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Water crisis in Iraq Statistical analysis for the years(2019-2022) and its prospects until 2030

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Abstract

water issue has acquired a major importance in shaping the third millennium development goals because of its role in achieving water and then food security, which can only be attained by preserving proper quantities of water that do not cause water imbalance, improving health and environmental conditions, besides protecting ecosystems. , and probable more than any other sector, water security is still considered one of the most important global challenges, since controlling its resources and cutting them off from other countries is a factor of continuous dependence and achieves the principle of economic dependence. As a result, the world will not be able to face the challenges of sustainable development in the twenty-first century, represented by development Without better water resources management and without ensuring regular access to water and sanitation services.

Keywords: Water crisis, ecosystems, environmental conditions.

1. INTRODUCTION

water issue has acquired a major importance in shaping the third millennium development goals because of its role in achieving water and then food security, which can only be attained by preserving proper quantities of water that do not cause water imbalance, improving health and environmental conditions, besides protecting ecosystems. , and probable more than any other sector, water security is still considered one of the most important global challenges, since controlling its resources and cutting them off from other countries is a factor of continuous dependence and achieves the principle of economic dependence. As a result, the world will not be able to face the challenges of sustainable development in the twenty-first century, represented by development Without better water resources management and without ensuring regular access to water and sanitation services.

Whoever looks at the map of the geological transformations of the world today could notice the transformations affect water sources, and there are experts and researchers who have become certain that if there is a dimension for regional or international wars, it may be wars over or because of water, until the centers of international strategic studies have called for (Water Rationalization) Because water, not oil anymore, is flammable in the future; Because of its great importance in the lives of societies and individuals, and that water, not energy, is the problem of the twenty-first century. This is the conclusion reached by international organizations working in the field of water, especially the specialized agencies of the United Nations, as the issue of water is a major concern for researchers, especially in dry areas. and semi-arid and for various reasons, including what is related to the importance and impact of water in overall development, and what is related to the scarcity of this important resource. One of the elements of the state’s strength and the reason for its prosperity, and one of the sources of tension and conflict, as water plays a role in redefining relations among states, particularly in the Middle East region. With the decline in the quantity of water and on going worsening of its quality, it has become an existing fact that water has a direct effect on security and stability. Water has become an issue of national security, foreign policy and internal stability; This is because most of the surface water in the Middle East comes from outside the region's borders, and most of its water basins are shared.

As it is known, economic resources are closely linked to politics, and perhaps their connection began with the emergence of political borders between countries and with them began the conflict between neighboring countries over the common water resource, whether it was superficial or underground, and political tensions revolved around it; Trans boundary water resources are therefore a source of tension in a region that is already unsteady, such as the Middle East. Water worries in the Middle East are more likely to provoke internal civil unrest and worsen other issues than to cause cross-border conflict. Water shortage is a “factor.” Contributing to the increase hostilities.” At the regional level, the risk of war may be low, but the risk of water shortages and conflicts contributing to political instability, protest movements, and economic challenges is much greater, thus, water scarcity should not be understood as just a physical phenomenon, but in fact as a dynamic that can affect the population of an whole region, with broader consequences as the concept of water scarcity is closely associated “water security” in reality. Water scarcity can also exacerbate “inequality,” fueling internal unrest and protests in cities. Climate variability, water scarcity and the loss of fertile land have exacerbated many of the region’s political problems, and some experts have connected the Arab uprisings to instability caused by drought and waves Free.

In Iraq, the water crisis arose because most of the water incoming from outside its political borders; accordingly, these resources have become hostage to the water, economic and political policies of the upstream and downstream countries, especially since the policies that have been established and are being carried out by the riparian neighboring countries with Iraq have led to a negative impact on the water supply and its quality. There is a widening water gap between the ever-increasing demand for water due to the increase in population The irrational use and waste of water, agricultural, industrial and civil uses, and the non-use of modern irrigation technologies in exchange for a diminishing supply of water, which has fallen to low levels; Due to the control of the neighboring riparian countries (Turkey, Iran, Syria) of Iraqi water resources through the construction of many reservoirs and dams that negatively affected Iraq, in addition to the scarcity of rain and desertification, and worse, the high level of pollution in the water.

And that the water crisis and its scarcity are a threat to food security and Iraqi national security, and this crisis has taken the center of attention, in a more serious manner, not only in terms of economic and political terms, but also in terms of social, cultural, humanitarian and security terms, as access to clean water has become a social, economic, environmental and political issue Important, but this interest was not sufficiently reflected in the national political programs, and this issue was not considered a development issue, despite its economic, political, social and environmental repercussions. Also, preserving water resources and limiting the decline in their quantities and the deterioration of their quality constitutes one of the most important basic factors in any strategic vision for the present and future of Iraq. And effective ways that enable a real water policy to be achieved through which economic development and sustainable water development can be achieved.

2. Analysis of the water situation in Iraq for the years (2002-2019):

The current research specializes in Time Series Analysis of the quantities of Iraqi water coming from surface waters (billion m3 / year), and the average amounts of rain in some regions of Iraq (mm), through the database of time series of water years for the period from The year (2002-2003) until the year (2018-2019), and predicting the total supply and demand for surface water quantities for the coming water years for the period from the year (2019-2020) until the year (2030-2031) in order to indicate the level of deficit or surplus from those coming.

The most important sources of Iraqi water coming from surface water are the main rivers represented by the rivers (Tigris and Euphrates) and tributaries of the Tigris, which are: (the Great or Upper Zab, or Lower Zab, the Great, and the Diyala River), where the basin of the Tigris and Euphrates rivers provides approximately 98% From Iraqi , are known as international rivers, which originate in one country and flow in another country or cross the territory of two or more countries (successive rivers) as it is in the Euphrates River, besides the rivers and secondary tributaries that originate in Iraqi territory and are also known as national rivers that fall from their sources to Its estuaries and all its tributaries are in the territory of one country, known as (the Sulaibian River, the Maysan River, and the Gharraf River), the estuaries represented by (the general estuary, Shatt al-Arab, and Shatt al-Basra) and the estuaries represented by (the Euphrates flood smuggler, and the flooded Kumait smuggler), and the many projects and water complexes Established over the past years led by (the Great Basra Water Project). This is besides what these rivers constitute a major source in the formation and sustainability of groundwater, as well as the formation and sustainability of water bodies, represented by lakes, marshes, basins and water swamps spread over spatially sprawling sites. The water bodies are galvanized iron structures for the speed of their installation, and their filtering efficiency is less than the efficiency of projects, and they are used in villages and relatively small areas. This, and rivers constitute the percentage of water resources, and according to the paper of the Iraqi Energy Institute entitled “Towards sustainable water resource management in Iraq” on August 30, 2018, it ranges between 93% - 98%, at a time when the percentage of groundwater constitutes 2% - Only 7% [7]. In addition to the above, groundwater reserves are vulnerable to consumption and the availability of surface water, so that any changes to the withdrawal from wells may affect the flow along the river, and any change in the flow of streams can affect the amount of available groundwater. Therefore, if the amount of surface flow coming into Iraq from its neighboring upstream countries is reduced as expected, this will also have a significant impact on the groundwater systems [8]. This, and that the annual active aquifer recharge rate in Iraq is not fully understood, although the Iraqi government, at the present time, in cooperation with UNESCO, is studying the country’s aquifers in order to better understand the potential of groundwater systems [9]. By analyzing the quantities of surface water from international and national river coming that extend over a comprehensive and long-term time series associated with the inflection of the strategic water policies of the upstream and downstream countries that have blatantly followed a path different from international treaties, charters and norms [10].

Mesopotamian region has been distinguished by its possession of enormous water resources and throughout the ages, and the reason for the emergence of the first civilizations known to the world was the Mesopotamian civilization. However, the Turkish strategic water policy, especially in the past three decades, as was mentioned previously, followed a path different from treaties, charters and customs. International, where the decision to oppose Turkey came from among the three countries opposing the 1997 United Nations Convention on the Use of International Watercourses for Non-Navigational Purposes, which are Burundi, China, and Turkey, where it represents the only treaty covering shared fresh water by defining the principles and rules that can be applied and modified to suit the distinctive features of the international watercourses concerned. This agreement, which consisted of 37 articles, was concluded on May 21, 1997 as an appendix to General Assembly Resolution No. 51. 229, and 103 countries voted on that agreement with 27 abstentions. The main reason for Turkey opposition to the treaty is that it is one of the upper-stream countries that, not recently, adopted water projects on the rivers that originate from its territory, which had a significant negative impact on various aspects of life in both Iraq and Syria [10].

The comprehensive data of surface water resources for the time series investigated, represented by the quantities of water from the water coming of the Tigris River, its tributaries and the Euphrates River, were collected with (billion m 3 / year), and estimates of the quantities of groundwater produced by (billion m 3 / year), and the average rainfall in (mm) for the elected areas (Sulaymaniyah, Mosul, Baghdad, Rutba, Basra), the annual losses from water bodies (evaporation) in (billion m 3 / year), and estimates of the supply quantities of surface water at (billion m 3 / year), and as it is shown in Table (1).

