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A Subject Review: Solutions to the Problems of Iraqi Environment Using Statistical Methods

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Abstract

This research reviews most the tools, and statistical methods that were used in the field of the environment that pertain to the Iraqi reality and contributed to improving the environmental reality and solving its problems for all environmental aspects in a way that serves strategic environmental planning to protect the environment of Iraq and make it more livable in a way that helps decision-makers to provide the appropriate action for the environment more prosperous and advanced ways using Linear regression model, Weighted Least Squares , time series models , multivariate analysis , factor analysis, spatial statistical analysis and neural networks .

1. Introduction

The environment in ancient times was free of problems because of the dependence of primitive man on hunting and picking fruits and eating them without cooking and wearing leaves of trees and wearing wood and living in caves that the sun enters widely, and after the emergence of agriculture led to more settlements and then began to agricultural tools to appear such as the plow tied to the bull and the wheel, and then the arts of architecture developed led to the emergence of villages that include home dwellings consisting of a stone wall with a roof of Straw, fireplace and stove In the Iron Age, a huge production of steel tools and tools of war appeared, hence we note that the effects of the human race on the environment have gradually increased since the Stone Age when man tried to generate fire, causing bad effects on the environment and the accompanying Iron Age of minor accumulations of polluting materials to the environment, and with the progress of humanity, human waste became polluting water sources and rivers, and with the production of minerals, air pollution increased, and after the increase in population growth and its concentration within cities. This created cavities for pollution and the associated transmission of diseases and infections from untreated human waste. Air pollution arose directly from burning wood, and after the emergence of several diseases, the official recognition of environmental pollution began, and with the increase in population growth and the

emergence of the industrial revolution, air pollution increased and became a problem in some industrial cities, the result of which was the construction of a sewage network, and since then with the establishment of large numbers of factories and the consumption of large quantities of coal and others caused unprecedented pollution, all of this led to an attempt to control pollution.

2. Natural and human sources of pollution in Iraq

The accumulation of natural, human and industrial pollutants led to the emergence of problems represented by climate change, desertification, the problem of population increase and human waste, as well as the use of internationally prohibited weapons, which caused the environment to suffer from several pollutants that affected public health and the environment. To diagnose the most important problems of the Iraqi environment, they are:

1. The increase in pollutants on the environment resulting from industrial activities, the development of means of transportation and open burning operations directly contributed to the exacerbation of the problem of climate change, desertification and environmental deterioration in Iraq, which it led to environmental, social and economic consequences, whether in the health sector, biodiversity, and agricultural sector or water resources to affect the environment.
2. The weakness of environmental awareness in Iraq and the weakness of procedures that reduce pollutants of all kinds, including commercial, industrial, medical and agricultural, has led to the deterioration of the environmental and service reality.
3. The increase in population and urban expansion and the accompanying pressure on public utilities and overburdening them beyond their capacity, followed by pressure on the environment in the form of discharge of semi-treated or untreated sewage, the accumulation of garbage and solid waste led to an increase in burdens on the environment and led to pollution of rivers and pollution of the environment and soil, which cause of increasing environmental problems.
4. The deterioration of the environmental system in Iraq, including water, air, and soil, was due to wars, conflicts, and the use of internationally prohibited weapons, which left a clear health and environmental impact that directly contributed to the pollution of the Iraqi environment, causing a number of diseases.
5. The use of internationally prohibited weapons has left serious environmental effects and the accumulation of various toxic wastes that threaten environmental security, as well as its impact on the Iraqi people and the emergence of several unspeakable diseases [11].

3. Statistical methods

3.1. Linear regression model :

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + u_i \quad , \qquad i = 1,2,\ldots,n \qquad (1)$$

$$\beta = (X'X)^{-1} X'Y$$

Weighted Least Squares

3.2. kriging Estimator

$$Z(x_\circ) = \sum_{i=1}^{n} \lambda_i z(x_i) \qquad (2)$$

The weights $\boldsymbol{\lambda_i}$ are estimated so that the Mean Squared Error (MSE) is as small as possible.

3.3. Autoregressive with Exogenous input model

The autoregressive model with exogenous inputs, which is denoted by ARX is considered one of the models that have wide applications in the field of environment. It is also called the dominant regression model, and the value of X in the model refers to the methodology of exogenous variable models.

$$\mathrm{Y(t)} = \frac{B(z)}{A(z)}\ u(t) + \frac{1}{A(Z)}\ a(t) \tag{3}$$

Where $A(z)$ and $B(z)$ are polynomials.

