume used during titration

B: The weight of EDTA

3.3.10 Magnesium (Mg⁺)

The concentration of magnesium was determined by subtracting the volume of EDTA used in calcium from the volume of EDTA used to calculate hardness using the following formula:

$$\text{Mg (mg/L)} = (\text{EDTA volume from hardness} - \text{EDTA volume from calcium}) * 4.88 \dots (3-5)$$

3.3.11 Sodium (Na⁺) and Potassium (K⁺)

According to the Department of Environmental Protection and Improvement, this approach was used to quantify salt and potassium using a flame photometer instrument.

The compressor was turned on, the air pressure was set to 0.45 kg/cm², and the supply of gas was turned on to hold the air-gas mixture in place so that a blue flame could be produced. The device was calibrated by aspirating with a series of established concentration criteria, and the samples were then applied and the values recorded using the curve fit technique.

3.3.12 Turbidity

Turbidity was measured in the lab using the Nephelometric Method and a Turbidimeter instrument. The device was linked to a standard solution with turbidity similar to the sample turbidity, and the turbidity was read after shaking the model well with a Nephelometric Turbidity Unit (NTU).

3.4 Main Statistical Tools Used to Analyze the Data of WQ

Various statistical tools to analyze the data of the quality of water have been demonstrated by [Jeffery S. Horsburgh, 2001], including Graphical analysis of the data of WQ, and WQI, as well as the various methods evolved for analyzing the data falling beneath the limits of detection. Also, a number of methods have been introduced for trend detecting and assessing the changes in the quality of water. In the present work, the Water Quality Indices (WQI) and other statistical tools were used for analyzing the data of the quality of water, as illustrated in the next section.

3.4.1 Water Quality Index (WQI):

Occasionally, it's hard to evaluate WQ from a big number of WQ parameters of a stream or a river. The conventional approaches for evaluating the WQ being conducted via comparing the obtained investigational values of parameters with those have already been existed with incomplete WQ data for such stream or river. The tendencies of spatial-temporal changes of the surface WQ in the watershed were characterized by different investigators using WQI from computing different physico-chemical parameters measured from time to time at various sampling sites for integrating the intricate data of WQ providing a simple and comprehensible tool to inform the managers and decision-makers about the status of the whole WQ.

Different water quality indices (WQI) were evolved used for giving a total sight upon the spatial-temporal variations of the WQ[Jeffery S. Horsburgh, 2001]. In addition, WQIs were used often in the public area for assessing the WQ using various indices in different states of the world. In the next two subsections, different WQ indices are introduced and compared with discussing their utilizations as well as limitations.

The river's WQI has been computed from thirteen parameters, including pH, DO, EC, TDS, NO₃, PO₄, SO₄, Mg, Na, Ca, K, TH, TUR for three sampling stations for assessing the appropriateness of the water of Euphrates River/Al-Musayyib.

3.4.1.1 Calculation of Sub Index (Qi)

$$Q_i = \frac{(M_i - I_i)}{(S_i - I_i)} \times 100 \quad \dots\dots\dots (3- 6)$$

Where:

Qi: The sub-index of the ith parameter

Mi: The observed value of parameter

Ii: The ideal value

Si: The standard value of the ith parameter

3.4.1.2 Calculation of Unit Weight (Wi)

$$W_i = \frac{K}{S_i} \quad \dots\dots\dots (3- 7)$$

Where:

Wi: The unit weightage of the ith parameter

Si: The standard value of the ith parameter

K: The constant of proportionality

The pH ideal value is (7), the dissolved O₂ value is (14.6 mg/l), and for the else parameters, it is equal to zero [J. K. Tripathy and K. C. Sahu, 2005], [R. M. Chowdhury, S. Y. Muntasir, and M. M. Hossain, 2012].

3.4.1.3 Calculation of Weighted Water Quality Indices

WQIs being commonly determined via allocating a proper weight for every WQI and averaging the musing certain types of the average functions. Here, three various weighted (WQI) are considered.

The first WQI for assessing the WQ from various measured parameters and for evaluating the spatial-temporal variations [Pesce, S. F. and Wunderlin, D. A., 2000] being:

$$WQI_{WA} = K \sum_{i=1}^n W_i Q_i \quad \dots\dots\dots (3- 8)$$

Where:

n: The no. of the WQ parameters

Q_i : The sub-index of the i th parameter

W_i : The comparative weight specified to the Q_i to satisfy $\sum_{i=1}^n w_i = 1$

K : A subjective constant that represents the visual impact of the contamination of river.

The K value is 1 (for the water with no pollution [Kannel, P. R.; Lee, S.; and Lees; Y. S., 2001]).

When K is equal to one in Eq. (3.8), equation (3.9) is the second objective WQI that was suggested via Horton (1965) and named by Weighted Arithmetic WQI used via numerous investigators.

$$WQI_{WG} = \prod_{i=1}^n Q_i^{w_i} \quad \dots\dots (3-9)$$

The weighted WQ indices manifest that every WQ parameter may possess various weights depending upon the significance of the state of WQ. Such feature could be needed if the indices of WQ being particular to the aquatic life protection.

3.4.1.4 Unweighted Water Quality Indices

Here, three unweighted QWIs are presented, and the following initial two indices are the Arithmetic/Geometric WQIs suggested via (Landwehr and Deininger, 1976):

$$WQI_A = 1/n \sum_{i=1}^n Q_i \quad \dots\dots (3-10)$$

$$WQI_G = (\prod_{i=1}^n Q_i)^{1/n} \quad \dots\dots (3-11)$$

For the relations between WQI_{WA} and WQI_{WG} , WQI_G is continuously lesser than the WQI_A .

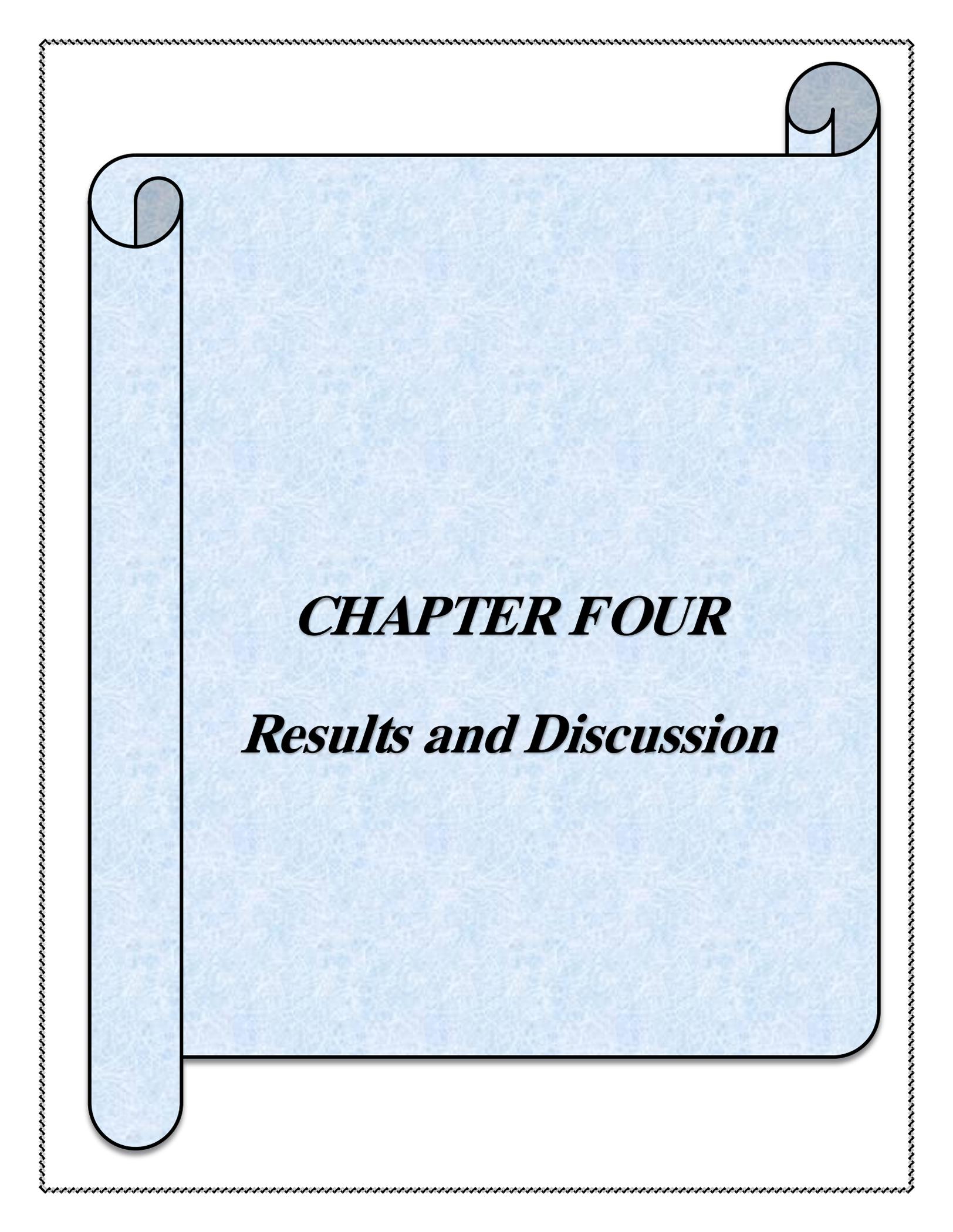
3.4.2 Statistical Correlation Analysis

A correlation analysis was performed utilizing Pearson's r correlation in the current study's analysis. Individual water quality parameters were subjected to correlation studies in attempt to find links between them.

The Statistical Package for Social Sciences (SPSS) was used to generate a correlation matrix with a r value for statistical analysis utilizing

Pearson correlation coefficient between parameters of water quality at each sampling point. Pearson correlation analysis was conducted to see whether there were any correlations between the locations' physiochemical and biological properties. The data analysis generates the coefficient of correlation, which is an r-value that indicates a linear relation among the data pairs

A (-1) or (1) correlation coefficient indicates the strongest linear relationship between two accessible variables, with (-1) indicating a considerable inverse connection. The interval of confidence, as well as the number of data pairings that make up the r-value, are the three variables that decide whether it is statistically significant. A 95 percent confidence interval, which is typically used in research, was chosen as the confidence interval. A table with a 0.05 or 0.01 p-value contains a significant r-value.



CHAPTER FOUR

Results and Discussion

Chapter Four

Results and Discussion

4.1 Sampling Data:

Water samples were collected for testing the physical, chemical once every month from Euphrates/Al-Musayyib River. The analysis was done for six months (July 2020 to Decembers 2020) from three sites during the dry and wet seasons. Table (4-1) shows the sampling dates of the water quality in dry and wet seasons. These samples have been chosen to help in understanding the variability of water quality due to seasonal differences. Wet and dry season have been analyzed to better determine the river pollution rates.

Table (4.1): Dates of sampling with the sampling weather

Sampling Date	Weather
July, 2020	Dry Season
August, 2020	Dry Season
September, 2020	Dry Season
October, 2020	Dry Season
November, 2020	Wet Season
December, 2020	Wet Season

Table4. 1

4.2 Standard Specifications for Parameters of Water Quality

Standards and guidelines of the river water quality, tributaries and branches according to the Department of Environmental Protection and Improvement, where these limits depend on the river maintenance system and the publication in [AlWaqi'a Iraqi newspaper in 2001], as shown in Table (4-2) depicting thirteen parameters with their limits which were considered in the present work according to the standard specification.

Table (4.2): Standard specifications for each parameter (Iraqi Standard Limit) [Al-Waqi'a Iraqi newspaper in 2001]

Parameters	Limits
pH	6.5-8.5
DO	More than 5 mg/L
EC	1000 μs/cm
TDS	1500 mg/L
NO₃	15 mg/L
PO₄	0.4 mg/L
SO₄	400 mg/L
Mg	50 mg/L
Na	200 mg/L
Ca	50 mg/L
K	12 mg/L
TH	500 mg/L
TUR	5 NTU

Table4.

2

4.3 The Basic Statistics of Water Quality in the Dry and Wet Seasons

The basic statistics of water quality of three stations for dry seasons and wet seasons are given in Tables (4-3), (4-4), (4-5), (4-6), (4-7), and (4-8). The values of minimum, maximum mean and standard deviation indicate that there is a large fluctuation in the values of the selected (13) parameters (PH, DO, EC, TDS, NO₃, PO₄, SO₄, Mg, Na, Ca, K, TH, and TUR). Variations of WQ were determined at various sampling sites at sampling date. The data from the sampling dates are presented in these tables to show the WQ patterns at Al-Musayyib River.

Table (4.3): The basic statistics of water quality in station 1 in the dry season

Parameters	Standard value	Min	Max	Mean	Standard Deviation
PH	6.5	6.7	7.2 75	6.931	0.228
DO	5	6.5	7.95	7.05	0.603
PO ₄	0.4	0.235	0.265	0.251	0.010
NO ₃	15	4.06	4.81	4.305	0.295
Ca	50	95.15	117.95	106.912	8.155
Mg	50	28.75	40.55	33.275	4.394
TH	500	359.3	388	376.387	11.212
K	12	3.5	3.8	3.675	0.129
Na	200	56	62.25	58.675	2.256
SO ₄	400	285.1	365.6	334.237	30.009
		5			
TDS	1500	592.2	630	612.425	13.480
E.C	1000	937	977.5	960.875	15.274
TUR	5	2.35	5.9	4.2	1.301

Table4. 3

Table (4.4): The basic statistics of water quality in the station 2 in the Dry season

Parameters	Standard value	Min	Max	Mean	Standard Deviation
pH	6.5	6.85	7.15	6.9625	0.124373
DO	5	5.85	7.95	6.95	0.839643
PO4	0.4	0.21	0.275	0.245	0.023184
NO3	15	3.98	4.56	4.33375	0.222525
Ca	50	95.95	117.5	104.8875	7.904301
Mg	50	25.37	44.8	33.8175	7.088171
TH	500	359.4	408.35	379.525	18.14836
K	12	3.7	4.1	3.9	0.145774
Na	200	56.85	62.15	58.5625	2.116712
SO4	400	328.85	374.25	356.1	16.86116
TDS	1500	594.6	624.4	613.1375	11.15792
E.C	1000	939.5	979	964.125	15.20845
TUR	5	2.35	9.2	4.8375	2.643713

**Table (4.5): The basic statistics of water quality in the station 3
in the Dry season**

Parameters	Standard value	Min	Max	Mean	Standard Deviation
pH	6.5	6.6	6.9	6.825	0.129
DO	5	6.6	7.3	6.957	0.328
PO₄	0.4	0.22	0.266	0.236	0.018
NO₃	15	4.2	4.4	4.257	0.083
Ca	50	95.9	115.6	105.875	6.966
Mg	50	25.1	42.5	33.535	6.496
TH	500	352	401	371.45	18.828
K	12	3.8	4.4	4.1	0.212
Na	200	56.85	63.1	59.312	2.339
SO₄	400	330.3	357.2	345	10.418
TDS	1500	597.3	624	613.325	9.837
E.C	1000	937.45	970	955.737	11.748
TUR	5	2.52	9.5	5.012	2.677

Table4. 5

Table (4.6): The basic statistics of water quality in first station in the Wet season

Parameter	Standard value	Min	Max	Mean	Standard Deviation
pH	6.5	6.75	6.9	6.825	0.075
DO	5	6.5	8.7	7.6	1.1
PO₄	0.4	0.22	0.265	0.2425	0.0225
NO₃	15	4.2	4.44	4.32	0.12
Ca	50	76	105.6	90.8	14.8
Mg	50	31.7	35.55	33.625	1.925
TH	500	329.55	384.65	357.1	27.55
K	12	3.4	3.8	3.6	0.2
Na	200	62.25	63.8	63.025	0.775
SO₄	400	317.1	338	327.55	10.45
TDS	1500	592.2	629.9	611.05	18.85
E.C	1000	937	942.5	939.75	2.75
TUR	5	3	3.8	3.4	0.4