This was achieved by referring to many sources represented by the publications of the Ministry of Water Resources, the Department of Planning and Follow-up, the Environmental Policies Department, the publications of the Ministry of Planning, the Central Statistical Organization, annual statistical groups, water resources estimates, and the publications of the Ministry of Agriculture, the Directorate of Agricultural Statistics, and the Food Program The World Economic Atlas of Iraq 2019. In addition, a number of published research and studies have been relied upon, [1], [2], [3], [4], [12].

Total surface water of the time series for the water years for the period from (2002-2003) to (2018-2019)

Table (1): *Water coming of the Tigris River and its tributaries and the Euphrates River, the quantities of produced groundwater, the estimated average rainfall (mm), the losses from the water bodies and the supply*

Researched water sources							
total surface water width	Waste from water bodies (evaporation) (2)	Average rainfall (mm) (3)	Produced ground water (Billion m3/year) Estimated (2)	total	Surface water (billion m3/year)		time series Water Years) (1)
					major rivers[3]		
					Euphrates	Tigris and its branches	
71.18	8.9	183.05	3.2	76.88	27.40	49.48	2003-2002
60.35	8.9	176.50	3.2	66.05	20.54	45.51	2004-2003
49.97	8.9	154.60	3.2	55.67	17.57	38.10	2005-2004
59.50	8.9	236.23	3.2	65.20	20.60	44.60	2006-2005
53.49	8.9	124.59	3.2	59.19	19.33	39.86	2007-2006
29.37	8.9	109.03	3.2	35.07	14.70	20.37	2008-2007
26.41	8.9	127.74	3.2	32.11	9.30	22.81	2009-2008
44.42	8.9	123.27	3.2	50.12	19.30	30.82	2010-2009
41.90	8.9	139.21	3.2	47.60	14.60	33.00	2011-2010
43.41	8.9	172.80	3.2	49.11	20.42	28.69	2012-2011

50.32	8.9	239.14	3.2	56.02	15.13	40.89	2013-2012
31.55	8.9	206.28	3.2	37.25	15.53	21.72	2014-2013
29.64	8.9	189.63	3.2	35.34	8.02	27.32	2015-2014
49.05	8.9	148.31	3.2	54.75	15.15	39.60	2016-2015
34.99	8.9	120.83	3.2	40.69	13.23	27.46	2017-2016
27.50	8.9	293.29	3.2	33.20	9.58	23.62	2018-2017
85.65	8.9	M	3.2	91.35	16.95	74.40	2019-2018

Sources: The researcher based on the data of the Ministry of Water Resources

Department of Planning and Follow-up, Policy Department - Al-Noor Center message, link auther<www.alnoor.se. The Ministry of Planning, the Central Statistical Organization, the estimates of the Ministry of Water Resources, the Directorate of Agricultural Statistics,

Population numbers according to the estimates of the Central Agency.

(1) The water year begins on the first of November of the first year and ends on the thirtieth of September of the following year.

. [12] (2) From the source "The Water Gap in Iraq",

(3) Average rainfall (mm) recorded for the areas (Sulaymaniyah, Mosul, Baghdad, Rutba, Basra)

Note: The amount of Al-Azim water was added to the quantities of the Tigris River and its tributaries.

Table (2) also presents the time series of estimates of population numbers and population density (person/km2), per capita surface water resources and estimates of total surface water demand (billion m3/year) for its uses of water for purposes: (agricultural-irrigation, livestock and industrial sector). Municipalities and Environment) for the time series for the water years for the period from (2002-2003) to (2018-2019).

Table (2): *Estimates of population numbers, population density and per capita surface water coming (m3 / year) to population numbers Estimated total water demand (billion m3 / year) for the time series for water years for the period from (2002-2003) to (2018-2019)*

time series (Water years) (1)	**In Iraq population density**	**Population numbers (person/km2)**	**percapita comin (m3/year) population numbers**	**Estimated total water demand (Billion m3/year** (*)
2003-2002	26340227	58.6	2702.3	47.81
2004-2003	27139585	60.2	2223.7	42.27
2005-2004	27962968	61.6	1787.0	49.71
2006-2005	28810441	62.8	2065.2	52.55
2007-2006	29682081	63.8	1802.1	53.02
2008-2007	30577798	64.9	960.5	53.50

2009-2008	31664466	66.7	834.1	53.97
2010-2009	32489972	68.5	1367.2	54.44
2011-2010	33338757	70.7	1256.8	54.92
2012-2011	34207248	73.4	1269.0	55.39
2013-2012	35096000	76.4	1433.8	55.86
2014-2013	36005000	79.3	876.3	56.33
2015-2014	35213000	81.9	841.7	56.81
2016-2015	36169000	84.3	1356.1	57.28
2017-2016	37139519	86.5	942.1	57.75
2018-2017	38124182	88.5	721.3	58.23
2019-2018	39309789	90.4	2178.8	58.70

(*) Estimates of total water demand (billion m 3 per year), which includes the demand for water uses for purposes: (agricultural - irrigation, livestock, industrial sector, municipalities and the environment).

Sources: Prepared by the researcher based on the publications of the Central Statistical Organization, the annual statistical collections and the first voluntary report on the sustainable development goals 2019 (the victory of the will of a homeland), and the published research "The Water Gap in Iraq [12]. The linear interpolation method was applied for the missing inter-year years.

3. Using statistical methods of analysis in analyzing the water crisis in Iraq.

There are many prediction models that can be used to obtain the values of special projections about the phenomenon in the coming periods. When it comes to time-regressed data, which is known as time-series data, some standard data analysts may resort to by performing cross-sectional analysis of those data using regression model analysis. Simple or multiple (linear or non-linear), which assumes the independence of observations from each other, which is contrary to the nature of time series data in which the observations are of a time-related or regressive nature, which requires (obligatory) an analysis of simple auto-regression models Or multiple (linear or non-linear) in order to obtain estimates of the general trend line and make future projections. There is often a time delay between when the results of a future event or need are required to be known and when that event occurs. This delay or delay is the main reason for carrying out planning and predicting. The level of predicting accuracy generally depends on the degree or level of fit of the model. For prior and current information about the phenomenon under study, which is known as time series. The topic of choosing the model depends on how it is used for predicting, the degree of accuracy required, how to overcome a violation in the data studied, the requirements of the method adopted in the estimation, the quantity and type of data available, and the extent of the time period that it must predict. In addition to the foregoing, the test of the quality of matching the optimal model remains the criterion that the data analyst generally adopts in choosing a specific model without other models, in addition to that, there may be a certain constraint (or more) that may establish the exact evidence or indicator in conducting an operation. Comparison and selection.

In order to achieve the objectives of the current study, the estimation models of Box-Jenkins (Box-Jenkins, 1976) [6], with low ranks represented by the ARMA models (p, q) were used to obtain the appropriate prediction values, which are used in the models. The immediacy in which there are interrelationships between the variables, they are also classified within the non-causal models by relying on the historical values of the variable whose future value is to be predicted and do not need to identify the variables that explain its behaviour, and one of the most important causal models are the long term trend models, The general trend projections are one of the most common methods in long-term predictions of environmental and economic variables. The general trend of a time series is defined as the general pattern of change in the values of the variable under consideration, while ignoring other components of the time series represented by seasonal fluctuations, cycling and irregular fluctuations. (Irregularity) that can occur for reasons or factors of nature, which is sometimes known as the sudden vehicle.

The mathematical formula ARMA (p, q) refers to an acronym that symbolizes the Auto-Regression and Moving Average model, and the letter (p) indicates the degree of regression of the autoregressive model, and the letter (q) indicates the degree of regression of the medians model. Animation. Thus, the autoregressive model (AR) is a model that uses the dependable relationship between observation and a number of time-rebound observations, and thus the current value is written as a linear function in the previous values of the same series variable, while the moving average (MA) model is a model that uses the dependent relationship Between the observation and the residual error of the moving average model applied to the time-returned observations, and thus the value of the variable is written as a linear function in the current value of the random error element and a number of the previous value. Finally, the mixed model (ARMA) is the model that mixes the two previous models at the same time, as these models focus on the random side of the time series.

The degree of time regression is clearly determined in the model as an estimated parameter when the time series is stable, where the time series is considered stable if it has a fixed arithmetic mean around which the data are gathered, that is, free from seasonal effects and having a constant variance. The application of these prediction models requires going through the following steps:

First: Identification

In this step, the model is diagnosed and the degree of its temporal regression is determined through the autocorrelation and partial autocorrelation functions.

Second: Estimation

After defining the model and determining the degree of its temporal regression, its parameters are estimated. There are several methods of estimation, among which the most common is the Maximum Likelihood method.

Third: Diagnostic Checking

Before estimating the parameters of the model, it is necessary to test it to see how well it represents the time series. This is done through the index of the autocorrelation coefficients of the residuals.