3.4. Time series models

- **ARMA Model**: **Autoregressive Integrated Moving Average Models**

$$Z_t = \phi_1 Z_{t-1} + \phi_2 Z_{t-2} + \cdots + \phi_p Z_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots - \theta_q a_{t-q}$$
$$a_t \sim IND(0, \sigma_a^2) \tag{4}$$

- **ARFIMA Model**

The time series is said to be fractionally integrated of order (d), where $(0 < d < 1)$

$$\phi(\mathrm{L})(1-\mathrm{L})^{\mathrm{d}}\mathrm{Z_t} = \theta(\mathrm{L})\mathrm{a_t} \quad \begin{cases} |\mathrm{d}| < {}^1\!/_2 \\ \mathrm{a_t\ i.i.d} \sim \mathrm{N}(0, \sigma_{\mathrm{a}}^2) \end{cases} \tag{5}$$

L: Backshift operator.

$\phi(\mathrm{L})$: is a AR polynomial of (p) and the roots outside unit circle.

$\theta(\mathrm{L})$: is a MA polynomial of (q) and the roots outside unit circle.

$\mathrm{a_t}$: is a white noise processes.

3.5. Multivariate analysis

- **Factor Analysis**

A Method to take a mass of observation and shrink it to a smaller data group that is more controllable and more comprehensible. It is a way to find hidden patterns, show how those patterns overlap and show what features are realized in several patterns. It is also used to sort a set of variables used for parallel items in the set. It can be present a very suitable instrument for difficult sets of data involving psychological revisions, socioeconomic position and other involved ideas.

- **Principal Component Analysis (PCA)**

This kind of analysis be able to recognize the greatest significant parameters that distinguish all datasets and generating factors. The factors that take >1 variance are included only because every component must clarify the difference other than any single component .

3.6. Spatial statistical analysis

Is one of the essential statistical techniques in the playing field of study of geographical variables to obtain the finest scheme of representation and explanation of spatial statistical variables. Amongst the statistical approaches used in this arena are the calculation of the correlation coefficient, analysis of elementary compounds and cluster analysis. Multivariate statistical procedures allow for the division and classification of broad aggregates of data from environmental observing programs to decrease data dimensions and abstract information that will be restricted to estimate the quality and organization of surface water.

3.7. Neural Networks

It consists of Supervised Learning and Unsupervised Learning, Prediction of ANN consists of (data collection , data preparation for prediction, Network architecture determination)

4. Literature review

There are many qualitative and quantitative research conducted by various researchers

Year	The author	The Objectives	Region	The statistical methods	Conclusions
2007	Esmaeel and Mosa[14]	The total estimate of lead dust present in the city of Mosul	Mosul	spatial statistics using Kriging Estimator	The best methods, especially when the data is staggered and normally distributed
2011	Abdulhussain and Al-Sarraf[2]	identify the dust storm phenomenon and to study the probabilistic distribution that it represents, which is the distribution of the Kemble outlier. In addition, the adoption of simulation in reaching the best estimates for the location and measurement parameters for the distribution of the Kemble extreme value of the maximum values, and the adoption of the MSE comparison criterion for comparison between the estimation methods. The maximum frequency of dust storms	Baghdad	The Gumbel distribution of the maximum values. Comparison of six methods for estimating its parameters and the adoption of the statistical measure Mean square error MSE for comparison	It was found that the Jackknife method (JM) is the best at estimating the parameters of the outlier value.
2015	Abudal-Rahman and Jasem[1]	estimate the parameter of fractional differences (d) and three ways and using real data from the Ministry of Environment, which includes rates of air pollution in the city of Baghdad polychlorinated nitrogen dioxide (NO2) and ozone material (O3)	Baghdad	ARFIMA (p, d, q)	1- The best model is (smoothed periodogram regression) to estimate the parameter of fractional differences (d) 2- It was found that ozone (O3) and nitrogen dioxide (NO2) have a long memory characteristic in their data, and this is a serious indicator of the long-term impact of these two substances and their negative impact on the environment.
2015	Ayad and Estabraq [11]	1- Determining the causes and solutions to the environmental problems of the Tigris River in Wasit Governorate. 2- To analyze the local river environment based on the foundations of determining the local river environment, with a focus on the most important factors affecting the river environment represented by studying the chemical and biological characteristics of the river water. 3- Conducting a spatial analysis of the river environment using statistical analysis techniques.	Wasit	Correlation coefficient, analysis of principal components and cluster analysis	1- The existence of a strong correlation between the elements that can form chemical compounds in the water, or that the presence of one of them is affected by the presence of the other, especially by the inverse correlation relationship. 2- The results of the Principal Components Analysis (PCA) showed its efficiency in the spatial statistical analysis. The concentrations of the different elements were reduced by representing the factor loading of the first eight compounds, with a cumulative representation of the number of elements and variables included, which amounted to 86.1% for the months of February. 3- As for the results of cluster analysis, they also proved their efficiency in spatial analysis in this study, by classifying water samples