Table4. 6

Table (4.7): The basic statistics of water quality in the second station in the wet season

Parameters	Standard value	Min	Max	Mean	Standard Deviation
pH	6.5	6.65	6.85	6.75	0.1
DO	5	5.85	8.95	7.4	1.55
PO₄	0.4	0.22	0.275	0.2475	0.0275
NO₃	15	3.65	4.56	4.105	0.455
Ca	50	67.05	101.6	84.325	17.275
Mg	50	30.85	35.4	33.125	2.275
TH	500	298.35	370.5	334.425	36.075
K	12	3.85	4.25	4.05	0.2
Na	200	62.15	74.95	68.55	6.4
SO₄	400	310	357.2	333.6	23.6
TDS	1500	594.6	645.5	620.05	25.45
E.C	1000	939.5	947	943.25	3.75
TUR	5	3.2	3.8	3.5	0.3

Table4. 7

Table (4.8): The basic statistics of water quality in the third station in the wet season

Parameters	Standard value	Min	Max	Mean	Standard Deviation
pH	6.5	6.65	7.07	6.86	0.21
DO	5	6.6	8.65	7.625	1.025
PO₄	0.4	0.23	0.267	0.2485	0.0185
NO₃	15	3.42	4.3	3.86	0.44
Ca	50	68.65	106	87.325	18.675
Mg	50	34.95	35.4298	35.1899	0.2399
TH	500	340.55	374.4	357.475	16.925
K	12	3.7	4.3	4	0.3
Na	200	63.17	71.95	67.56	4.39
SO₄	400	315.5	340	327.75	12.25
TDS	1500	594.1	646.7	620.4	26.3
E.C	1000	939	945.3	942.15	3.15
TUR	5	3.65	3.65	3.65	0

Table4. 8

4.4 Water Quality Parameter Changes of AL-Musayyib River

4.4.1 Average of PH between three sampling sites

The average PH at each site was measured as shown in figure (1), PH values were ranged between (6.75 – 6.86) mg/L in wet season, while PH values were ranged between (6.82 -6.93) mg/L in dry season. The highest value recorded in the site R 2, during dry weather, was 6.96, and the reason for the increase in this value is the increase in the rate of photosynthesis of algae and plankton, which consume carbon dioxide, which in turn increases the pH (Al-Yasiri, 2007). While the lowest pH value was recorded in the site R2, it was 6.75 during wet weather, and the reason for this decrease is the decrease in the photosynthesis process (Agarwal, A.K and Rajwar, G.S. 2010).

The PH results conformed to the standard specifications for Iraqi drinking water for the year (2009) and ranged within (6.5 - 8.5) and for the year (2008) WHO, its values ranged within (6.5 - 9), in the three stations, during the wet and dry weather.

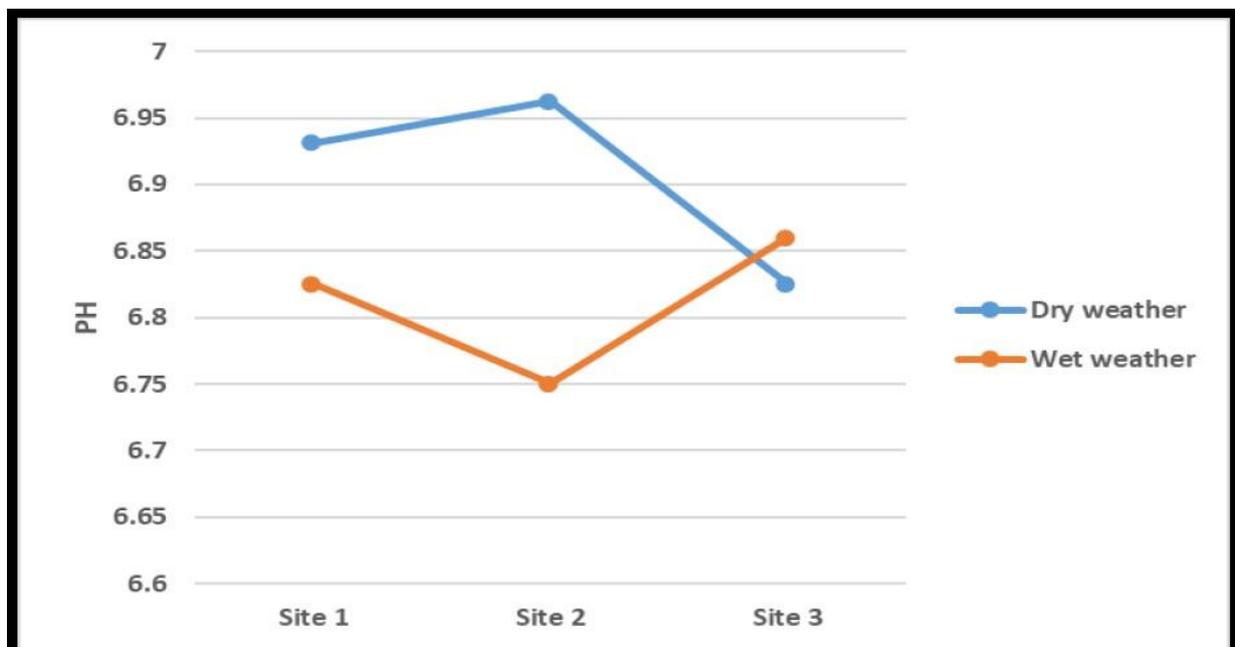


Figure (4.1): Variation of PH at sampling three sites during dry and wet season period

4.4.2 Average of dissolved oxygen between three sampling sites:

The average dissolved oxygen at each site is measured as shown in Figure (2). DO values were ranged between (7.60 – 7.62) mg/L in wet weather while the values were ranged between (6.95 – 7.05) mg/L in dry weather. The highest value of dissolved oxygen was recorded during wet weather (7.62) in the site R3, and the reason for this is due to serious ventilation, continuous mixing, and high water level (Mohammed, 2007), while the lowest value was recorded during the dry weather (6.95) in the site R2. This is due to the gradual rise in temperature and the oxidation of organic matter by microorganisms, as well as due to the decrease in the water level in the river (AL-saad et al. 1994).

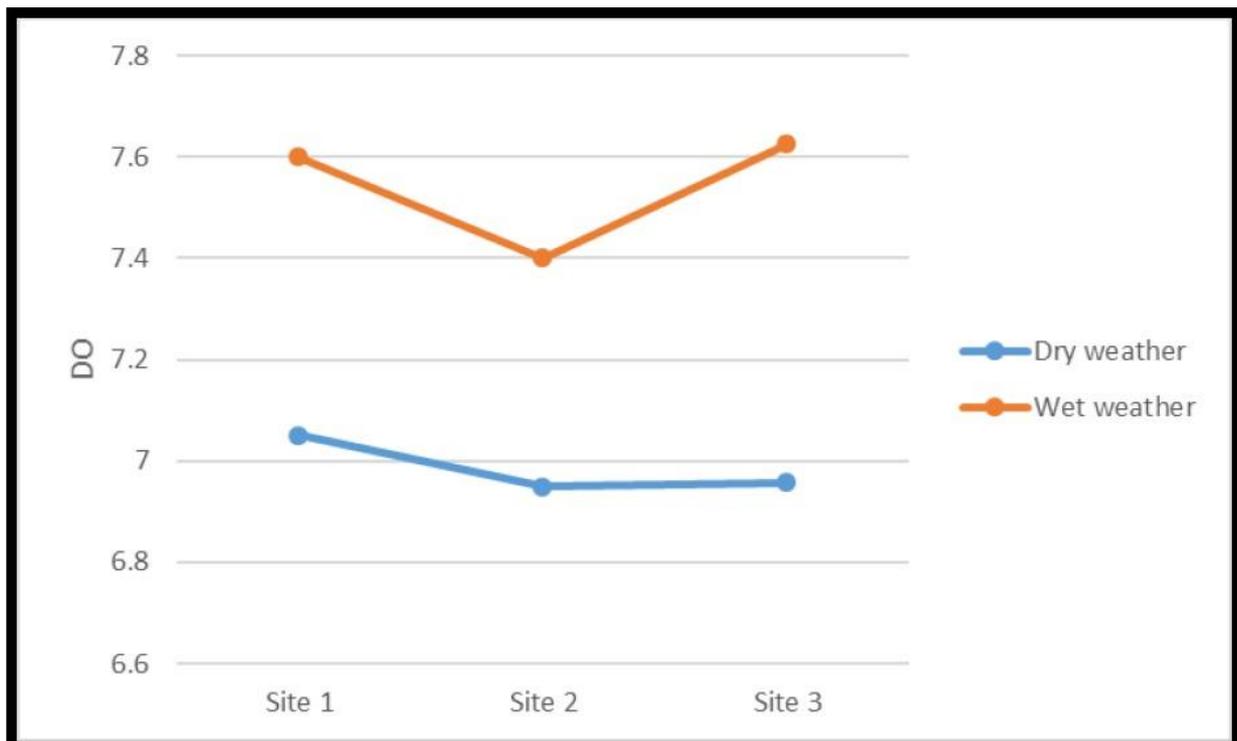


Figure4. 1

Figure (2): Variation of DO at sampling three sites during dry and wet season period

4.4.3 Average of phosphate between three sampling sites

The average phosphate at each site is measured as shown in Figure (3). Phosphate values were ranged between (0.242 – 0.248) mg/L in wet weather while the values were ranged between (0.236 – 0.251) mg/L in dry weather.

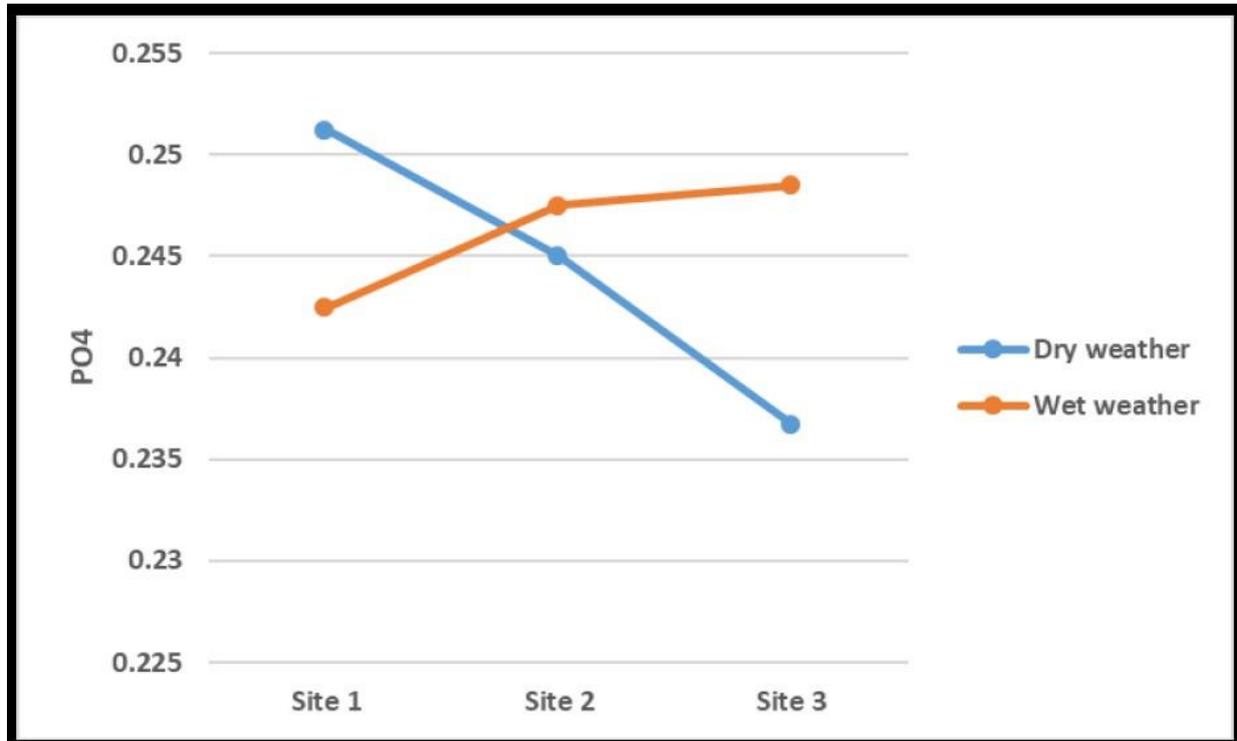


Figure4. 2

Figure (3): Variation of PO_4 during dry and wet season period

4.4.4 Average of nitrates between three sampling sites:

The average nitrates at each site are measured as shown in Figure (4). Nitrates values were ranged between (3.86–4.32) mg/L in wet weather while the values were ranged between (4.25–4.33) mg/L in dry weather. The highest value of nitrates was recorded during wet weather (0.251) in site R1, The reason for the high level of nitrates in the water of the river is due to its passage in agricultural lands where the compound fertilizers containing nitrates and pesticides are used, which descends into the waters of the river .

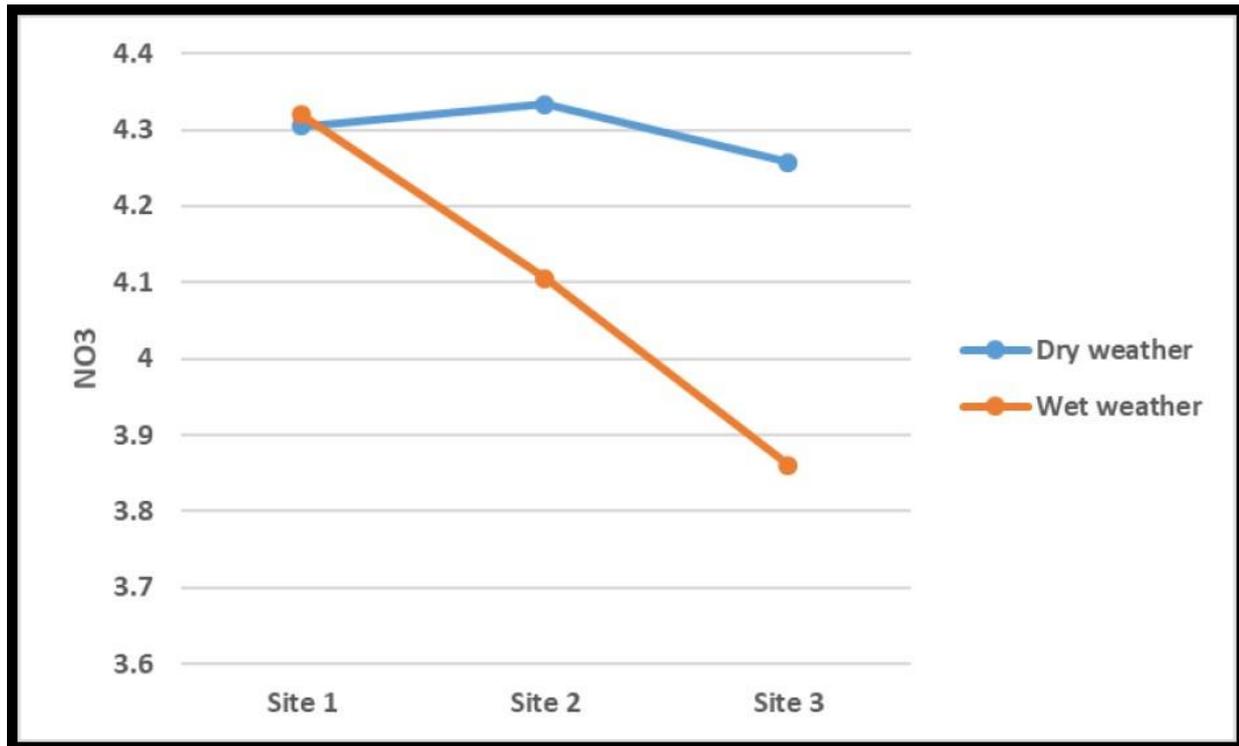


Figure4. 3

Figure (4): Variation of NO_3 during dry and wet season period

4.4.5 Average of calcium between three sampling sites

The average calcium at each site is measured as shown in Figure (5). Calcium values were ranged between (84.32–90.80) mg/L in wet season while the values were ranged between (104.88–106.91) mg/L in dry season.