Fourth: predicting

It is the last step through which the estimated values of the prediction for the series data are obtained and an estimate of the confidence interval for the prediction values with calculating the values of the residuals.

In the following pages, the results of the estimated values for predicting the time series investigated represented by the quantities of surface water in (billion m 3 / year) for the water years of the time series for the coming years (2020-2030) of Iraqi expected water coming for each of the Tigris and its tributaries and the Euphrates and the total output of the two rivers coming , as well as predicting estimates of the expected values of rainfall in (mm) for the water years for the time series for the coming years (2020-2030), and finally, the prediction of the quantities of supply and demand for surface water was made (billion m 3 / year) for the water years for the next time series for the period from (2019-2020) until (2030-2031) with the aim of showing the level of deficit or surplus from those coming, as follows:

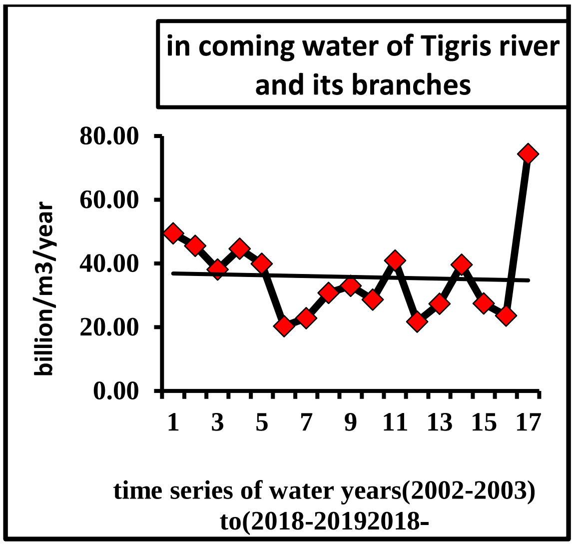


Figure (1) *Time series of surface water coming of the Tigris River and its tributaries for the successive water years from (1990 - 1991) to (2018 – 2019)*

Source: the researcher, based on computer output.

A general trend is gradually decreasing, the series is unstable on average. In order to determine the stability in the average, the autocorrelation function of the residuals was examined, which resulted after the first displacement that it falls within the confidence limits at a significance level of 0.05 from two sides:

-0.485071<r_k<0.485071

where : r_k denotes the autocorrelation coefficients for the residuals.

and that (k = 0, 1, 2, ……., L of coefficients, and that L is greater than n/4.

Table (3) presents the results of the autocorrelation coefficients after the second shift.

Table (3): Autocorrelation coefficients for the residuals (errors) of the Tigris River and its tributaries after the first displacement and the estimate of the critical degree of the test when estimating (>0.485071)

Autocorrelations of Residuals of Tigris

Lag	Correlation	Lag	Correlation	Lag	Correlation	Lag	Correlation
1	-0.015476	5	-0.256630	9	-0.010868	13	0.094269
2	-0.083996	6	0.141992	10	-0.140918	14	-0.056365
3	0.210105	7	-0.079551	11	-0.331469		
4	-0.078559	8	-0.083512	12	-0.009583		

Significant if |Correlation|> 0.485071

Source: the researcher based on computer outputs, (Lag): regression degree

Thus, it is clear that the random distribution of the series data has been achieved after the first displacement, which indicates that the series has become stable after taking the first difference to it.

After the series was stable, the model was determined and its degree based on the behavior of the autocorrelation function. The data analyst may sometimes face the presence of more than one model that achieves a high level of alignment with the stable time series, which is based on the reliance on the mean square error index (MSE) resulting from the use of each of the models with low ranks in order to reach the optimal model, as it became clear that The mixed model ARMA(1,1) is the best model for estimating the predictive values of the investigated time series data for the upcoming water years, as shown in Table (4).

Table (4) *The index of the average sum of squares of random errors for the quantities of water from the water coming of the Tigris River and its tributaries for the time series (1990 - 2019) distributed according to models with low ranks, subject of trade-o*

ARMA (p, q)	MSE
ARMA(1, 0)	252.78
ARMA(0, 1)	702.53
ARMA(1, 1)	207.66
ARMA(2, 0)	263.59
ARMA(0, 2)	402.67
ARMA(1, 2)	222.70
ARMA(2, 1)	264.55
ARMA(2, 2)	Determinant zero

Source: the researcher, based on computer output.

MSE: mean sum of residuals, ARMA(p, q): low-degree autoregressive median model

Table (5) presents the results of the estimates of the estimated parameters according to the optimal model ARMA(1, 1), which are highly significant with less than the 0.01 level.

Table (5) *results of the estimates of the estimated parameters according to the optimal model ARMA(1, 2) for the quantities of water coming of the Tigris River and its tributaries for the time series (1990 - 2019)*

Parameter Name	$\hat{\beta}$	SE	T-value	P-value	C.S.
AR(1)	0.9929928	0.01056106	94.0240	0.000000	HS
MA(1)	0.9166574	0.09088808	10.0790	0.000000	HS

Source: the researcher, based on computer output.

HS: highly significant, with a significance less than the 0.01 level, S: significant, with a significance less than the 0.05 . level

In light of this, the prediction function for the quantities of water coming of the Tigris River and its tributaries for the time series (2003 - 2019) and according to the adapted model is as follows:

y^_t=0.9929928y_(t-1)+ 〖0.9166574a〗_(t-1)+a_t

Chart (2) also presents the lines of the observed values and the estimated values of the results of the quantities of water coming of the Tigris River and its tributaries for the time series (2003 - 2019) and according to the adapted model ARMA(1, 1).

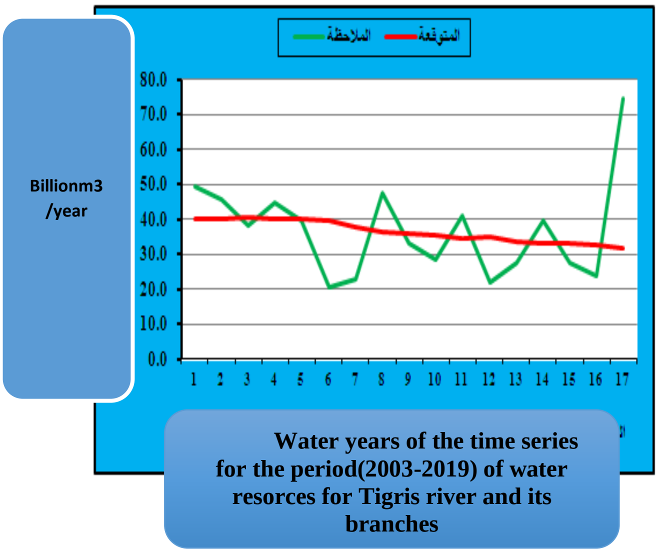


Figure (2) *The graphic polygon line of the results of the observed quantities of water coming and their estimates of the Tigris River and its tributaries for the time series of water years for the successive period (2003 – 2019)*

Table (6) also presents the results of the estimates of the quantities of water coming of the Tigris and its tributaries for the time series of the successive water years from the year (2002-2003) until the year (2018-2019), in addition to the estimates of the quantities of water coming of the Tigris and its tributaries for the forecasted water years of the coming year. (2019 - 2020) until the year (2030 - 2031) and according to the optimal model ARMA (1, 1). The table also included a statement of the residual values resulting from the differences between the observed quantities of water coming of the Tigris River and its tributaries and the expected quantities in the light of the model, in addition to an estimate 95% confidence interval limits for the extent of prediction values for the investigated time series and estimates of the quantities of water coming of the Tigris River and its tributaries for the predicted water years.

Table (6) *Estimates of the quantities of water coming of the Tigris River and its tributaries for the time series investigated and their estimates for the coming years for the period from (2003 - 2019) to (2030 - 2031), with a confidence limit of 95%*

water of Tigris river and their branches prediction						
Item No.	Waters Yrs.	Actual Data	Residual Differences)	Forecast data	95% Confidence Interval	
					Lower Limit	Upper Limit
1	2003-2002	49.5	9.6	39.9	11.5	68.2
2	2004-2003	45.5	5.2	40.3	12	68.7
3	2005-2004	38.1	-2.3	40.4	12.1	68.8
4	2006-2005	44.6	4.6	40.0	11.7	68.3
5	2007-2006	39.9	-0.2	40.1	11.7	68.4
6	2008-2007	20.4	-19.4	39.8	11.4	68.1
7	2009-2008	22.8	-15.2	38.0	9.7	66.3
8	2010-2009	30.8	-5.7	36.6	8.2	64.9
9	2011-2010	33.0	-2.9	35.9	7.5	64.2
10	2012-2011	28.7	-6.7	35.4	7.1	63.7
11	2013-2012	40.9	6.3	34.6	6.3	63.0
12	2014-2013	21.7	-13.1	34.9	6.5	63.2
13	2015-2014	27.3	-6.3	33.6	5.3	61.9
14	2016-2015	39.6	6.7	32.9	4.6	61.2
15	2017-2016	27.5	-5.7	33.2	4.8	61.5
16	2018-2017	23.6	-8.9	32.5	4.2	60.8
17	2019-2018	74.4	42.8	31.6	3.3	59.9
18	2020-2019			34.7	6.3	63.0
19	2021-2020			34.4	6.0	62.8
20	2022-2021			34.2	5.7	62.7
21	2023-2022			33.9	5.4	62.5
22	2024-2023			33.7	5.1	62.3
23	2025-2024			33.5	4.7	62.2
24	2026-2025			33.2	4.4	62.0
25	2027-2026			33.0	4.1	61.9
26	2028-2027			32.8	3.8	61.7
27	2029-2028			32.5	3.5	61.6
28	2030-2029			32.3	3.2	61.4
29	2031-2030			32.1	2.9	61.2

source: the researcher, based on computer output.