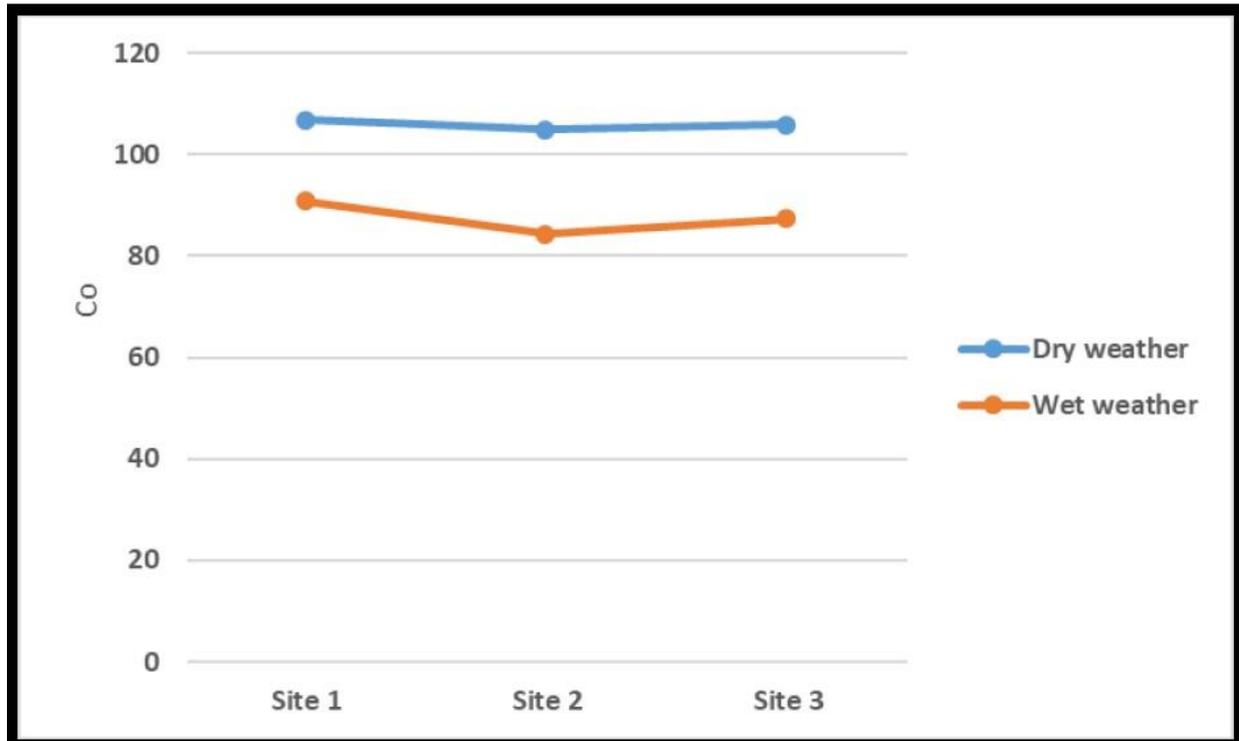


Figure (5): Variation of Ca during dry and wet season period

4.4.6 Average of magnesium between three sampling sites

The average magnesium at each site is measured as shown in Figure (6). Magnesium values were ranged between (33.12–34.95) mg/L in wet weather while the values were ranged between (33.27–33.81) mg/L in dry season.

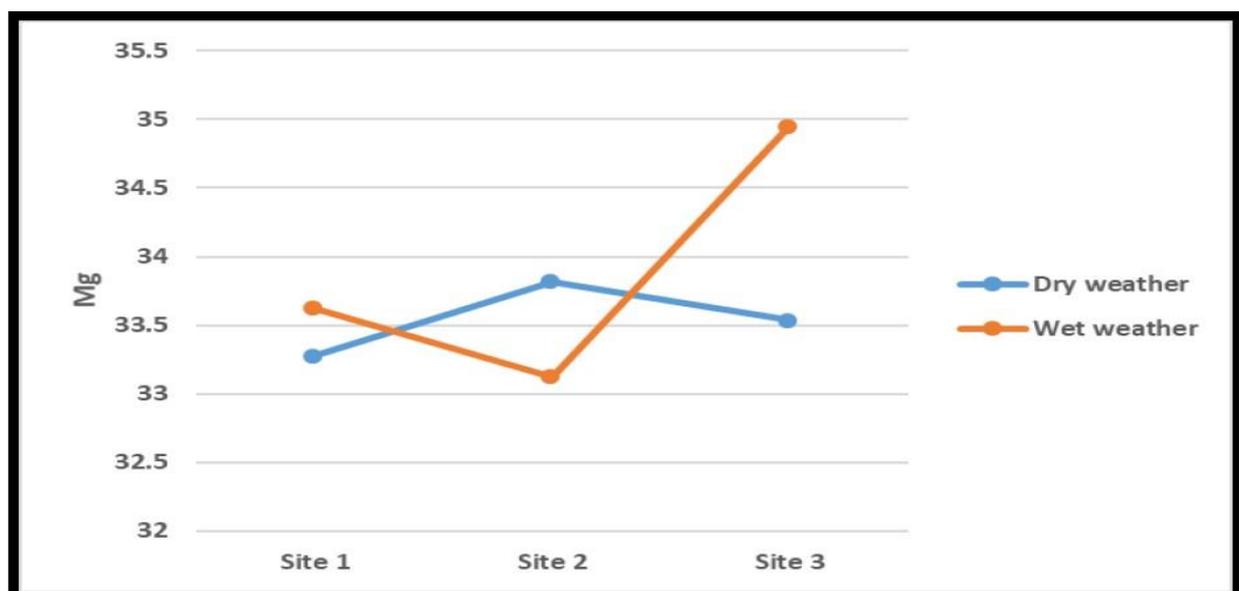


Figure (6): Variation of Mg during dry and wet season period

4.4.7 Average of total hardness between three sampling sites

The average total hardness at each site is measured as shown in Figure (7). Total hardness values were ranged between (334.42–357.47) mg/L in wet weather, while the values were ranged between (371.45–379.52) mg/L in dry season.

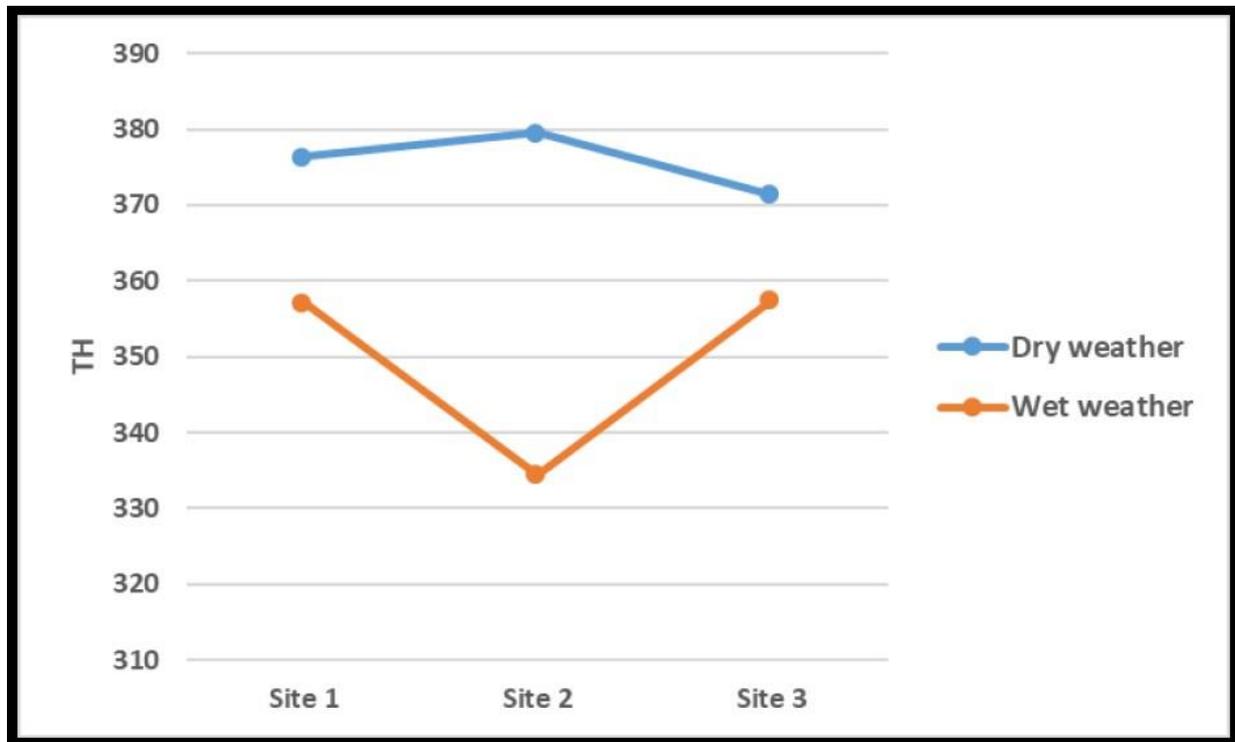


Figure4. 4

Figure (7): Variation of TH during dry and wet season period

4.4.8 Average of potassium between three sampling sites

The average potassium at each site is measured as shown in Figure (8). Potassium values were ranged between (3.60–4.05) mg/L in wet weather, while the values were ranged between (3.67–4.10) mg/L in dry weather. The highest value of potassium was recorded during dry weather (4.10) in site R3, The reason for the increase is because potassium enters as an essential component in the The decrease in potassium is due to the high temperatures that lead to an increase in the dissolution of salts and an increase in the consumption of salts and minerals by aquatic organisms, especially algae.

The presence of high values of potassium with permanent hardness poses a threat to the general health of the population, where many cases of vascular diseases and atherosclerosis were recorded, as well as kidney disease and skin rashes, In concentrations that ranged between (30-100) mg /L (Pomeranz et, al, 2002).

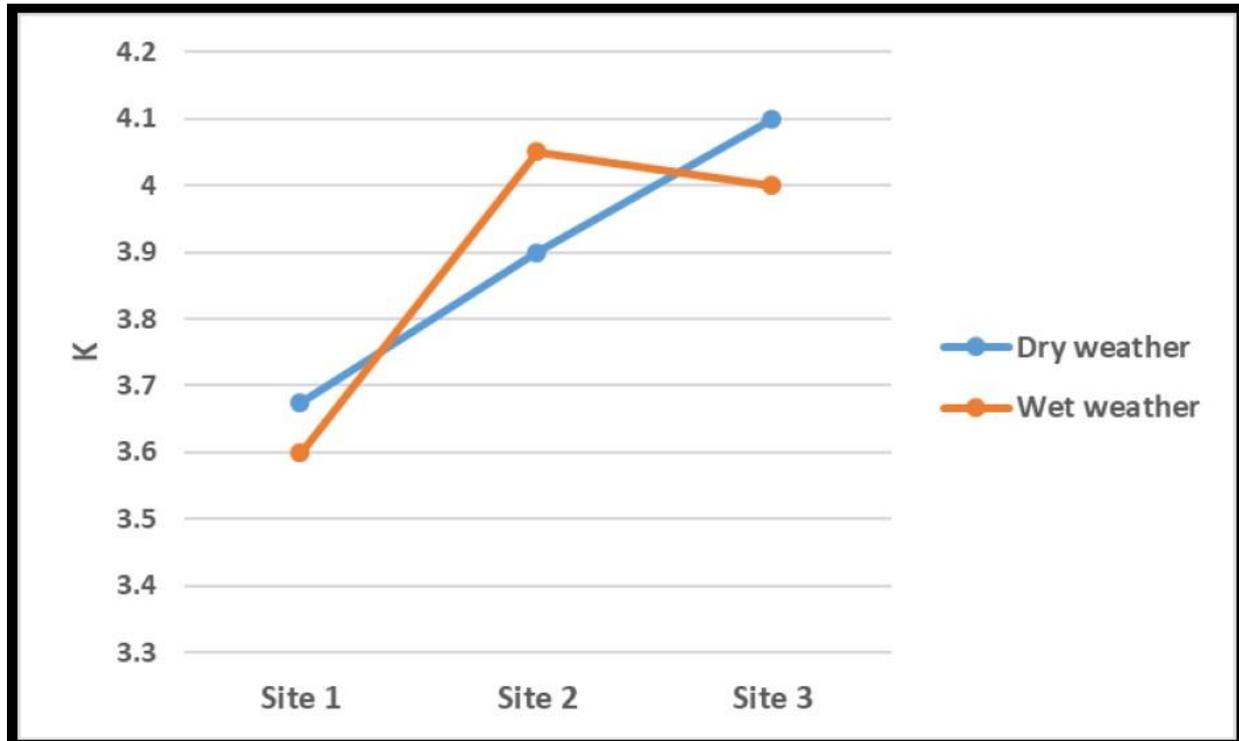


Figure4. 5

Figure (8): Variation of K during dry and wet season period

4.4.9 Average of sodium between three sampling sites

The average sodium at each site is measured as shown in Figure (9). Sodium values were ranged between (63.02–68.55) mg/L in wet weather, while the values were ranged between (58.56–59.31) mg/L in dry weather, the highest value of sodium concentration recorded during wet weather in Site R3 is (68.55) And the reason is due to the processes of washing salts from the soil and geological formations as a result of rainwater and irrigation water (Al-Janabi, 2011, Budy, 1980).

The results of the study showed that the concentration of sodium in the three stations during dry and humid weather is outside the limits of Iraqi specifications.

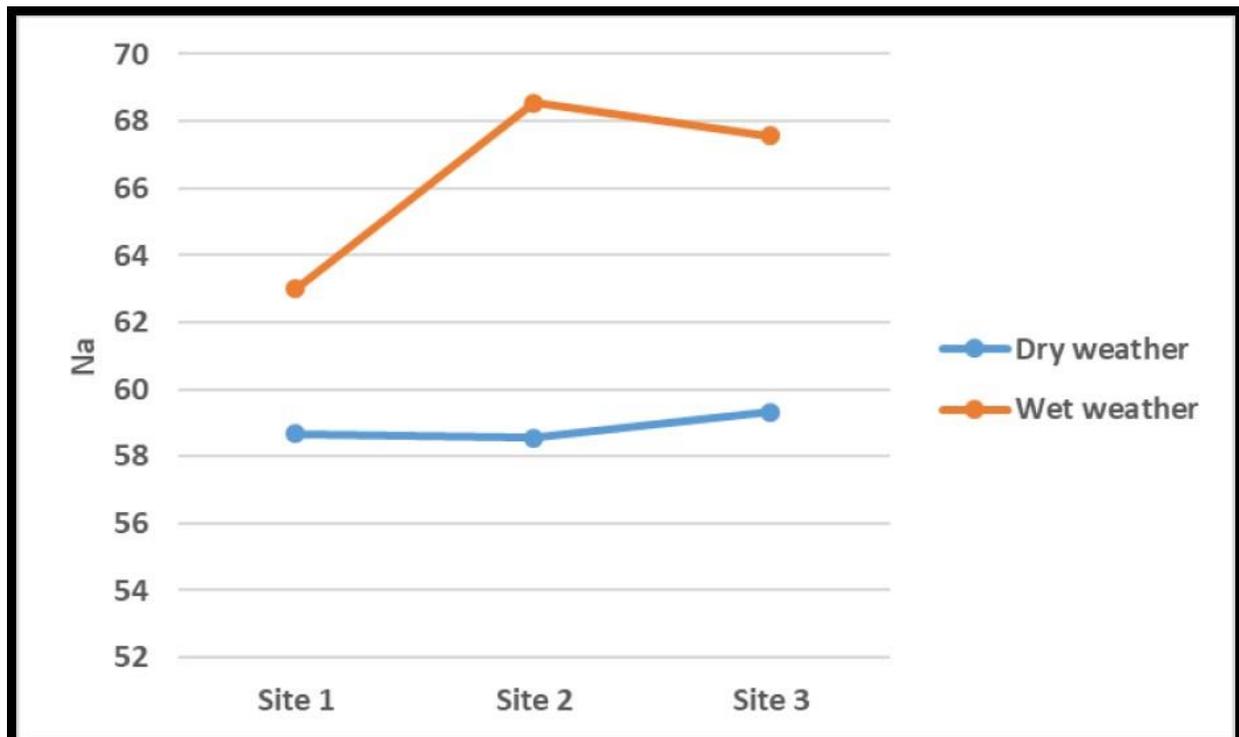


Figure (9): Variation of Na during dry and wet season period

4.4.10 Average of sulfate between three sampling sites

The average sulfate at each site is measured as shown in Figure (10). Sulfate values were ranged between (327.55–333.60) mg/L in wet weather, while the values were ranged between (334.23–356.10) mg/L in dry weather, the highest value of sulfate concentration recorded during wet weather in Site R2 is (356.10) mg/L, The reason for the rise of sulfates is due to the gypsum nature of sedimentary rocks Which is a major source of dissolved sulfate in water (Salman, 2008). The reason is also due to the use of chemical fertilizers, especially in the agricultural season (Al-Saeedi and Al-Aboudi, 2011). The other reason for the rise of sulfates in the sedimentation basins is the lack of cleanliness in the sedimentation basins.

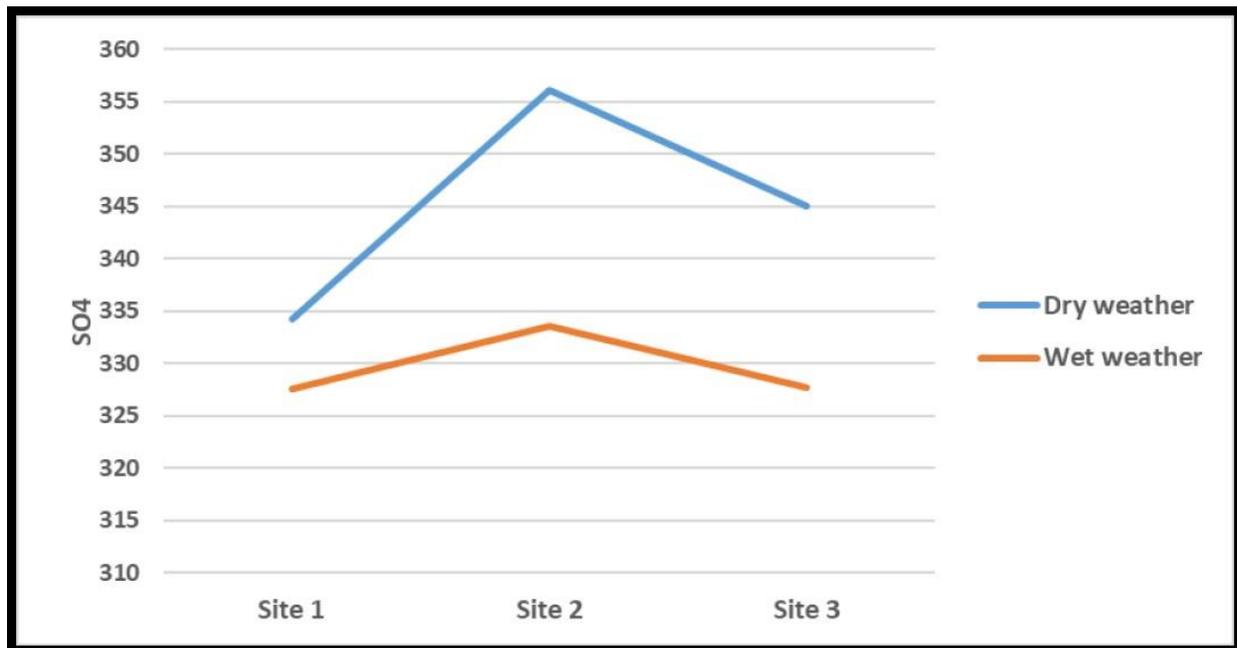


Figure4. 6

Figure (10): Variation of SO₄ during dry and wet season period

4.4.11 Average of total dissolved solids between three sampling sites

The average total dissolved solids at each site are measured as shown in figure (11). The total dissolved solids values were ranged between (611.42–620.40) mg/L in wet weather, while the values were ranged between (612.42–613.32) mg/L in dry weather, the highest value of total dissolved solids concentration recorded during wet weather in Site R3 is (620.40) mg/L, the reason for the increase in the concentrations of total dissolved solids in the water is the natural hydrological processes, untreated sewage water, industrial waste, and irrigation water. Increasing the total dissolved solids in the water above the permissible level leads to an increase in algae that increases the percentage of dissolved oxygen produced in the water.

Thus, this leads to an increase in the lifespan of microorganisms (Daoud, 2000). The results of the study showed that the water in the three stations, during dry and wet weather, is within the Iraqi standards (2009) and the organization (WHO, 2008), which allows a concentration of 1000 mg/liter of TDS.

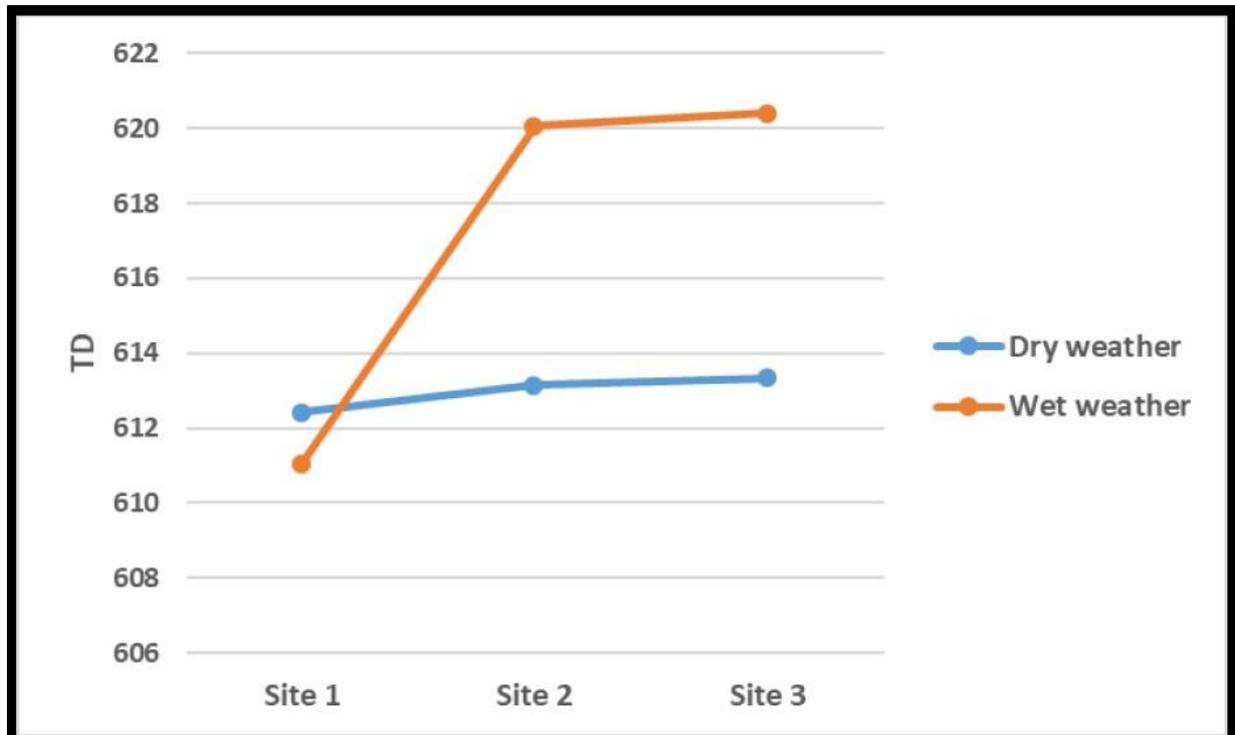


Figure4. 7

Figure (11): Variation of TDS during dry and wet season period

4.4.12 Average of electric conductivity between three sampling sites

The average electric conductivity at each site is measured as shown in figure (12). The electric conductivity values were ranged between (939.75–943.25) Micro Siemens/cm in wet weather, while the values were ranged between (955.73–964.12) Micro Siemens/cm in dry weather, the highest value of electric conductivity concentration recorded during wet weather in Site R2 is (964.12) Micro Siemens/cm, the process of electrical conductivity in water is related to the rise and fall of salinity values through the precipitation of calcium carbonate and the rise and fall of temperatures.

The study showed that all electrical conductivity values for the water of the three stations during dry and wet weather are outside the permissible limits according to the international standard specifications (WHO, 2008). The electrical conductivity value was set at 250 Siemensmicro/cm in potable water.

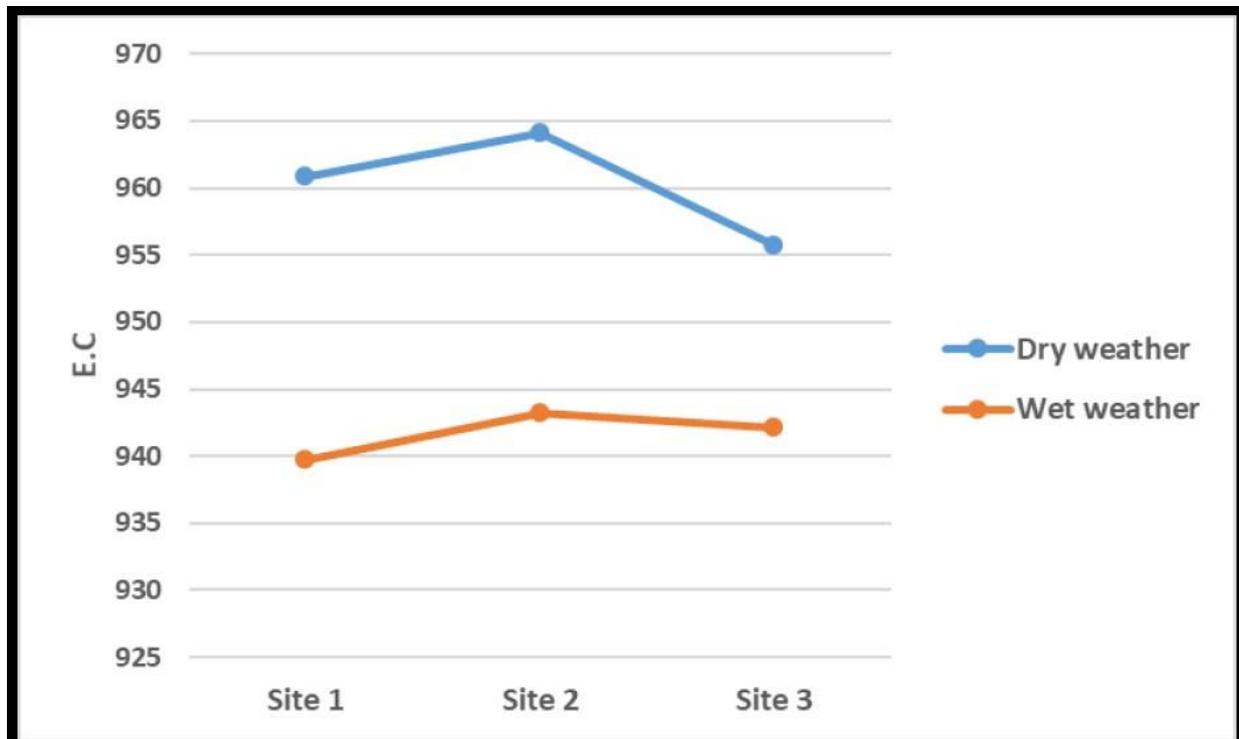


Figure4. 8

Figure (12): Variation of E.C during dry and wet season period

4.4.13 Average of turbidity between three sampling sites

The average turbidity at each site is measured as shown in figure (13). The turbidity values were ranged between (3.40–3.65) NTU in wet weather, while the values were ranged between (4.20–5.01) NTU in dry weather, the highest value of turbidity concentration recorded during wet weather in Site R3 is (5.01) NTU .

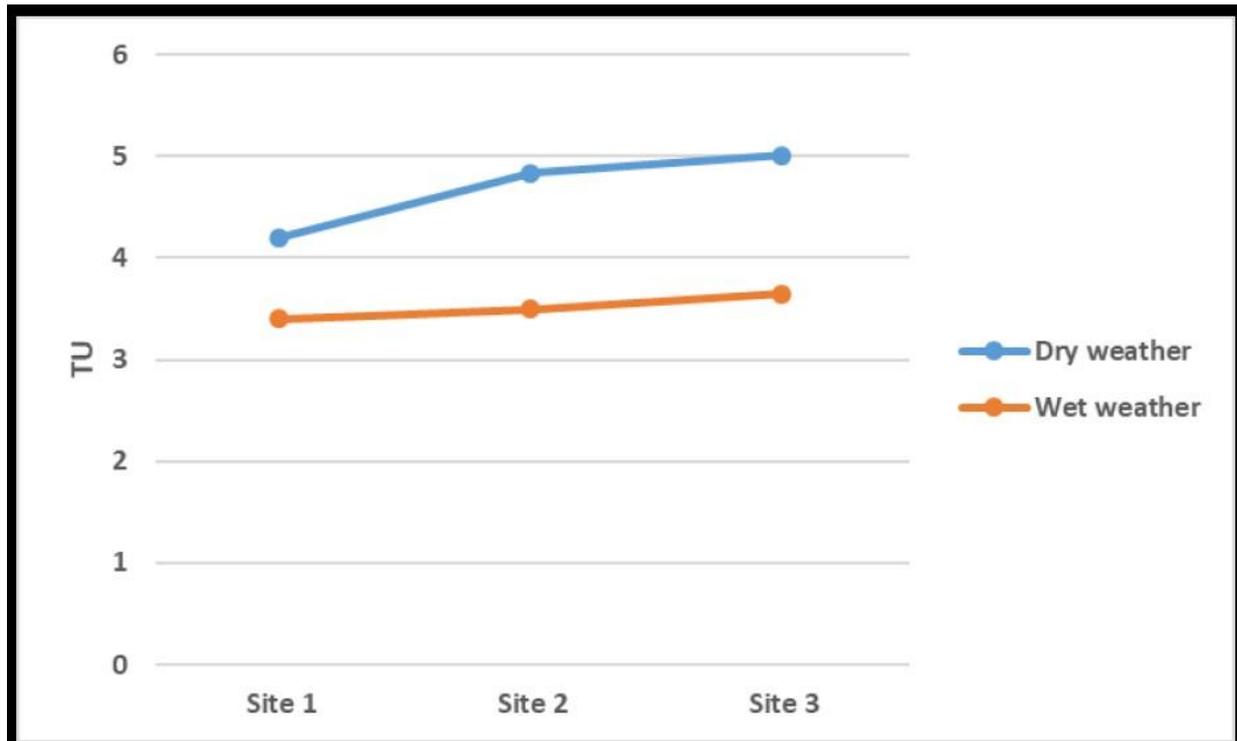


Figure4. 9

Figure (13): Variation of TU during dry and wet season period

4.5 Water quality index of weighted methods

For integrating the complex WQ data as well as providing a simple, comprehensible tool to inform the administrators and the decision creators on the general WQ state, different indices of water quality were evolved, which are able to be utilized for giving an overall vision upon the WQ spatial as well as temporal variations [P. R. Kannel, S. Lee, S. R. Kanel, and S. P. Khan, 2007]. The spatial and temporal changes of water at the three sampling sites are illustrated below. Water quality indices of weighted methods are commonly determined via allocating an appropriate weight to every parameter of WQI as well as averaging all utilizing certain kinds of mean functions. In the present section, the following (2) WQIs are used:

4.5.1 Water quality index arithmetic method (WQI_{WA})

Depending on the results of the basic statistics of WQ in first station in dry as well as wet seasons given in Tables from (4-3) to (4-8), the water quality index weighted arithmetic method (WQI_{WA}) of the parameters for $k = 1$ (for water without contamination) [P. R. Kannel, S. Lee, S. R. Kanel, and S. P. Khan, 2007] was calculated using the equation depicted in the last row of each table, as shown in the Tables from (4-9) to (4-14).