By reviewing the results of the predicted quantities for the coming water years, it becomes clear, beyond any doubt, the significant decline in the expected water coming of the Tigris River and its tributaries for the coming water years from the water year (2019-2020) until the water year (2030-2031), and graph (3) shows The nature of the behavior of the general trend line for the quantities of water from the water coming of the Tigris River and its tributaries for the predicted water years for the coming water years and the estimates of the 95% confidence interval limits, where the general trend line indicates a decline in the quantities of water from the water coming of the Tigris and its tributaries for the predicted water years.

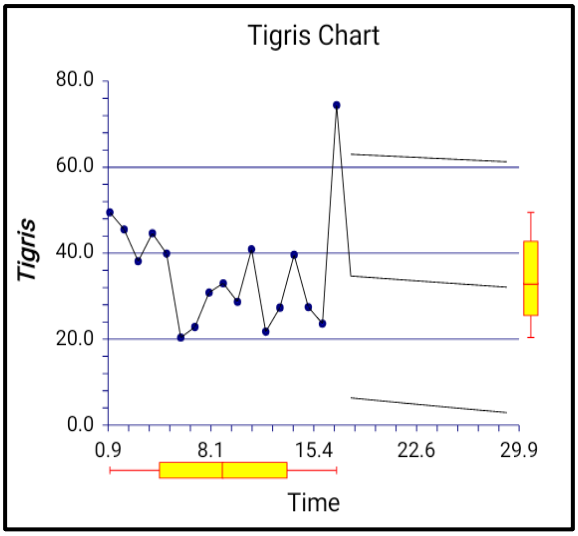


Figure (3) *The general trend line for the results of the predicted quantities of water coming of the Tigris River and its tributaries for the time series for the water years of the period under study.*

The general trend and future prediction of the quantities of water resources of the Euphrates River:

By plotting the data of the time series of water coming for the Euphrates River with (billion m 3 / year) for the follow-up water years from (2002 - 2003) to (2018 - 2019), where the data of the series indicate through the general trend line that it is unstable and as in the figure (4)

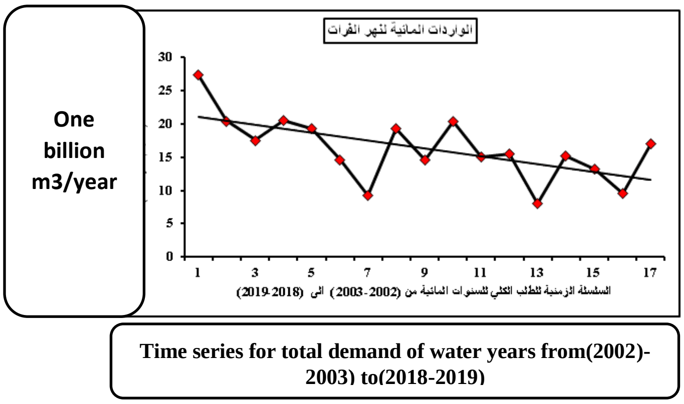


Figure (4) *The time series of the surface water coming of the Euphrates River for the successive water years from (2002 - 2003) to (2018 – 2019)*

Source: the researcher, based on computer output.

Where it is observed that there is a general decreasing trend significantly with the passage of time, the series is unstable on average. In order to determine the stability characteristic of the average, the autocorrelation function was examined, which resulted after the first displacement that it falls within the two confidence limits at a significance level of 0.05 from two sides:

-0.485071<r_k<0.485071

where : r_k denotes the autocorrelation coefficients for the residuals.

and that (k = 0, 1, 2, ……., L of coefficients, and that L is greater than n/4.

Table (7) presents the results of the autocorrelation coefficients for the residuals, after the first displacement.

Table (4-2-2-1): Autocorrelation coefficients after the second displacement of the Euphrates River and the estimate of the critical degree of the test when estimating (>0.485071)c

Autocorrelations of Residuals of Euphrates

Lag	Correlation	Lag	Correlation	Lag	Correlation	Lag	Correlation
1	-0.106372	5	-0.218005	9	0.277432	13	0.088130
2	-0.113636	6	-0.037312	10	-0.019783	14	-0.042034
3	-0.157789	7	0.194175	11	-0.089086		
4	-0.052678	8	-0.086660	12	-0.192846		

Significant if |Correlation|> 0.485071

Source: the researcher based on computer outputs, (Lag): regression degree

Where it is clear that the random distribution of the series data is achieved after the first shift, which indicates that the series has become stable after taking the first difference to it.

After the series was stable, the model was determined and its degree based on the behavior of the autocorrelation function. As we mentioned, the data analyst may sometimes face the presence of more than one model that achieves a high level of alignment with the stable time series as well, which was based on the Mean Squares Error Index (MSE) resulting from the use of each of the low-ranked models, as it became clear that the mixed model ARMA(1,1) is the ideal model for estimating the predictive values of the researched time series data for the coming years, as shown in Table (8).

Table (8) *Index of the average sum of squares of random errors for the quantities of water from the water coming of the Euphrates River for the time series (1990 - 2019) distributed according to models with low ranks, subject of trade-off*

ARMA (p, q)	MSE
ARMA(1, 0)	29.210
ARMA(0, 1)	143.79
ARMA(1, 1)	22.004
ARMA(2, 0)	28.616
ARMA(0, 2)	73.158
ARMA(1, 2)	23.401
ARMA(2, 1)	23.779
ARMA(2, 2)	25.287

Source: the researcher, based on computer output.

MSE: mean sum of residuals, ARMA(p, q): low-degree autoregressive median model

Table (9) presents the results of parameter estimates according to the optimal model ARMA(1, 1), which are highly significant and less than the 0.01 level.

Table (9) *results of the estimates of the estimated parameters according to the optimal model ARMA(1, 1) for the quantities of water coming of the Euphrates River for the time series (1990 – 2019)*

Parameter Name	$\hat{\beta}$	SE	t-value	P-value	C.S.
AR(1)	0.9927378	0.01132328	87.6723	0.000000	HS
MA(1)	0.6876256	0.1503607	4.5732	0.000005	HS

Source: the researcher, based on computer output.

HS: highly significant, less than 0.01

In light of this, the prediction function for the quantities of water coming of the Euphrates River for the time series (1990 - 2019) and according to the matched model is as follows:

$\hat{y}_t=0.9927378y_{(t-1)}+ 〖0.6876256a〗_{(t-1)}+a_t$

Chart (5) also presents the lines of the observed values and the estimated values of the results of the quantities of water coming of the Euphrates River for the time series (2003 - 2019) and according to the adapted model ARMA (1, 1

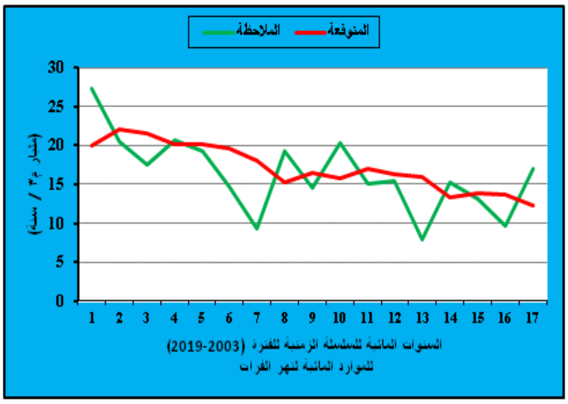


Figure (5) *The polygonal graphic line of the results of the observed quantities of water coming and their estimates of the Euphrates River for the time series of water years for the successive time period (2003 - 2019)*

Table (10) also presents the results of the estimates of the quantities of water coming of the Euphrates River for the time series of the successive water years from the year (2002 - 2003) until the year (2018-2019), in addition to the estimates of the quantities of water coming of the Euphrates River for the upcoming water years predicted from the year (2019). – 2020) and until the year (2030 – 2031) and according to the optimal model ARMA (1, 1). The table also included a statement of the residual values resulting from the differences between the observed quantities of the water coming of the Euphrates River and the expected quantities in light of the Fitted Model, in addition to Estimates of 95% confidence interval limits for the extent of prediction values for the investigated time series and estimates of the quantities of water coming of the Euphrates River for the predicted water years.