Table (4.9): The calculation of (WQI_{WA}) of parameters in dry season in station 1

Parameters	Station (1) in Dry season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Wi*Qi
PH	6.5	7	6.93125	0.047264377	13.75	0.649885187
DO	5	14.6	7.05	0.06144369	78.64583333	4.832290235
PO4	0.4	0	0.25125	0.76804613	62.8125	48.24289754
NO3	15	0	4.305	0.02048123	28.7	0.587811305
Ca	50	0	106.9125	0.006144369	213.825	1.31381971
Mg	50	0	33.275	0.006144369	66.55	0.40890776
TH	500	0	376.3875	0.000614437	75.2775	0.046253274
K	12	0	3.675	0.025601538	30.625	0.784047091
Na	200	0	58.675	0.001536092	29.3375	0.045065107
SO4	400	0	334.2375	0.000768046	83.559375	0.064177455
TDS	1500	0	612.425	0.000204812	40.82833333	0.008362145
E.C	1000	0	960.875	0.000307218	96.0875	0.029519853
TUR	5	0	4.2	0.06144369	84	5.161269994
$WIQ = k \sum_{i=1}^{13} WiQi = 62.1743, \quad k = 1$						

Table4.

9

Table (4.10): The calculation of (WQI_{WA}) of parameters in dry season in station 2

Parameters	Station (2) in Dry season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Wi*Qi
PH	6.5	7	6.9625	0.047264377	7.5	0.354482829
DO	5	14.6	6.95	0.06144369	79.6875	4.896294079
PO4	0.4	0	0.245	0.76804613	61.25	47.04282546
NO3	15	0	4.33375	0.02048123	28.89166667	0.591736874
Ca	50	0	104.8875	0.006144369	209.775	1.288935015
Mg	50	0	33.8175	0.006144369	67.635	0.4155744
TH	500	0	379.525	0.000614437	75.905	0.046638833
K	12	0	3.9	0.025601538	32.5	0.832049974
Na	200	0	58.5625	0.001536092	29.28125	0.044978701
SO4	400	0	356.1	0.000768046	89.025	0.068375307
TDS	1500	0	613.1375	0.000204812	40.87583333	0.008371873
E.C	1000	0	964.125	0.000307218	96.4125	0.029619699
TUR	5	0	4.8375	0.06144369	96.75	5.944677046
13						
$WIQ = k \sum_{i=1}^{13} WiQi = 61.564, \quad k = 1$						

Table4. 10

Table (4.11): The calculation of (WQI_{WA}) of parameters in dry season in station 3

Parameters	Station (3) in Dry season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Wi*Qi
PH	6.5	7	6.825	0.047264377	35	1.654253203
DO	5	14.6	6.9575	0.06144369	79.609375	4.891493791
PO4	0.4	0	0.23675	0.76804613	59.1875	45.45873032
NO3	15	0	4.2575	0.02048123	28.38333333	0.581325582
Ca	50	0	105.875	0.006144369	211.75	1.301070144
Mg	50	0	33.535	0.006144369	67.07	0.412102832
TH	500	0	371.45	0.000614437	74.29	0.045646518
K	12	0	4.1	0.025601538	34.16666667	0.874719204
Na	200	0	59.3125	0.001536092	29.65625	0.045554736
SO4	400	0	345	0.000768046	86.25	0.066243979
TDS	1500	0	613.325	0.000204812	40.88833333	0.008374434
E.C	1000	0	955.7375	0.000307218	95.57375	0.02936202
TUR	5	0	5.0125	0.06144369	100.25	6.159729963
$WIQ = k \sum_{i=1}^{13} WiQi = 61.528, \quad k = 1$						

Table4. 11

Table (4.12): The calculation of (WQI_{WA}) of parameters in wet season in station 1

Parameters	Station (1) in Wet season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Wi*Qi
PH	6.5	7	6.825	0.047264377	35	1.654253195
DO	5	14.6	7.6	0.06144369	72.91667	4.480269063
PO4	0.4	0	0.2425	0.76804613	60.625	46.56279663
NO3	15	0	4.32	0.02048123	28.8	0.589859424
Ca	50	0	90.8	0.006144369	181.6	1.11581741
Mg	50	0	33.625	0.006144369	67.25	0.413208815
TH	500	0	357.1	0.000614437	71.42	0.043883091
K	12	0	3.6	0.025601538	30	0.76804614
Na	200	0	63.025	0.001536092	31.5125	0.048406099
SO4	400	0	327.55	0.000768046	81.8875	0.062893367
TDS	1500	0	611.05	0.000204812	40.73667	0.008343358
E.C	1000	0	939.75	0.000307218	93.975	0.028870812
TUR	5	0	3.4	0.06144369	68	4.17817092
$WIQ = K \sum_{i=1}^{13} WiQi = 59.95482, \quad k = 1$						

Table4. 12

Table (4.13): The calculation of (WQI_{WA}) of parameters in wet season in station 2

Parameters	Station (2) in Wet season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Wi*Qi
PH	6.5	7	6.75	0.047264377	50	2.363218862
DO	5	14.6	7.4	0.06144369	75	4.60827678
PO4	0.4	0	0.2475	0.76804613	61.875	47.5228543
NO3	15	0	4.105	0.02048123	27.36666667	0.560502998
Ca	50	0	84.325	0.006144369	168.65	1.036247839
Mg	50	0	33.125	0.006144369	66.25	0.407064449
TH	500	0	334.425	0.000614437	66.885	0.041096612
K	12	0	4.05	0.025601538	33.75	0.864051896
Na	200	0	68.55	0.001536092	34.275	0.052649562
SO4	400	0	333.6	0.000768046	83.4	0.064055047
TDS	1500	0	620.05	0.000204812	41.33666667	0.008466258
E.C	1000	0	943.25	0.000307218	94.325	0.02897838
TUR	5	0	3.5	0.06144369	70	4.301058328
$WIQ = k \sum_{i=1}^{13} WiQi = 61.858 \quad k = 1$						

Table4. 13

Table (4.14): The calculation of (WQI_{WA}) of parameters in wet season in station 3

Parameters	Station (3) in Wet season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Wi*Qi
PH	6.5	7	6.86	0.047264377	28	1.323402563
DO	5	14.6	7.625	0.06144369	72.65625	4.464268131
PO4	0.4	0	0.2485	0.76804613	62.125	47.71486583
NO3	15	0	3.86	0.02048123	25.73333333	0.527050322
Ca	50	0	87.325	0.006144369	174.65	1.073114053
Mg	50	0	35.1899	0.006144369	70.3798	0.432439464
TH	500	0	357.475	0.000614437	71.495	0.043929166
K	12	0	4	0.025601538	33.33333333	0.853384589
Na	200	0	67.56	0.001536092	33.78	0.051889197
SO4	400	0	327.75	0.000768046	81.9375	0.06293178
TDS	1500	0	620.4	0.000204812	41.36	0.008471037
E.C	1000	0	942.15	0.000307218	94.215	0.028944586
TUR	5	0	3.65	0.06144369	73	4.485389399
13						
$WIQ = k \sum_{i=1}^{13} WiQi = 61.070, \quad k = 1$						

Table4. 14

Table4. 15

4.5.2 Water quality index weighted geometric (WQI_{WG})

Depending on the results of the basic statistics of WQ in first station in dry as well as wet seasons given in Tables from (4-3) to (4-8), the water quality index (WQI_{WG}) of the parameters was calculated using the equation depicted in the last row of each table, as shown in the Tables from (4-15) to (4-20).

Table (4.15): The calculation of (WQI_{WG}) of Parameters in dry season in station 1

Parameters	Station (1) in Dry season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Qi Wi
PH	6.5	7	6.93125	0.047264377	13.75	1.13109
DO	5	14.6	7.05	0.06144369	78.64583	1.48118
PO4	0.4	0	0.25125	0.76804613	62.8125	23.2549
NO3	15	0	4.305	0.02048123	28.7	1.06944
Ca	50	0	106.9125	0.006144369	213.825	1.03351
Mg	50	0	33.275	0.006144369	66.55	1.02612
TH	500	0	376.3875	0.000614437	75.2775	1.00265
K	12	0	3.675	0.025601538	30.625	1.09154
Na	200	0	58.675	0.001536092	29.3375	1.00206
SO4	400	0	334.2375	0.000768046	83.55938	1.00277
TDS	1500	0	612.425	0.000204812	40.82833	1.00075
E.C	1000	0	960.875	0.000307218	96.0875	1.00140
TUR	5	0	4.2	0.06144369	84	1.31288
13 $WIQ = \prod_{i=1} WiQi = 58.714$						

Table4. 16

Table (4.16): The calculation of (WQI_{WG}) of Parameters in dry season in station 2

Parameters	Station (2) in Dry season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Qi^{Wi}
PH	6.5	7	6.9625	0.047264377	7.5	1.099725
DO	5	14.6	6.95	0.06144369	79.6875	1.308643
PO4	0.4	0	0.245	0.76804613	61.25	23.5819611
NO3	15	0	4.33375	0.02048123	28.89166667	1.071318044
Ca	50	0	104.8875	0.006144369	209.775	1.033393467
Mg	50	0	33.8175	0.006144369	67.635	1.026231282
TH	500	0	379.525	0.000614437	75.905	1.002663736
K	12	0	3.9	0.025601538	32.5	1.09321741
Na	200	0	58.5625	0.001536092	29.28125	1.005200779
SO4	400	0	356.1	0.000768046	89.025	1.003453645
TDS	1500	0	613.1375	0.000204812	40.87583333	1.000760252
E.C	1000	0	964.125	0.000307218	96.4125	1.001404553
TUR	5	0	4.8375	0.06144369	96.75	1.324358987
13						
$WIQ = \prod_{i=1}^{13} Qi^{Wi} = 56.591$						

Table4. 17

Table (4.17): The calculation of (WQI_{WG}) of Parameters in dry season in station 3

Parameters	Station (3) in Dry season					
	Standard value	Ideal value	Monitored value	Wi	Qi	$Qiwi$
PH	6.5	7	6.825	0.047264377	35	1.246035033
DO	5	14.6	6.9575	0.06144369	79.60938	1.308585959
PO4	0.4	0	0.23675	0.76804613	59.1875	22.96965066
NO3	15	0	4.2575	0.02048123	28.38333	1.070928622
Ca	50	0	105.875	0.006144369	211.75	1.033452969
Mg	50	0	33.535	0.006144369	67.07	1.026178388
TH	500	0	371.45	0.000614437	74.29	1.002650486
K	12	0	4.1	0.025601538	34.16667	1.094618
Na	200	0	59.3125	0.001536092	29.65625	1.005220429
SO4	400	0	345	0.000768046	86.25	1.00342924
TDS	1500	0	613.325	0.000204812	40.88833	1.000760314
E.C	1000	0	955.7375	0.000307218	95.57375	1.001401865
TUR	5	0	5.0125	0.06144369	100.25	1.327253895
$WQI = \prod_{i=1}^{13} Qi^{wi} = 62.634$						

Table4. 18

Table (4.18): The calculation of (WQI_{WG}) of parameters in wet season in station 1

Parameters	Station (1) in Wet season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Qiwi
PH	6.5	7	6.825	0.047264377	35	1.18298548
DO	5	14.6	7.6	0.06144369	72.91667	1.301544295
PO4	0.4	0	0.2425	0.76804613	60.625	23.39692479
NO3	15	0	4.32	0.02048123	28.8	1.071248318
Ca	50	0	90.8	0.006144369	181.6	1.032478083
Mg	50	0	33.625	0.006144369	67.25	1.026195287
TH	500	0	357.1	0.000614437	71.42	1.002626215
K	12	0	3.6	0.025601538	30	1.090979464
Na	200	0	63.025	0.001536092	31.5125	1.005314178
SO4	400	0	327.55	0.000768046	81.8875	1.003389239
TDS	1500	0	611.05	0.000204812	40.73667	1.000759553
E.C	1000	0	939.75	0.000307218	93.975	1.001396675
TUR	5	0	3.4	0.06144369	68	1.295973465
13 $WIQ = \prod_{i=1}^{13} Qi^{Wi} = 58.594$						

Table4. 19

Table (4.19): The calculation of (WQI_{WG}) of parameters in wet season in station 2

Parameters	Station (2) in Wet season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Qi^{wi}
PH	6.5	7	6.75	0.047264377	50	1.203097318
DO	5	14.6	7.4	0.06144369	75	1.303799118
PO4	0.4	0	0.2475	0.76804613	61.875	23.76655997
NO3	15	0	4.105	0.02048123	27.36667	1.07012885
Ca	50	0	84.325	0.006144369	168.65	1.03200886
Mg	50	0	33.125	0.006144369	66.25	1.026100828
TH	500	0	334.425	0.000614437	66.885	1.002585801
K	12	0	4.05	0.025601538	33.75	1.094274198
Na	200	0	68.55	0.001536092	34.275	1.005443953
SO4	400	0	333.6	0.000768046	83.4	1.003403344
TDS	1500	0	620.05	0.000204812	41.33667	1.00076255
E.C	1000	0	943.25	0.000307218	94.325	1.001397818
TUR	5	0	3.5	0.06144369	70	1.298283782
13 $WIQ = \prod_{i=1}^{13} Qi^{wi} = 60.838$						

Table4. 20

Table (4.20): The calculation of (WQI_{WG}) of parameters in wet season in station 3

Parameters	Station (3) in Wet season					
	Standard value	Ideal value	Monitored value	Wi	Qi	Qi^{wi}
PH	6.5	7	6.86	0.047264377	28	1.170574402
DO	5	14.6	7.625	0.06144369	72.65625	1.301258202
PO4	0.4	0	0.2485	0.76804613	62.125	23.84027825
NO3	15	0	3.86	0.02048123	25.73333	1.068780924
Ca	50	0	87.325	0.006144369	174.65	1.032230557
Mg	50	0	35.1899	0.006144369	70.3798	1.026482152
TH	500	0	357.475	0.000614437	71.495	1.002626861
K	12	0	4	0.025601538	33.33333	1.093926235
Na	200	0	67.56	0.001536092	33.78	1.005421486
SO4	400	0	327.75	0.000768046	81.9375	1.00338971
TDS	1500	0	620.4	0.000204812	41.36	1.000762665
E.C	1000	0	942.15	0.000307218	94.215	1.001397459
TUR	5	0	3.65	0.06144369	73	1.301635642
$WIQ = \prod_{i=1}^{13} Qi^{wi} = 59.355$						

Table4. 21

Table (4.21): Summary of Water Quality Indices (WQI) calculate by the weighted methods

Station	Season	QI Weighted Methods	
		WQI_{WA} k = 1	WQI_{WG}
1	Dry	62.174	58.714
	Wet	59.954	58.594
2	Dry	61.564	56.591
	Wet	61.858	60.838
3	Dry	61.528	62.634
	Wet	61.070	59.355

Table4. 22

The abovementioned weighted WQIs reveals that every parameter of WQ may possess various weights if the WQIs being particular to the aquatic lifetime safety [P. R. Kannel, S. Lee, S. R. Kanel, and S. P. Khan, 2007]. According to the calculated values of the WQI weighted methods for the three stations in dry and wet season given in Table (4-21), both WQI_{WA} and WQI_{WG} values in indicate to the 'Poor' water quality in all stations in both seasons.

Table (4.22): Classification of the calculated WQI values [Călmuc, V-A., Călmuc, Țopa, M. M. C. et al, 2018

WQI value	Quality of water
0 – 25	Excellent
26 - 50	Good
51 - 75	Poor
76 - 100	Very Poor
> 100	Inadequate to drink

4.6 Unweighted water quality indices methods

When the sensitivity to variations in every parameter of WQ is highly wanted than that to the utmost heavily weighted parameter of the WQ, such weighting could be needless [P. R. Kannel, S. Lee, S. R. Kanel, and S. P. Khan, 2007]. Therefore, the following two unweighted water quality indices are used and introduced in these subsections:

4.6.1 Water quality index arithmetic unweighted method (WQI_A)

Depending on the results of the basic statistics of WQ in first station in dry as well as wet seasons given in Tables from (4-3) to (4-8), the water quality index unweighted arithmetic method (WQI_A) of the parameters was calculated using the equation depicted in the last row of each table, as shown in the Tables from (4-23) to (4-28).

Table (4.23): The calculation of (WQI_A) of the paramets in dry season in station 1

Parameters	Station (1) in Dry season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.93125	13.75
DO	5	14.6	7.05	78.64583
PO ₄	0.4	0	0.25125	62.8125
NO ₃	15	0	4.305	28.7
Ca	50	0	106.9125	213.825
Mg	50	0	33.275	66.55
TH	500	0	376.3875	75.2775
K	12	0	3.675	30.625
Na	200	0	58.675	29.3375
SO ₄	400	0	334.2375	83.55938
TDS	1500	0	612.425	40.82833
E.C	1000	0	960.875	96.0875
TUR	5	0	4.2	84
$WIQ = \frac{1}{n} \sum_{i=1}^{13} Qi = \frac{903.999}{13} = 69.538$				

Table4.

23

Table (4.24): The calculation of the (WQI_A) of parameters in dry season in station 2

Parameters	Station (2) in Dry season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.9625	7.5
DO	5	14.6	6.95	79.6875
PO4	0.4	0	0.245	61.25
NO3	15	0	4.33375	28.89167
Ca	50	0	104.8875	209.775
Mg	50	0	33.8175	67.635
TH	500	0	379.525	75.905
K	12	0	3.9	32.5
Na	200	0	58.5625	29.28125
SO4	400	0	356.1	89.025
TDS	1500	0	613.1375	40.87583
E.C	1000	0	964.125	96.4125
TUR	5	0	4.8375	96.75
$WIQ = \frac{1}{n} \sum_{i=1}^{13} Qi = \frac{915.488}{13} = 70.422$				

Table4. 24

Table (4.25): The calculation of the (WQI_A) of parameters in dry season in station 3

Parameters	Station (3) in Dry season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.825	35
DO	5	14.6	6.9575	79.60938
PO4	0.4	0	0.23675	59.1875
NO3	15	0	4.2575	28.38333
Ca	50	0	105.875	211.75
Mg	50	0	33.535	67.07
TH	500	0	371.45	74.29
K	12	0	4.1	34.16667
Na	200	0	59.3125	29.65625
SO4	400	0	345	86.25
TDS	1500	0	613.325	40.88833
E.C	1000	0	955.7375	95.57375
TUR	5	0	5.0125	100.25
$WIQ = \frac{1}{n} \sum_{i=1}^{13} Qi = \frac{1012.075}{13} = 77.851$				

Table4. 25

Table (4.26): The calculation of the (WQI_A) of parameters in wet season in station 1

Parameters	Station (1) in Wet season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.825	35
DO	5	14.6	7.6	72.91667
PO4	0.4	0	0.2425	60.625
NO3	15	0	4.32	28.8
Ca	50	0	90.8	181.6
Mg	50	0	33.625	67.25
TH	500	0	357.1	71.42
K	12	0	3.6	30
Na	200	0	63.025	31.5125
SO4	400	0	327.55	81.8875
TDS	1500	0	611.05	40.73667
E.C	1000	0	939.75	93.975
TUR	5	0	3.4	68
$WIQ = \frac{1}{n} \sum_{i=1}^{13} Qi = \frac{863.723}{13} = 66.440$				

Table4. 26

Table (4.27): The calculation of the (WQI_A) of parameters in wet season in station 2

Parameters	Station (2) in Wet season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.75	50
DO	5	14.6	7.4	75
PO4	0.4	0	0.2475	61.875
NO3	15	0	4.105	27.36667
Ca	50	0	84.325	168.65
Mg	50	0	33.125	66.25
TH	500	0	334.425	66.885
K	12	0	4.05	33.75
Na	200	0	68.55	34.275
SO4	400	0	333.6	83.4
TDS	1500	0	620.05	41.33667
E.C	1000	0	943.25	94.325
TUR	5	0	3.5	70
$WIQ = \frac{1}{n} \sum_{i=1}^{13} Qi = \frac{873.1133}{13} = 67.162$				

Table4. 27

Table (4.28): The calculation of the (WQI_A) of parameters in wet season in station 3

Parameters	Station (3) in Wet season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.86	28
DO	5	14.6	7.625	72.65625
PO ₄	0.4	0	0.2485	62.125
NO ₃	15	0	3.86	25.73333
Ca	50	0	87.325	174.65
Mg	50	0	35.1899	70.3798
TH	500	0	357.475	71.495
K	12	0	4	33.33333
Na	200	0	67.56	33.78
SO ₄	400	0	327.75	81.9375
TDS	1500	0	620.4	41.36
E.C	1000	0	942.15	94.215
TUR	5	0	3.65	73

$$WIQ = 1/n \sum_{i=1}^{13} Qi = \frac{862.6652}{13} = 66.358$$

Table4. 28

4.6.2 Water quality index geometric unweighted method (WQI_G)

Depending on the results of the basic statistics of WQ in first station in dry as well as wet seasons given in Tables from (4-3) to (4-8), the water quality index unweighted geometric method (WQI_G) of the parameters was calculated using the equation depicted in the last row of each table, as shown in the Tables from (4-29) to (4-33).

Table (4.29): The calculation of (WQI_G) of parameters in dry season in station 1

Parameters	Station (1) in Dry season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.93125	13.75
DO	5	14.6	7.05	78.64583
PO4	0.4	0	0.25125	62.8125
NO3	15	0	4.305	28.7
Ca	50	0	106.9125	213.825
Mg	50	0	33.275	66.55
TH	500	0	376.3875	75.2775
K	12	0	3.675	30.625
Na	200	0	58.675	29.3375
SO4	400	0	334.2375	83.55938
TDS	1500	0	612.425	40.82833
E.C	1000	0	960.875	96.0875
TUR	5	0	4.2	84
$WQI = \left(\prod_{i=1}^n Qi \right)^{\frac{1}{n}} = (5.1663E + 22)^{\frac{1}{13}} = 55.868$				

Table4.

Table (4.30): The calculation of (WQI_G) of parameters in dry season in station 2

Parameters	Station (2) in Dry season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.9625	7.5
DO	5	14.6	6.95	79.6875
PO4	0.4	0	0.245	61.25
NO3	15	0	4.33375	28.89166667
Ca	50	0	104.8875	209.775
Mg	50	0	33.8175	67.635
TH	500	0	379.525	75.905
K	12	0	3.9	32.5
Na	200	0	58.5625	29.28125
SO4	400	0	356.1	89.025
TDS	1500	0	613.1375	40.87583333
E.C	1000	0	964.125	96.4125
TUR	5	0	4.8375	96.75
$WIQ = \left(\prod_{i=1}^{13} Qi \right)^{\frac{1}{n}} = (3.68E + 22)^{1/13} = 54.428$				

Table4. 30

Table (4.31): The calculation of (WQI_G) of parameters in dry season in station 3

Parameters	Station (3) in Dry season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.825	35
DO	5	14.6	6.9575	79.60938
PO4	0.4	0	0.23675	59.1875
NO3	15	0	4.2575	28.38333
Ca	50	0	105.875	211.75
Mg	50	0	33.535	67.07
TH	500	0	371.45	74.29
K	12	0	4.1	34.16667
Na	200	0	59.3125	29.65625
SO4	400	0	345	86.25
TDS	1500	0	613.325	40.88833
E.C	1000	0	955.7375	95.57375
TUR	5	0	5.0125	100.25
$WQI = \left(\prod_{i=1}^{13} Qi \right)^{\frac{1}{n}} = (5.07E + 23)^{1/13} = 66.600$				

Table4. 31

Table (4.32): The calculation of (WQI_G) of parameters in wet season in station 1

Parameters	Station (1) in Wet season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.825	35
DO	5	14.6	7.6	72.91667
PO4	0.4	0	0.2425	60.625
NO3	15	0	4.32	28.8
Ca	50	0	90.8	181.6
Mg	50	0	33.625	67.25
TH	500	0	357.1	71.42
K	12	0	3.6	30
Na	200	0	63.025	31.5125
SO4	400	0	327.55	81.8875
TDS	1500	0	611.05	40.73667
E.C	1000	0	939.75	93.975
TUR	5	0	3.4	68
$WIQ = \left(\prod_{i=1}^{13} Qi \right)^{\frac{1}{n}} = (7.83E + 22)^{1/13} = 57.685$				

Table4. 32

Table (4.33): The calculation of (WQI_G) of parameters in wet season in station 2

Parameters	Station (2) in Wet season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.75	50
DO	5	14.6	7.4	75
PO4	0.4	0	0.2475	61.875
NO3	15	0	4.105	27.36667
Ca	50	0	84.325	168.65
Mg	50	0	33.125	66.25
TH	500	0	334.425	66.885
K	12	0	4.05	33.75
Na	200	0	68.55	34.275
SO4	400	0	333.6	83.4
TDS	1500	0	620.05	41.33667
E.C	1000	0	943.25	94.325
TUR	5	0	3.5	70
$WIQ = \left(\prod_{i=1}^{13} Qi \right)^{\frac{1}{n}} = (1.25E + 23)^{1/13} = 59.796$				

Table4. 33

Table (4.34): The calculation of (WQI_G) of parameters in wet season in station 3

Parameters	Station (3) in Wet season			
	Standard value	Ideal value	Monitored value	Qi
PH	6.5	7	6.86	28
DO	5	14.6	7.625	72.65625
PO4	0.4	0	0.2485	62.125
NO3	15	0	3.86	25.73333
Ca	50	0	87.325	174.65
Mg	50	0	35.1899	70.3798
TH	500	0	357.475	71.495
K	12	0	4	33.33333
Na	200	0	67.56	33.78
SO4	400	0	327.75	81.9375
TDS	1500	0	620.4	41.36
E.C	1000	0	942.15	94.215
TUR	5	0	3.65	73
$WIQ = \left(\prod_{i=1}^{13} Qi \right)^{\frac{1}{n}} = (7.5E22)^{1/13} = 57.494$				

Table4. 34

Table (4-47): Summary of Water Quality Index (WQI) calculation for unweighted methods

Station	Season	<i>WQI_A</i>	<i>WQI_G</i>
1	Dry	69.538	55.868
	Wet	66.440	57.685
2	Dry	70.422	54.428
	Wet	67.162	59.796
3	Dry	77.851	66.600
	Wet	66.358	57.494

Table4. 35

The abovementioned WQIs depict that every parameter of the WQ may possess various weights depending upon the significance of the WQ state. Such feature could be wanted if the WQIs being particular to the aquatic lifetime safety [P. R. Kannel, S. Lee, S. R. Kanel, and S. P. Khan, 2007]. According to the calculated values of the WQI unweighted methods for the three stations in dry and wet season given in Table (4-47)

4.7 Correlation Analysis

In this analysis, a correlation has been conducted for determining the relations between the WQ parameters using the package of Statistical Package for Social Sciences (SPSS). The evaluation of Pearson's correlation values was done to obtain the relationship extent between the different parameters of WQ. In this analysis, a linear correlation between any two parameters was depicted to give the linear coefficient of correlation. The r-value and the p-value for any two parameters were supplied by this statistical package to assess the significance of correlation. This statistical package obtained the correlation coefficient values to supply the r-value for each pair of parameters and the p-value to assess significance of correlation. The p-value is considered statistical significant (≤ 0.05), or a level of probability (95% level of confidence).

A Pearson (r) statistical correlation should always be between (-1 and 1) when measuring the influence of the correlation between any pair of parameters. The (-1) indicates a strong reverse correlation, and the (+1) indicates a strong direct correlation of any pair of parameters. When the value of (r) is zero, this means there is no relationship.

The statistical analysis was applied in calculating the Pearson correlation coefficients on the data of the three stations during the dry and wet season, as the results showed that there is a correlation between the water parameters and the strength of the correlation can be determined by comparing the results with broad interpretations the Table (4-48).

Table (4.48): Broad interpretations of Pearson's correlation coefficient

Value of Correlation	Interpretation
0.7 to 1.0	Strong linear correlation
0.5 to 0.7	Moderate linear correlation
0.3 to 0.5	Weak linear correlation
0 to 0.3	Little or no linear correlation

Table4. 36

4.7.1 Correlation between Water Quality Parameters in the Dry Weather

The results of the analysis of correlation for the elements of the quality of water that collected during this study of the dry weather at each site in the study means show on the Tables (4.49), (4.50), (4.51), and (4,52) which gives the value of coefficient of correlation to know which parameter have correlation of statistically significant. Note that in all Tables, the sign (**) means that the correlation is significant at the 0.01 level, while the sign (*) means that the correlation is significant at the 0.05 level.

4.7.1.1 Correlation analysis of the three stations during July

It can be noticed from the Table (4-49) that there is a strong negative correlation exists between, (PO_4 and DO, $r=-0.99$), (SO_4 and Mg, $r=-0.99$), (E.C and K, $r=-0.99$), (TUR and Mg, $r=-0.99$) (TUR and SO_4 , $r=-0.99$) during July. This means that mainly PO_4 , SO_4 , E.C, and TUR parameters have a strong negative influence ($p \leq 0.05$ level) on the DO, Mg, and K parameters. This explains that PO_4 , SO_4 , E.C, and TUR parameters come from the existence of DO, Mg, and K. In other words, this indicates that DO, Mg, and K are the source of PO_4 , SO_4 , E.C, and TUR. Thus, if DO, Mg, and K increase, the total PO_4 , SO_4 , E.C, and TUR decrease during July.