Table (10) *Estimates of the quantities of water coming of the Euphrates River for the time series investigated and their estimates for the coming years for the period from (2003 - 2019) to (2030 - 2031) and the confidence limit is 95%.*

Forecast Section of Euphrates river						
Item No. **1**	Waters Yrs.	Actual Data	Residual	Forecast data	95% Confidence Interval	
					Lower Limit	Upper Limit
1	2003-2002	27.4	7.4	20.0	10.4	29.6
2	2004-2003	20.5	-1.6	22.1	12.5	31.7
3	2005-2004	17.6	-3.9	21.5	11.9	31.1
4	2006-2005	20.6	0.5	20.1	10.5	29.7
5	2007-2006	19.3	-0.8	20.1	10.5	29.7
6	2008-2007	14.7	-5.0	19.7	10.1	29.3
7	2009-2008	9.3	-8.8	18.1	8.4	27.7
8	2010-2009	19.3	4.0	15.3	5.6	24.9
9	2011-2010	14.6	-1.8	16.4	6.8	26.0
10	2012-2011	20.4	4.7	15.7	6.1	25.3
11	2013-2012	15.1	-1.9	17.0	7.4	26.6
12	2014-2013	15.5	-0.8	16.3	6.7	25.9
13	2015-2014	8.0	-7.9	16.0	6.4	25.6
14	2016-2015	15.2	1.7	13.4	3.8	23.0
15	2017-2016	13.2	-0.6	13.9	4.2	23.5
16	2018-2017	9.6	-4.0	13.6	4.0	23.2
17	2019-2018	17.0	4.7	12.2	2.6	21.9
18	2020-2019			13.6	4.0	23.2
19	2021-2020			13.5	3.5	23.5
20	2022-2021			13.4	3.0	23.8
21	2023-2022			13.3	2.6	24.0
22	2024-2023			13.2	2.1	24.3
23	2025-2024			13.1	1.7	24.5
24	2026-2025			13.0	1.3	24.7
25	2027-2026			12.9	0.9	24.9
26	2028-2027			12.8	0.5	25.1
27	2029-2028			12.7	0.2	25.3
28	2030-2029			12.6	-0.2	25.5
29	2031-2030			12.5	-0.6	25.7

Source: the researcher, based on computer output

By reviewing the results of the predicted quantities for the coming water years, it becomes clear, beyond any doubt, the state of decline in the expected water coming of the Euphrates River for the coming water years from the year (2019-2020) until the year (2030-2031), and the graph (6) shows the nature of the behavior of water quantities. Of the water coming of the Euphrates River for the water years investigated by (billion m 3 / year) and the predicted quantities for the coming water years and estimates of confidence limits 95%, where the general trend line indicates a decline in the quantities of water from the water coming of the Euphrates River for the predicted water years.c

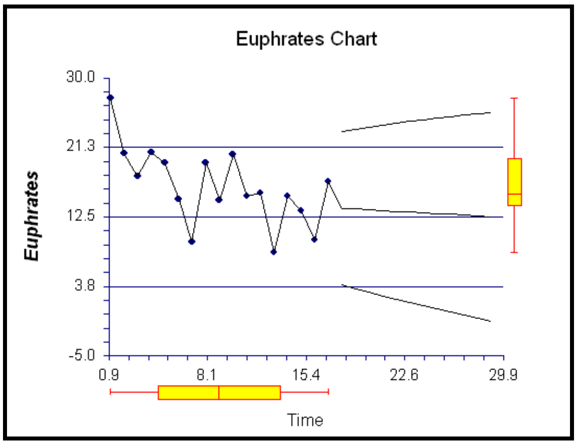


Figure (6): *The general trend line of the results of the predicted quantities of water coming for the Euphrates River for the time series for the water years for the period under study*

- The general trend and future prediction of the quantities of water resources of the Tigris and its tributaries and the Euphrates:

By plotting the time series data of water coming for the Tigris and its tributaries and the Euphrates with (billion m 3 / year) for the follow-up water years from (2002 - 2003) to (2018 - 2019), where the data of the series indicate through the general trend line that it is unstable As in Figure (7):

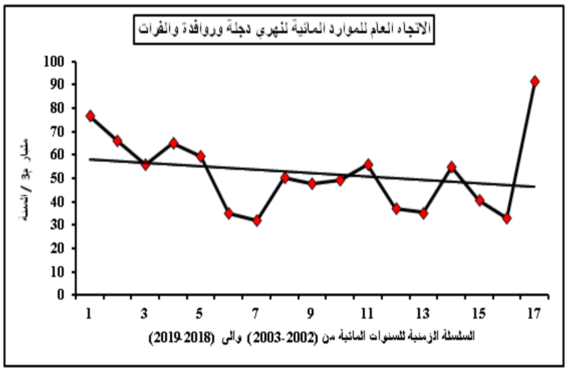


Figure (7) *c*

Source: the researcher, based on computer output.

As we notice a general decreasing trend, the series is unstable on average. In order to neutralize the stability characteristic of the average, the autocorrelation function was examined, which resulted after the second shift that it falls within the two confidence limits at a significance level of 0.05 from two sides:

$-0.485071<r\_k<0.485071$

where : r_k denotes the autocorrelation coefficients for the residuals, and that (k = 0, 1, 2, ……., L of coefficients, and that L is greater than n/4.

Table (10) *presents the results of the autocorrelation coefficients for the residuals, after the second shift.*

Autocorrelations of Residuals of Total

Lag	Correlation	Lag	Correlation	Lag	Correlation	Lag	Correlation
1	-0.036656	5	-0.284825	9	0.141597	13	0.157948
2	-0.265254	6	0.124241	10	-0.069879	14	-0.081489
3	0.239494	7	0.080945	11	-0.299774		
4	-0.023790	8	-0.190848	12	-0.100841		

Significant if |Correlation|> 0.485071

Source: the researcher based on computer outputs, (Lag): regression degree

It is clear that the random distribution of the string data is achieved after the second shift, which indicates that the series has become stable after taking the second difference to it.

After the series was stable, the model was determined and its degree based on the behavior of the autocorrelation function.

Because of the presence of more than one model that may achieve a high level of alignment to the stable time series, which was based on the mean square error index (MSE) resulting from the use of each of the models with low ranks, where it became clear that the mixed model ARMA(1,2) It is the ideal model for estimating the predictive values of the investigated time series data for the upcoming water years, as shown in Table (12).

Table (12) *index of the average sum of squares of random errors of water quantities from the water coming of the Tigris River and its tributaries and the Tigris River for the time series (1990 - 2019) distributed according to models with low ranks, subject of trade-off*

ARMA (p, q)	MSE
ARMA(1, 0)	354.623
ARMA(0, 1)	1163.479
ARMA(1, 1)	301.181
ARMA(2, 0)	375.489
ARMA(0, 2)	553.910
ARMA(1, 2)	244.645
ARMA(2, 1)	315.765
ARMA(2, 2)	263.102

Source: the researcher, based on computer output. MSE

: mean sum of residuals, ARMA(p, q): low-degree autoregressive median model

Table (13) presents the results of the estimates of the estimated parameters according to the optimal model ARMA(1, 2), which are significant with less than 0.05 level for AR(1), and MA(2), and not significant with a level greater than 0.05 for MA(1).

Table (13) *results of the estimates of the estimated parameters according to the optimal model ARMA(1, 2) for the quantities of water coming of the Tigris River and its tributaries and the Euphrates River for the time series (2003 – 2019)*

Parameter Name	$\hat{\beta}$	SE	t-value	P-value	C.S.
AR(1)	0.9946027	0.00751948	132.2701	0.000000	HS
MA(1)	0.0459856	0.1225994	0.3751	0.707595	NS
MA(2)	0.8562607	0.1009994	8.4778	0.000000	HS

Source: the researcher, based on computer output.

HS: highly significant with a significance less than the 0.01 level, S: significant with a significance less than the 0.05 level.

In light of this, the prediction function for the quantities of water coming of the Tigris and its tributaries and the Euphrates River for the time series (2003 - 2019) is according to the conciliated model, as shown below:

y ̂_t=0.9946027y_(t-1)+ 〖0.0459856 a〗 _(t-1)+0.8562607a_(t-2)+a_t

Chart (8) presents the lines of the observed values and the estimated values of the results of the quantities of water coming of the Tigris River and its tributaries and the Euphrates River for the time series (2003 - 2019) and according to the adapted model ARMA(1, 2).