Table (4.49): Correlation matrix for water quality parameters during July

Parameter	PH	DO	PO ₄	NO ₃	Ca	Mg	TH	K	Na	SO ₄	TDS	E.C	TUR
PH	1												
DO	-.08	1											
PO ₄	.08	-0.99*	1										
NO ₃	-.821-	-.500-	.500	1									
Ca	.563	-.870-	.870	.009	1								
Mg	.985	-.254-	.254	-.711-	.697	1							
TH	.900	-.509-	.509	-.491-	.867	.81	1						
K	-.174-	.996	-.996-	-.419-	-.911-	-.341-	-.585-	1					
Na	.143	.974	-.974-	-.682-	-.737-	-.030-	-.302-	.950	1				
SO ₄	-.991-	.217	-.217-	.737	-.669-	-.99*	-.951-	.304	-.009-	1			
TDS	-.740-	.732	-.732-	.224	-.973-	-.845-	-.959-	.791	.560	.824	1		
E.C	.202	-.993-	.993	.392	.923	.368	.609	-0.99*	-.940-	-.332-	-.809-	1	
TUR	-.984-	.262	-.262-	.705	-.703-	-0.99*	-.964-	.349	.038	.99*	.849	-.376-	1

*Correlation is significant at the 0.05 level (2-tailed).

4.7.1.2 Correlation analysis of the three stations during Augusts

It can be noted from the Table (4-50) that there is a strong a significant negative correlation exists between, (Mg and PH, $r=-0.99$), (SO₄ and TH, $r=-0.99$) during Augusts. This means that mainly Mg and SO₄ parameters have a strong negative influence ($p \leq 0.05$ level) on the PH and TH parameters. This explains that Mg and SO₄ come from the existence of PH and TH. In other words, this indicates that PH and TH are the source of Mg and SO₄. Thus, if PH and TH increase, the total Mg and SO₄ increase during August.

Table (4.50): Correlation matrix for water quality parameters during Augusts (for three stations)

Parameter	PH	DO	PO ₄	NO ₃	Ca	Mg	TH	K	Na	SO ₄	TDS	E.C	TUR
PH	1												
DO	-.00	1											
PO ₄	.18	-.98	1										
NO ₃	.70	-.71	.83	1									
Ca	-.10	.99	-.99	-.78	1								
Mg	-.99	-.04	-.14	-.66	.06	1							
TH	-.84	.54	-.69	-.97	.63	.81	1						
K	.84	.52	-.35	.21	.43	-.87	-.42	1					
Na	.69	.72	-.58	-.03	.64	-.72	-.18	.96	1				
SO ₄	.82	-.56	.70	.98	-.64	-.79	-.099	.40	.16	1			
TDS	.97	.22	-.03	.52	.11	-.98	-.69	.94	.83	.68	1		
E.C	.35	-.93	.98	.91	-.96	-.30	-.80	-.19	-.43	.81	.13	1	
TUR	-.50	.86	-.94	-.96	.91	.45	.89	.03	.28	-.90	-.29	-.98	1

*Correlation is significant at the 0.05 level (2-tailed).

4.7.1.3 Correlation analysis of the three stations during September

It can be observed note from the Table (4-51) that there's a positive correlation, which being strong and moderate, between (PH) and (PO₄) with ($r = 0.99$). This means that the PH parameter has a strong positive influence ($p \leq 0.05$ level) on the PO₄ parameter. This explains that PH comes from the existence of PO₄. In other words, this indicates that PO₄ is the source of PH. Thus, if PO₄ increases, the total PH increases during September.

A significant negative correlation exists between, (TUR and PH, $r = -0.99$), (TUR and PO₄, $r = -0.99$) during September. This means that the TUR parameter has a

strong negative influence ($p \leq 0.05$ level) on the PH and PO_4 parameters. This explains that TUR comes from the existence of PH and PO_4 . In other words, this indicates that PH and PO_4 are the source of TUR. Thus, if PH and PO_4 increase, the total TUR increases during September.

Table (4-51): Correlation matrix for water quality parameters during September (for three stations)

Parameter	PH	DO	PO_4	NO_3	Ca	Mg	TH	K	Na	SO_4	TDS	E.C	TUR
PH	1												
DO	.79	1											
PO_4	0.99	.79	1										
NO_3	-.67	-.08	-.67	1									
Ca	-.45	-.90	-.45	-.35	1								
Mg	-.85	-.99	-.85	.18	.85	1							
TH	.51	-.11	.51	-.98	.53	.00	1						
K	-.78	-1.00	-.78	.07	.90	.99	.12	1					
Na	-.23	-.77	-.23	-.55	.97	.70	.71	-.98	1				
SO_4	.86	.37	.86	-.95	.06	-.46	.88	-.36	.29	1			
TDS	-.02	.59	-.02	.75	-.88	-.50	-.86	-.60	-.96	-.52	1		
E.C	.69	.98	.69	.06	-.95	-.96	-.25	-.99	-.86	.23	.70	1	
TUR	-0.99	-.79	-0.99	.67	.45	.85	-.51	.78	.23	-.86	.02	-.69	1

*Correlation is significant at the 0.05 level (2-tailed).

4.7.1.4 Correlation analysis of the three stations during October

It can be noticed from the Table (4-52) that there's a positive correlation, which being strong, between (K) and (TH) with ($r = 0.99$). This means that the K parameter has a strong positive influence ($p \leq 0.05$ level) on the TH parameter. This explains that K comes from the existence of TH. In other words, this indicates that TH is the source of K. Thus, if TH increases, the total K increases during October.

A significant negative correlation exists between, (TH and Ca, $r=-0.99$), (K and Ca, $r=-0.99$) during October. This means that the TH and K parameters have a strong negative influence ($p \leq 0.05$ level) on the Ca parameter. This explains that TH and K come from the existence of Ca. In other words, this indicates that Ca is the source of TH and K. Thus, if Ca increases, the total TH and K increase during October.

Table (4.52): Correlation matrix for water quality parameters during October (for three stations)

Parameter	PH	DO	PO ₄	NO ₃	Ca	Mg	TH	K	Na	SO ₄	TDS	E.C	TUR
PH	1												
DO	.98	1											
PO ₄	-.51	-.67	1										
NO ₃	-.20	-.39	.94	1									
Ca	-.63	-.77	.98	.88	1								
Mg	.79	.90	-.92	-.75	-.97	1							
TH	.65	.79	-.98	-.87	-0.99	.97	1						
K	.63	.77	-.99	-.88	-0.99	.97	0.99	1					
Na	-.48	-.64	.99	.95	.98	-.91	-.97	-.98	1				
SO ₄	.98	.93	-.37	-.05	-.51	.69	.53	.50	-.34	1			
TDS	.92	.98	-.80	-.57	-.88	.96	.89	.88	-.78	.85	1		
E.C	.73	.84	-.96	-.81	-.99	.99	.99	.99	-.95	.61	.93	1	
TUR	.20	.01	.73	.91	.62	-.42	-.60	-.62	.75	.35	-.19	-.519	1

*Correlation is significant at the 0.05 level (2-tailed).

4.7.2 Correlation between Water Quality Parameters in the Wet Weather

The results of the analysis of correlation for the elements of the quality of water that collected during this study of the wet weather at each site in the study means show on the Tables (4.53), (4.54) which gives the value of coefficient of correlation to know which parameter have correlation of statistically significant.

Note that in all Tables the signal (**) means that the correlation is significant at the 0.01 level, while the signal (*) means that the correlation is significant at the 0.05 level.

4.7.2.1 Correlation analysis of the three stations during November

It can be noted from the Table (4-53) that there's a positive correlation, which being strong, between (Ca) and (Do) with ($r= 0.99$), (TH and Mg, $r=0.99$), (Na and Mg, $r=0.99$), (E.C and TDS, $r=0.99$), (TUR and Mg, $r=0.99$) during November. This means that the Ca, TH, Na, E.C and TUR parameters have a strong positive influence ($p \leq 0.05$ level) on the DO, Mg, and TDS parameters. This explains that Ca, TH, Na, E.C and TUR come from the existence of DO, Mg, and TDS. In other words, this indicates that DO, Mg, and TDS are the source of Ca, TH, Na, E.C and TUR. Thus, if DO, Mg, and TDS increase, the total Ca, TH, Na, E.C and TUR increase during October.

A significant negative correlation exists between (Mg and PH, $r=-0.99$), (Mg and DO, $r=-0.99$), (Mg and PO_4 , $r=-0.99$), (Mg and NO_3 , $r=-0.99$), (Mg and Ca, $r=-0.99$), (Mg and K, $r=-0.99$), (Mg and SO_4 , $r=-0.99$), (Mg and TDS, $r=-0.99$), (Mg and E.C, $r=-0.99$), (TDS and TH, $r=-0.99$) during November. This means that the Mg and TDS parameters have a strong negative influence ($p \leq 0.05$ level) on the PH, DO, PO_4 , NO_3 , Ca, K, SO_4 , E.C, and TH parameters. This explains that Mg and TDS come from the existence of PH, DO, PO_4 , NO_3 , Ca, K, SO_4 , E.C, and TH. In other words, this indicates that PH, DO, PO_4 , NO_3 , Ca, K, SO_4 , E.C, and TH are the source of Mg and TDS. Thus, if PH, DO, PO_4 , NO_3 , Ca, K, SO_4 , E.C, and TH increase, the total Mg and TDS increase during November.

Table (4.53): Correlation matrix for water quality parameters during November (for three stations)

Parameter	PH	DO	PO ₄	NO ₃	Ca	Mg	TH	K	Na	SO ₄	TDS	E.C	TUR
PH	1												
DO	-.92	1											
PO ₄	.86	-.99	1										
NO ₃	.70	-.92	.96	1									
Ca	-.90	.99	-.99	-.93	1								
Mg	-.99	-.99	-.99	-.99	-.99	1							
TH	-.26	.62	-.71	-.87	.65	.99	1						
K	.98	-.83	.75	.55	-.80	-.99	-.08	1					
Na	-.90	.67	-.57	-.33	.64	.99	-.16	-.97	1				
SO ₄	.81	-.97	.99	.98	-.98	-.99	-.77	.69	-.00	1			
TDS	.19	-.56	.66	.83	-.59	-.99	-.97	.00	.23	.72	1		
E.C	.18	-.55	.65	.83	-.59	-.99	-.99	.00	.24	.72	.99	1	
TUR	-.721-	.934	-.971-	-.99	.948	.99	.86	-.57	.36	-.98	-.822-	-.817-	1

*Correlation is significant at the 0.05 level (2-tailed).

4.7.2.2 Correlation analysis of the three stations during December

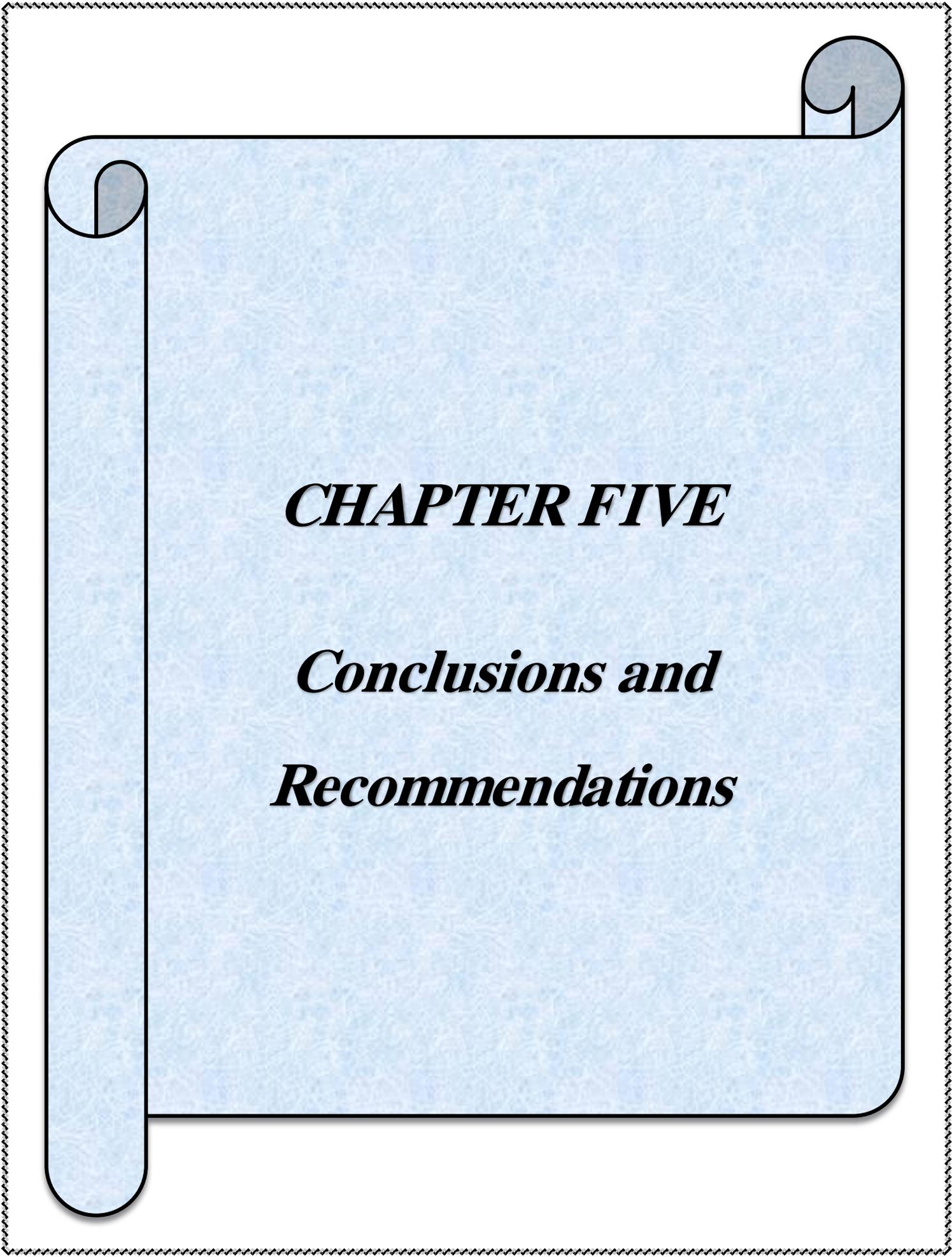
It can be noticed from the Table (4-54) that there's a positive correlation, which being strong, between (TDS) and (K) with ($r = 0.99$). This means that the TDS parameter has a strong positive influence ($p \leq 0.05$ level) on the K parameter. This explains that TDS comes from the existence of K. In other words, this indicates that K is the source of TDS. Thus, if K increases, the total TDS increases during December.

A significant negative correlation exists between, (TUR and Ca, $r=-0.99$) during December. This means that the TUR parameter has a strong negative influence ($p \leq 0.05$ level) on the Ca parameter. This explains that TUR comes from the existence of Ca. In other words, this indicates that Ca is the source of TUR. Thus, if Ca increases, the total TUR increases during December.

Table (4.54): Correlation matrix for water quality parameters during December (for three stations)

Parameter	PH	DO	PO ₄	NO ₃	Ca	Mg	TH	K	Na	SO ₄	TDS	E.C	TUR
PH	1												
DO	-.96	1											
PO ₄	.80	-.62	1										
NO ₃	-.10	-.15	-.67	1									
Ca	.27	-.51	-.34	.92	1								
Mg	-.64	.42	-.97	.83	.56	1							
TH	.98	-.99	.70	.05	.42	-.51	1						
K	-.06	.31	.54	-.986	-.97	-.72	-.21	1					
Na	-.36	.58	.25	-.88	-.99	-.48	-.50	.95	1				
SO ₄	.80	-.93	.30	.50	.78	-.06	.89	-.63	-.84	1			
TDS	-.04	.29	.55	-.98	-.97	-.73	-.20	0.99*	.94	-.62	1		
E.C	-.47	.68	.14	-.82	-.97	-.37	-.60	.90	.99	-.90	.90	1	
TUR	-.28	.51	.33	-.92	- 0.99*	-.55	-.43	.97	.99	-.79	.97	.97	1

*Correlation is significant at the 0.05 level (2-tailed).