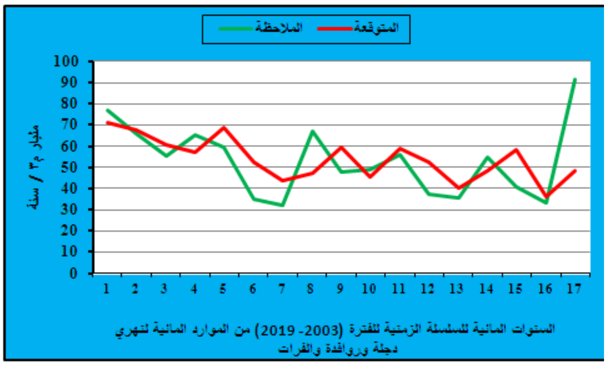


Figure (8): *The polygonal graphic line of the results of the observed quantities of water coming and their estimates of the Tigris River and its tributaries and the Euphrates River for the time series of water years for the successive period (2003 – 2019)*

Table (14) also presents the results of the estimates of the quantities of water coming of the Tigris and its tributaries and the Euphrates River for the time series of the successive water years from (2002 - 2003) until the year (2018-2019), in addition to the estimates of the quantities of water coming of the Tigris and its tributaries and the Euphrates River for the coming water years The forecast for the water years from the year (2019 - 2020) until the year (2030 - 2031) and according to the optimal model ARMA (1, 2). The table also included a statement of the residual values resulting from the differences between the quantities observed for the water coming of the Tigris River and its tributaries and the Euphrates River and the expected quantities It has, in addition to estimating the 95% confidence interval limits for the extent of the prediction values for the investigated time series and estimates of the quantities of water coming of the Tigris River and its tributaries and the Euphrates River for the predicted water years.

Table (14): *Estimates of the quantities of water coming of the Tigris and its tributaries and the Euphrates River for the time series investigated and their estimates for the coming years for the period from (2003 - 2019) to (2030 - 2031) and the confidence limit is 95%*

Forecast Section of Tigris river and their branches and Euphrates river						
Item No.	Waters' Yrs.	Actual Data	Residual	Forecast	95% Confidence Interval	
					Lower Limit	Upper Limit
1	2003-2002	76.9	6.0	70.9	28.6	113.1
2	2004-2003	66.1	-1.6	67.7	25.4	109.9
3	2005-2004	55.7	-4.9	60.6	18.4	102.9
4	2006-2005	65.2	8.2	570	14.7	99.2
5	2007-2006	59.2	-9.5	68.7	26.4	111
6	2008-2007	35.1	-17.2	52.3	10	94.5
7	2009-2008	32.1	-11.7	43.8	1.6	86.1
8	2010-2009	50.1	2.9	47.2	4.9	89.5
9	2011-2010	47.6	-12.1	59.7	17.5	102
10	2012-2011	49.1	3.7	45.4	3.1	87.7
11	2013-2012	56.0	-3.0	59.1	16.8	101.3
12	2014-2013	37.3	-15.4	52.7	10.4	94.9
13	2015-2014	35.3	-5.0	40.4	-1.9	82.6
14	2016-2015	54.8	6.2	48.6	6.3	90.9
15	2017-2016	40.7	-17.8	58.5	16.2	100.7
16	2018-2017	33.2	-2.8	36.0	-6.2	78.3
17	2019-2018	91.4	43.0	48.4	6.1	90.6
18	2020-2019			91.3	49	133.5
19	2021-2020			54.0	11.7	96.3
20	2022-2021			53.7	11.3	96.1
21	2023-2022			53.4	10.9	95.9
22	2024-2023			53.1	10.6	95.7
23	2025-2024			52.9	10.2	95.5
24	2026-2025			52.6	9.8	95.3
25	2027-2026			52.3	9.5	95.1
26	2028-2027			52.0	9.1	94.9
27	2029-2028			51.7	8.7	94.7
28	2030-2029			51.4	8.4	94.5
29	2031-2030			51.2	8.0	94.3

Source: the researcher, based on computer output.

By reviewing the results of the predicted quantities for the coming water years, it becomes clear, beyond any doubt, the significant decline in the expected water coming of the Tigris River and its tributaries and the Euphrates River for the coming water years from the year (2019-2020) until the year (2030-2031), and the graph (9) shows The nature of the behavior of the general trend line of water quantities from the water coming of the Tigris and its tributaries and the Euphrates River predicted for the coming water years and the estimates of the 95% confidence interval limits, where the general trend line indicates a decline in water quantities from the water coming of the Tigris and its tributaries and the Euphrates River for the forecast water years.c

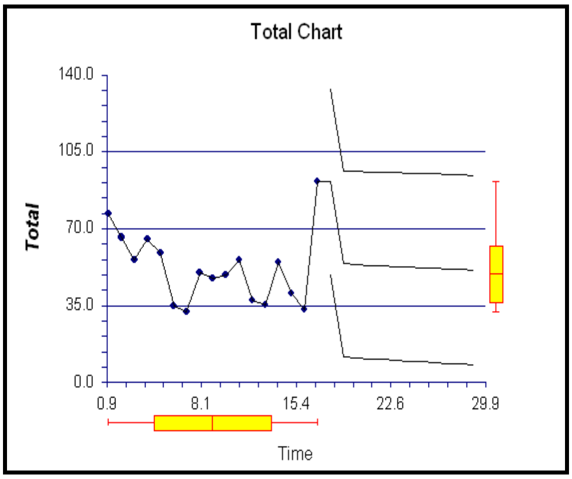


Figure (9) *The general trend line for the results of the quantities of water coming predicted in the future for the Tigris River and its tributaries and the Euphrates River for the time series for the water years for the period under study*

Table (15) presents the results of the estimations of the average amounts of rain for the time series of the successive water years from the year (2002 - 2003) until the year (2017-2018), in addition to the estimates of the average amounts of rain for the upcoming water years that are predicted for the water years from (2018 - 2019).) and until (2030-2031) and according to the optimal model ARMA (2, 1), the table also included a statement of the residual values resulting from the differences between the observed values of the average amounts of rain falling on the elected areas and the expected quantities, in addition to the 95% estimates of the confidence interval limits for the range of values Forecast averages for the investigated time series and estimates of average amounts of rain for the forecast water years.

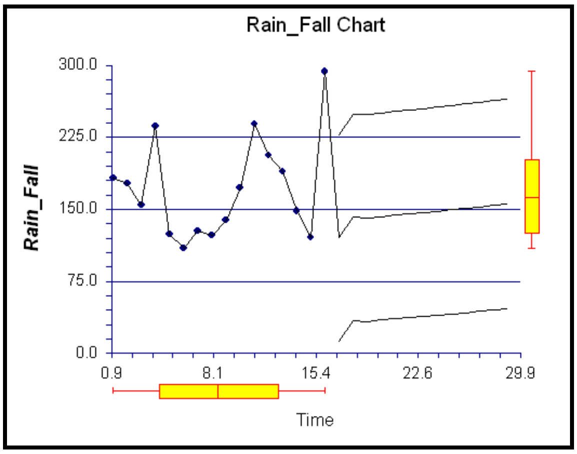
Table (15) *estimates of the average amounts of rain for the time series investigated and its estimates for the coming years and an estimate of the 95% confidence limit*

Forecast Section of Rain Fall on the selected area						
Item No.	Waters' Yrs.	Actual Data	Residual	Forecast	95% Confidence Interval	
					Lower Limit	Upper Limit
1	2003-2002	183.1	41.3	141.8	34.3	249.3
2	2004-2003	176.5	41.3	135.2	27.8	242.7
3	2005-2004	154.6	19.3	135.3	27.8	242.7
4	2006-2005	236.2	97.9	138.3	30.8	245.7
5	2007-2006	124.6	-0.4	125.0	17.5	232.4
6	2008-2007	109.0	-30.5	139.5	32.0	246.9
7	2009-2008	127.7	-16.7	144.5	37.0	251.9
8	2010-2009	123.3	-21.5	144.7	37.3	252.2
9	2011-2010	139.2	-8.8	148.0	40.5	255.5
10	2012-2011	172.8	24.6	148.2	40.8	255.7
11	2013-2012	239.1	94.6	144.6	37.1	252.0
12	2014-2013	206.3	73.0	133.3	25.8	240.7
13	2015-2014	189.6	54.9	134.7	27.3	242.2
14	2016-2015	148.3	13.1	135.2	27.8	242.7
15	2017-2016	120.8	-20.0	140.9	33.4	248.3
16	2018-2017	293.3	146.6	146.7	39.3	254.2
17	2019-2018	M	-	120.2	12.7	227.6
18	2020-2019			141.9	34.4	249.4
19	2021-2020			140.9	33.2	248.5
20	2022-2021			142.5	34.8	250.3
21	2023-2022			143.9	36.0	251.8
22	2024-2023			145.3	37.3	253.4
23	2025-2024			146.7	38.5	254.9
24	2026-2025			148.2	39.8	256.5
25	2027-2026			149.6	41.1	258.1
26	2028-2027			151.1	42.5	259.7

27	2029-2028			152.6	43.8	261.4
28	2030-2029			154.1	45.1	263.0
29	2031-2030			155.6	46.5	264.7

Source: the researcher, based on computer output.

By reviewing the results of the average forecast quantities for the coming water years, it becomes clear, beyond any doubt, the case of the expected relative increase for the upcoming water years from (2018-2019) to (2030-2031), and the graph (10) illustrates the nature of the behavior of the average amounts of rain falling on the regions The elected water years for the investigated water years are in (mm) and the averages of the predicted quantities for the coming water years and the estimates of the confidence limits are 95%, where the general trend line indicates a relatively slight rise in the average amounts of rainfall for the elected areas for the predicted water years.c



It is clear from table (16) the results of the estimates of the total supply of surface water coming for the time series for the successive water years (2003 - 2019), in addition to the estimates of the upcoming water years predicted according to the optimal model ARMA (1, 2). The table also included a statement of the residual values Resulting from the differences between the observed quantities of surface water resources display and the expected quantities, in addition to the 95% confidence interval estimates of the extent of the prediction values for the investigated time series and estimates of the supply quantities on surface water coming for the predicted water years.

Table (16): *Estimates of the total supply of surface water coming for the time series investigated and their estimates for years and the 95% confidence interval*

predicting total surface water Supply						
Item No.	Waters' Yrs.	Actual Data	Residual	Forecast	95% Confidence Interval	
					Lower Limit	Upper Limit
1	2003-2002	71.2	6.1	65.1	22.9	107.3
2	2004-2003	60.4	-1.6	61.9	19.7	104.2
3	2005-2004	50.0	-4.9	54.9	12.6	97.1
4	2006-2005	59.5	8.2	51.3	9.0	93.5
5	2007-2006	53.5	-9.5	62.9	20.7	105.2
6	2008-2007	29.4	-17.2	46.5	4.3	88.8
7	2009-2008	26.4	-11.7	38.1	-4.2	80.3
8	2010-2009	44.4	2.9	41.5	-0.8	83.7
9	2011-2010	41.9	-12.1	54.0	11.8	96.2
10	2012-2011	43.4	3.7	39.7	-2.5	81.9

11	2013-2012	50.3	-3.0	53.3	11.1	95.6
12	2014-2013	31.6	-15.4	47.0	4.7	89.2
13	2015-2014	29.6	-5.0	34.6	-7.6	76.9
14	2016-2015	49.1	6.2	42.9	0.7	85.1
15	2017-2016	35.0	-17.8	52.8	10.5	95.0
16	2018-2017	27.5	-2.8	30.3	-11.9	72.6
17	2019-2018	85.7	43.0	42.7	0.4	84.9
18	2020-2019			85.6	43.4	127.8
19	2021-2020			48.3	6.0	90.6
20	2022-2021			48.0	5.6	90.4
21	2023-2022			47.7	5.2	90.2
22	2024-2023			47.4	4.9	90.0
23	2025-2024			47.2	4.5	89.8
24	2026-2025			46.9	4.2	89.6
25	2027-2026			46.6	3.8	89.4
26	2028-2027			46.3	3.4	89.2
27	2029-2028			46.0	3.1	89.0
28	2030-2029			45.8	2.7	88.8
29	2031-2030			45.5	2.4	88.6

Source: the researcher, based on computer output.

By reviewing the results of the total supply of surface water predicted for the coming water years, it becomes clear, beyond any doubt, the level of decline in these quantities of water for the coming water years from the year (2019-2020) until the year (2030-2031), and the graph (13) illustrates the nature of The behavior of the total supply of water quantities from surface water coming for the investigated water years (billion m 3 / year) and the predicted supply quantities for the coming water years and the 95% confidence bound estimates, where the general trend line indicates a decline in the quantities of water supplied from surface water coming for the predicted water years .

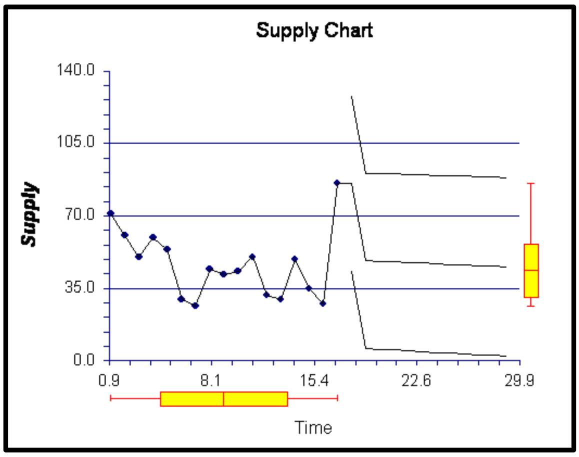


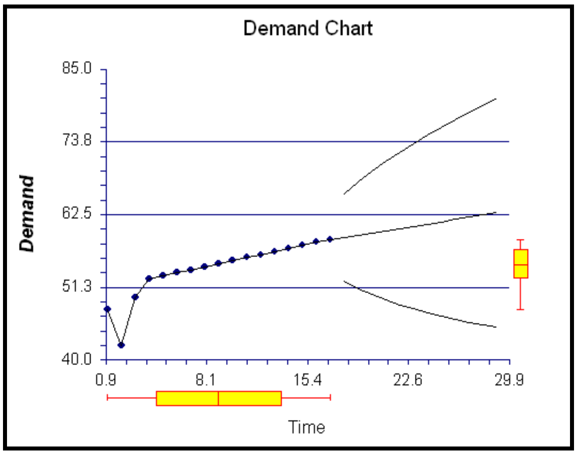
Table (17) presents the results of the estimates of the quantities of total demand for surface water coming for the time series of successive water years, in addition to the estimates of the quantities of total demand for surface water coming for the upcoming water years, which are forecast for the water years from (2019-2020) to (2030-2031).) According to the optimal model ARMA (1, 0), the table also included a statement of the residual values resulting from the differences between the total demand quantities observed for surface water coming and the expected demand quantities, in addition to the estimates of the 95% confidence interval for the extent of the forecast values for the investigated time series and estimates of demand quantities. aggregate on the predicted surface water coming.

Table (17): *Estimates of the total demand for surface water coming for the time series investigated and its estimates for the coming years for the period from (2003 - 2019) to the year (2030 - 2031), with a confidence limit of 95%*

predicting the quantities of demand for surface water coming						
Item No.	Waters' Yrs.	Actual Data	Residual	Forecast	95% Confidence Interval	
					Lower Limit	Upper Limit
1	2003-2002	47.8	-0.5	48.3	41.6	55.1
2	2004-2003	42.3	-5.8	48.1	41.3	54.8
3	2005-2004	49.7	7.2	42.5	35.8	49.2
4	2006-2005	52.6	2.6	50.0	43.3	56.7
5	2007-2006	53.0	0.2	52.8	46.1	59.6
6	2008-2007	53.5	0.2	53.3	46.6	60.1
7	2009-2008	54.0	0.2	53.8	47.1	60.5
8	2010-2009	54.4	0.2	54.3	47.5	61.0
9	2011-2010	54.9	0.2	54.7	48.0	61.5
10	2012-2011	55.4	0.2	55.2	48.5	62.0
11	2013-2012	55.9	0.2	55.7	49.0	62.4
12	2014-2013	56.3	0.2	56.2	49.4	62.9
13	2015-2014	56.8	0.2	56.6	49.9	63.4
14	2016-2015	57.3	0.2	57.1	50.4	63.9
15	2017-2016	57.8	0.1	57.6	50.9	64.3
16	2018-2017	58.2	0.2	58.1	51.3	64.8
17	2019-2018	58.7	0.1	58.6	51.8	65.3
18	2020-2019			59.0	52.3	65.8
19	2021-2020			59.4	51.1	67.6
20	2022-2021			59.7	50.1	69.3
21	2023-2022			60.0	49.3	70.8
22	2024-2023			60.4	48.6	72.2
23	2025-2024			60.7	47.9	73.5
24	2026-2025			61.0	47.3	74.8
25	2027-2026			61.4	46.8	76.0
26	2028-2027			61.7	46.3	77.1
27	2029-2028			62.1	45.9	78.3
28	2030-2029			62.4	45.5	79.4
29	2031-2030			62.8	45.1	80.5

Source: the researcher, based on computer output.

By reviewing the results of the predicted quantities for the coming water years, it becomes clear, beyond any doubt, the case of the significant increase in the demand for surface water coming expected for the coming water years from the year (2019-2020) until the year (2030-2031), and the graph (14) illustrates the nature of the behavior of The quantities of demand for surface water for the investigated water years (billion m3/year), the predicted quantities for the coming water years, and the 95% confidence bound estimates, where the general trend line indicates an increase in the total surface water demand for the forecast water years.c



predicting the future to estimate the levels of deficit or surplus of surface water:

After obtaining the results of forecast estimates for the total supply of surface water resources at (billion m3 / year), represented by displaying the quantities of surface water for river resources in general and adding the estimated quantities of groundwater after subtracting the quantities of losses from water bodies for the forecast period for the coming water years of the year (2019 - 2020) and up to the year (2030-2031), as well as obtaining the results of forecast estimates of the total demand for surface water at (billion m 3 / year), represented by its uses of surface water for purposes: (agricultural - irrigation, livestock, industrial sector, municipalities and the environment), with the aim of showing the level of deficit Or the surplus from those coming, the table (18) presents the total quantities of supply and demand for surface water for the next time series for the water years for the period from 2019-2020 until the year (2030-2031) and also presents the results of the surplus quantities and the expected deficit quantities of water resources surface for the coming water years.