CHAPTER FIVE

***Conclusions and
Recommendations***

Chapter Five

Conclusions and Recommendations

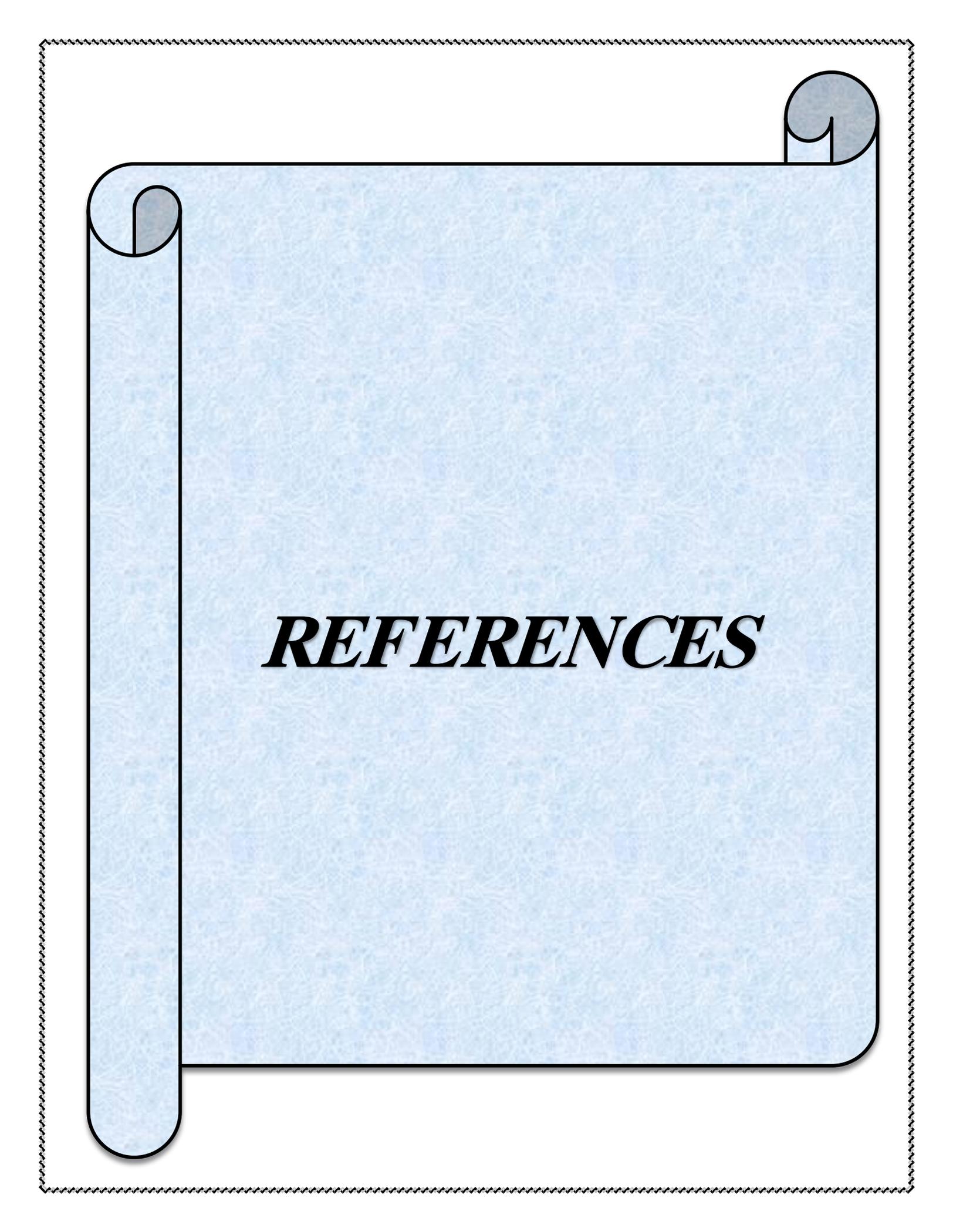
5.1 Conclusions:

The present study was carried out in Euphrates/Al-Musayyib River. Water samples were collected for testing the physical, chemical once every month from Euphrates/Al-Musayyib River. The analysis was done for six months (July 2020 to Decembers 2020) from three sites during the dry and wet seasons. These samples have been chosen from three stations to help in understanding the variability of water quality due to seasonal differences. Wet and dry weather have been analyzed to better determine the river pollution rates. Thirteen parameters with their limits were considered in the present work according to the standard specifications, collected and analyzed from physical and chemical parameters (pH, DO, EC, TDS, NO₃, PO₄, SO₄, Mg, Na, Ca, K, TH, and TUR) were chosen parameter using weighted and unweighted water quality indices (WQI). All WQI values in indicate to the 'Poor' water quality in all stations in both seasons. According to the Pearson correlation coefficients on the data of the three stations during the dry and wet season for six months (July 2020 to Decembers 2020), it was generally found a strong and moderate positive as well as a significant negative correlations between the water quality parameters.

5.2 Recommendations

The followings can be recommended for the present work:

1. Developing management strategies and policies, like the strict water and sanitation legislation for the industries that discharge their water in Al-Musayyib River in order to enhance the resources of water.
2. For a good water quality, it is necessary to control the chemical and physical parameter contents, especially the Calcium (Ca) in Al-Musayyib River by testing more samples that should be taken during the different months of year.
3. Implementing more restricted rules according to the Iraqi laws for strongly avoiding the release of wastes, chemicals, and other poisonous materials in Al-Musayyib River, by pretreating them .
4. Using other methods to obtain the water quality index (QWI) of Al-Musayyib River which are not utilized in the present study, such as Harkins' water quality index, Simple deletion/substitution methods, Parametric methods, Nonparametric methods, etc.
5. Study the influence of the other physical and chemical parameters that are not considered in the this work on the water quality of Al-Musayyib River, like temperature, heavy metals, and the bacteria in water that was selected as an index of the biological parameter.



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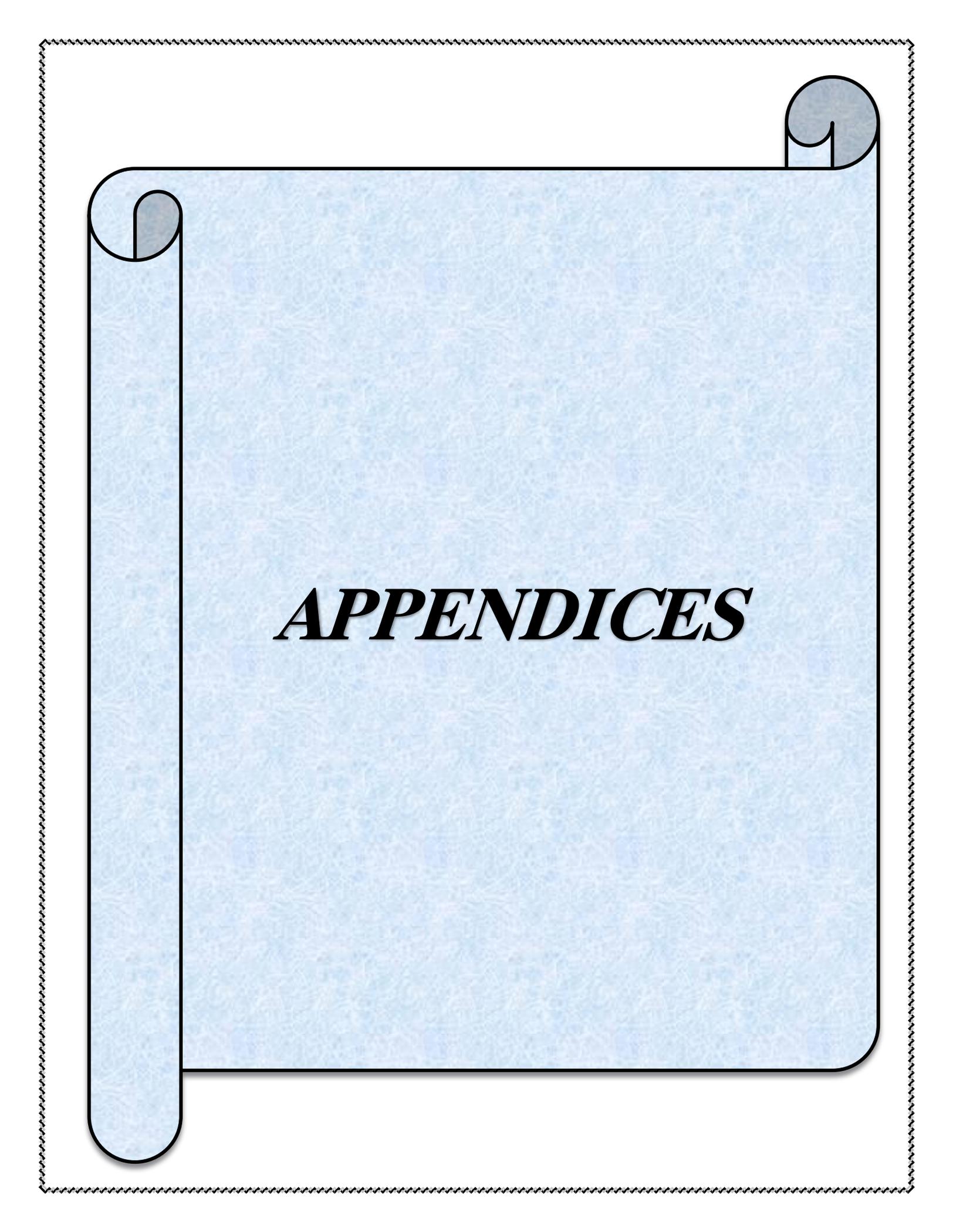
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APPENDICES

Appendix**Data of Samples for Each Month****Table (1): Data of samples for July**

Parameters	Station 1	Station 2	Station 3
PH	7.275	6.85	6.9
DO	6.5	6.45	6.6
PO4	0.235	0.245	0.22
NO3	4.06	4.48	4.2
Ca	117.95	117.5	115.6
Mg	28.75	25.37	25.1
TH	373.6	359.4	352
K	3.8	3.7	4.1
Na	58.1	56.85	59.2
SO4	285.15	328.85	330.3
CL	89.7	92.65	88.7
TDS	615.4	616.05	617
E.C	970	974	956
ALK	116	116	115.6
TUR	5.9	9.2	9.5

Table (2): Data of samples for August

Parameters	Station 1	Station 2	Station 3
PH	6.75	6.85	6.9
DO	6.5	5.85	6.66
PO4	0.265	0.275	0.266
NO3	4.2	4.56	4.4
Ca	105.6	101.6	106
Mg	31.7	30.85	30.34
TH	384.65	370.5	374
K	3.8	3.85	4.1
Na	62.25	62.15	63.1
SO4	338	357.2	352
CL	91.65	100.55	98.2
TDS	592.2	594.6	597.3
E.C	937	939.5	937.45
ALK	117	105	107
TUR	3.8	3.2	3.6

Table (3): Data of Samples for September

Parameters	Station 1	Station 2	Station 3
PH	7	7	6.9
DO	7.95	7.55	7.3
PO4	0.25	0.25	0.24
NO3	4.15	3.98	4.2
Ca	95.15	95.95	95.9
Mg	32.1	34.25	36.2
TH	359.3	379.85	358.8
K	3.6	4.1	4.4
Na	56	57.2	56.85
SO4	365.6	374.25	357.2
CL	103.5	110.65	100.5
TDS	630	617.5	624
E.C	977.5	964	959.5
ALK	106	102	105
TUR	2.35	2.35	2.52

3-A

Table (4): Data of Samples for October

Parameters	Site 1	Site 2	Site 3
PH	6.7	7.15	6.6
DO	7.25	7.95	7.27
PO4	0.255	0.21	0.221
NO3	4.81	4.315	4.23
Ca	108.95	104.5	106
Mg	40.55	44.8	42.5
TH	388	408.35	401
K	3.5	3.95	3.8
Na	58.35	58.05	58.1
SO4	348.2	364.1	340.5
CL	95.3	97.5	94.6
TDS	612.1	624.4	615
E.C	959	979	970
ALK	115.5	97	116
TUR	4.75	4.6	4.43

4-A

Table (5): Data of Samples for November

Parameters	Station 1	Station 2	Station 3
PH	6.75	6.85	6.65
DO	6.5	5.85	6.6
PO4	0.265	0.275	0.267
NO3	4.2	4.56	4.3
Ca	105.6	101.6	106
Mg	31.7	30.85	35.4298.35
TH	384.65	370.5	374.4
K	3.8	3.85	3.7
Na	62.25	62.15	63.17
SO4	338	357.2	340
CL	91.65	100.55	99.45
TDS	592.2	594.6	594.1
E.C	937	939.5	939
ALK	117	105	109
TUR	3.8	3.2	3.65

Table (6): Data of Samples for December

Parameters	Station 1	Station 2	Station 3
PH	6.9	6.65	7.07
DO	8.7	8.95	8.65
PO4	0.22	0.22	0.23
NO3	4.44	3.65	3.42
Ca	76	67.05	68.65
Mg	35.55	35.4	34.95
TH	329.55	298.35	340.55
K	3.4	4.25	4.3
Na	63.8	74.95	71.95
SO4	317.1	310	315.5
CL	106.45	99.45	97.6
TDS	629.9	645.5	646.7
E.C	942.5	947	945.3
ALK	107	117	109
TUR	3	3.8	3.65

الخلاصة

أجريت الدراسة الحالية فينهر الفرات /المسيب. تم جمع عينات المياه للفحص الفيزيائية والكيميائية مرة كل شهر من نهر الفرات / المسيب. تم إجراء التحليل لمدة ستة أشهر (يوليو 2020 إلى ديسمبر 2020) من ثلاثة مواقع خلال المواسم الجافة والرطبة. تم اختيار هذه العينات من ثلاث محطات للمساعدة في فهم التباين في جودة المياه بسبب الاختلافات الموسمية. تم تحليل الطقس الرطب والجاف لتحديد معدلات تلوث الأنهار بشكل أفضل. تم أخذ ثلاثة عشر معلمة بحدودها في الاعتبار في العمل الحالي وفقاً للمواصفات القياسية ، وتم جمعها وتحليلها من المعلمات الفيزيائية والكيميائية (الأس الهيدروجيني ، PO_4 ، NO_3 ، TDS ، EC ، DO ، TH ، K ، Ca ، Na ، Mg ، SO_4 ، و TUR) باستخدام مؤشرات جودة المياه الموزونة وغير الموزونة. اعتماداً على نتائج العمل الحالي أظهرت الإحصائيات الأساسية لجودة المياه أن جميع معايير جودة المياه في المحطات الثلاث خلال المواسم الجافة والرطبة خلال الفترة المذكورة أعلاه كانت أقل من حدودها القياسية. باستثناء الكالسيوم (Ca) الذي لوحظ أنه أعلى من حده بسبب طبيعة الصخور والتربة في هذا الموقع ، حيث تحتوي على كمية عالية من الأملاح والضغط البشري مثل تدفقات المياه العادمة . ظهر نتائج مؤشر جودة المياه أن جودة المياه كانت غير مناسبة للاستخدام في الشرب في الطقس الجاف والرطب ما لم يتم معالجتها.



جمهورية العراق
وزارة التعليم العالي والبحث العلمي
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قسم الهندسة البيئية

تقييم نوعية مياه نهر الفرات في مدينة المسيب باستخدام مؤشر
جودة المياه

رسالة مقدمة الى
قسم الهندسة البيئية في كلية الهندسة / جامعة بابل كجزء من متطلبات
نيل درجة الماجستير في الهندسة / هندسة البيئة

أعداد

نور علي هاشم مرزة
(بكالوريوس هندسة البيئية - 2015)

أشرف

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