Table (18) *predicting estimates of total surface water supply and demand for the next time series for the water years for the period from (2019-2020) to (2030-2031) deficit or surplus (billion m3 / year)*

In coming water years	**Prediction total View on surface water (billion m3 per year)**	**Prediction total surface water demand (Billion m3 / year)**	**deficit or surplus (billion m3 per year)**
2020-2019	85.6	59.0	26.6
2021-2020	48.3	59.4	-11.1
2022-2021	48.0	59.7	-11.7
2023-2022	47.7	60.0	-12.3
2024-2023	47.4	60.4	-13.0
2025-2024	47.2	60.7	-13.5
2026-2025	46.9	61.0	-14.1
2027-2026	46.6	61.4	-14.8
2028-2027	46.3	61.7	-15.4
2029-2028	46.0	62.1	-16.1
2030-2029	45.8	62.4	-16.6
2031-2030	45.5	62.8	-17.3

Source: Prepared by the researcher based on computer output

As it becomes clear that the only water year that recorded an excess of water supply over demand for it is the water year (2019-2020), due to the arrival of large torrents as a result of rainfall, which raised the level of the main rivers during the water year to about 91.35 billion m3, an increase from the general average to reach To 148%, as well as an increase in the quantities of water in the eastern rivers of the governorates of Diyala, Wasit, Maysan and Basra, which was the highest compared to previous years, as it exceeded 8 billion cubic meters, according to what was stated in the message of the Ministry of Water Resources / Al-Noor Center on February 26, 2020. On the other hand, the results of the deficit were recorded consecutively in the other years, forming a gradual rise to reach its highest level in the last water year of forecast (2030-2031)

And Chart (13) presents the results of the predicted values for the total quantities of supply and demand for surface water for the next time series for the water years for the period from 2019-2020 until the year (2030-2031).

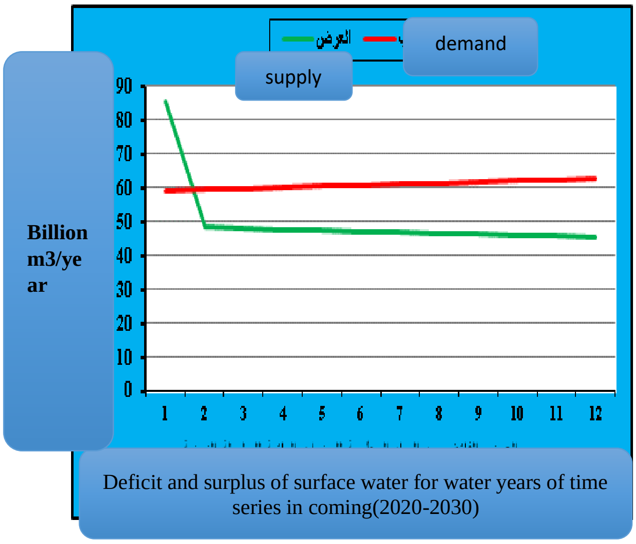


Figure (13) *predicting estimates of total surface water supply and demand for the next time series for the water years for the period from (2019-2020) to (2030-2031) deficit or surplus (billion m3 / year)*

Conclusion:

In light of the results of the current research through quantitative analysis of the time series that included the past three decades and successively represented by the water years' incoming from surface water, for the water of the main rivers (Tigris and Euphrates) and tributaries of the Tigris River, for the period (1990-1991) until The year (2018-2019) in order to obtain forecast estimates characterized by the characteristics of good estimates and for the upcoming water years from (2019-2020) until the year (2030-2031), the following was reached:

It has been shown that the proposed formula for estimating the indicator of the ratio of the total lengths of rivers extending inside Iraqi territory in general to the total area unit of Iraq compared to other Arab countries is a case of Iraqi distinction in progress over all those countries in light of that indicator, which reflects the importance of that formula in measurement and evaluation processes , especially when the main source of water resources are both international and national rivers (resources and estuaries).

The results of the predicted quantities for the in coming water years showed the significant decline in the expected water incoming of the Tigris River and its tributaries for the coming water years from (2019-2020) to (2030-2031), in addition to the index significance of the decrease in the predicted distribution of water quantities from water incoming. of the Tigris River and its tributaries during the coming water years, compared to the observed distribution of water quantities recorded for the water years for the period from (1990 - 1991) to (2018 – 2019).

Also, the results of the predicted quantities for the coming water years are the case of the significant decline in the expected water incoming of the Euphrates River for the coming water years from the year (2019-2020) until the year (2030-2031), in addition to the index significance of the decrease in the predicted distribution of water quantities from the water incoming of the Tigris River. and its tributaries during the coming water years compared to the observed distribution of water quantities recorded for the water years for the period from (1990 - 1991) to (2018 – 2019).

The results of the predicted quantities for the incoming water years also demonstrated the case of the significant decline in the water incoming expected in general for (Tigris River and its tributaries and the Euphrates River) for the in coming water years from (2019-20) until the year (2030-2031), in addition to the significance index of the predicted decline in distribution The quantities of water from water incoming in general during the incoming water years compared to the observed distribution of water quantities recorded for the water years for the period from (1990 - 1991) to (2018 – 2019)

It is noted through the correlation coefficients (coupling) of Kendall between the studied indicators related to the time series represented by (the water incoming of the Tigris River and its tributaries, the water incoming of the Euphrates River, and the water incoming in general) for the water years starting from the year (1990-1991) until the year (2018-2019).) The existence of causal association relationships between these indicators with each other and with a high significance at a level less than 0.01, which reflects the case of the symmetric behavior of the decline in the quantities of water incoming for these sources with the passage of the past three decades, which are the water years of the time series investigated.

The results of the correlation coefficients (coupling) of Kendall proved between the investigated indicators related to the time series represented by (the water incoming of the Tigris River and its tributaries, the water incoming of the Euphrates River, and the water incoming in general) for the water years starting from the year (1990-1991) until the year (2018-2019). On the one hand, and the per capita share of the water incoming of the Tigris and Euphrates rivers and the tributaries of the Tigris during the mentioned period on the other hand, there are causal relationships between these indicators with each other and with a high index significance at a level less than 0.01, which reflects the case of the similar behavior of the decline in the quantities of water incoming for those The sources with the obsolescence of the past three decades, which are the water years of the time series investigated by the decline in the per capita share of those incoming waters.

Reference

[1] Yassin, Bushra Ramadan, (2013), “Environmental Challenges for the Management of Surface Water Resources in Iraq”, Journal of the College of Basic Education / University of Babylon, No. 12, pp. 194-209.

[2] Duaij, Mona Ali, (2018), “A Hydrogeographical Analysis of Quantitative Water Resources Characteristics in Iraq”, Journal of Geographical Research, No. 27, Volume 2, pp. 205-224

[3] Kazem, Duha Jawad, (2016), “The Water Possibilities Available to Iraq (A Study in the Geography of Iraq), Journal of the College of Basic Education for Educational and Human Sciences / Babylon University, No. 30, pp. 672-683.

[4] Salem, Majid Saddam, (2015), “The Impact of Terrorism on Iraqi Water Security (Research in Political Geography)”, Maysan Research Journal, Vol. 11, No. 22, pp. 206-230.

[5] Robert J. Nordness, "Epidemiology and Biostatistics", Secret, MOSBY ELSEVIER, P.152, USA, 2006.

[6] Box G E P and Jenkins G M, "Time series predicting and control", San Francisco, Holdenday,1979.

[7] Towards Sustainable Water Management In Iraq, 30 August 2018, Publication Number: IEI 300818, Iraq Energy Institute.

[8] Nurit Kliot, 1994, Routledge. Water Resources and Conflict in the Middle East; John Kolars, William Mitchell, 1991. The Euphrates River and the South Eastern Anatolia Development Project; Dogan Altinbilek, Water Resources Development, vol. 20, no. 1, pp. 15-33, March 2004. Development and Management of the Euphrates-Tigris Basin.

[9] Nurit Kliot, 1994, Routledge. Water Resources and Conflict in the Middle East; John Kolars,

[10] William Mitchell, 1991. The Euphrates River and the South Eastern Anatolia Development Project; Dogan Altinbilek, Water Resources Development, vol. 20, no. 1, pp. 15-33, March 2004. Development and Management of the Euphrates-Tigris Basin.

[11] Convention on the Law of the Non-navigational Uses of International Watercourses in 1997, Adopted by the General Assembly of the United Nations on 21 May 1997. Entered into force on 17 August 2014. See General Assembly resolution 51/229, annex, Official Records of the General Assembly, Fifty-first Session, Supplement No. 49 (A/51/49), Copyright © United Nations 2014.

[12] Al-Shukry, Abdul-Azim Abdul-Wahed, and Al-Shallal, Muhannad Aziz (2012), “The water gap in Iraq for the period (1980-2005) and its future expectations until 2030, an analytical study using economic measurement methods”, Al-Qadisiyah Journal of Administrative and Economic Sciences, Volume 14, No. 4, page 197.