					according to locations and degrees of concentrations of elements and components in them into 4 groups in February and according to their similarity in chemical composition.
2015	Hamood and Ali[17]	Estimate the number of times the phenomenon of suspended dust occurs in Iraq and the influencing geographical factors	Iraq	Multi-level model (partial pooling model) - The partial pooling model - Full Maximum likelihood FML - partial pooling models (fixed and random)	The results show that the direct affect for the both degrees maximum temperature and the Rising Duston the Suspended Dust, where humidity was on a direct affect (so increases the average monthly humidity will cause fewer occurrences of Suspended Dustin the same time the results show also the significant effect of geographical areas, and when the comparison between the three estimated models show that the Varying intercept -Varying slope Model is the better model .
2016	Al-Muhyi[3]	A study of the effect of time (days, months, seasons and years) on the salinity change in Shatt Al-Arab water	Shatt Al-Arab	Person correlation coefficient.	The conclusion of the study was that the time factor represented by days, months, seasons and years did not have an effective and clear effect on the difference in salinity concentration rates in the Shatt al-Arab River. The reason is due to the hydrology and the dynamics of the waters of the Shatt al-Arab River, which is under the influence of the tidal force and the force of the discharge of the water source supplied to the Shatt al-Arab River. which in turn mixes marine water with fresh water coming from the source, in addition to other environmental and climatic factors.
2016	Mohammed and Al.doori [25]	Calculating the quantities of future solid wastes in Baghdad Governorate; through time series model as a statistical tool, and to find out the best forecasting model that can be used to process existing data.	Baghdad	non- seasonal model of Box and Jerkins	The best model is ARIMA (1,0,0) model, to forecast the quantities of solid wastes in Baghdad. On the other hand, the second aspect focused on the economic revenues that can be achieved by calculating the annual quantities of CH generated from recycled waste in landfills. It was concluded that methane can be produced in huge quantities in line with the quantities of solid waste.
2016	AL-mohana and Fakhri[6]	Prediction of (30) values of the daily maximum temperature depending on the daily wind speed.in Baghdad	Baghdad	(ARMAX) model	The best model is ARIMAX (4,3,4,1) model, to predict the values of the daily maximum temperature depending on the daily wind speed

2017	Mohammed and Reda[23]	Finding the method by which solid medical waste is treated in some of the Medical City hospitals in Baghdad, and through which international standards are applied when treating waste.	Medical City complex in Baghdad	The comparative study method was used, and statistical analyzes were used, including testing the difference between ratios, the difference between two ratios, and variance analysis for one criterion, as well as frequency and ratios for the items of the questionnaire.	There are 22 statistically significant differences between the four hospitals (the research sample), meaning that they are in violation of the quantities of medical waste that were disposed of during the years 2011-2016.
2017	Juma and Rasool [22]	To predict The future values by using the deferent models for the period from 4/2015 1 to 30/4/2015 of the turbidity scale for drinking water	Baghdad Al-Karkh	ARMAX models	The best model are ARX(5,4,1), ARMAX(1,2,1,1)
2017	Issa and Fad'am[20]	Estimate the conditional logistic regression model for the purpose of analyzing environmental pollution resulting from oil refinery in refineries as a function of oil production and environmental factors,	Iraq	-the conditional logistic regression model -the Generalized Estimating Equation (GEE) method - Maximum Likelihood Estimator MLE	It has been proven that by using the conditional logistic regression model is robust evaluation method for environmental studies
2018	Alsoltany and Alnaqash [9]	Measurements the concentrations of airborne stuck which represents the response variable.	Bagdad	the method of estimation fuzzy linear regression parameters	There is an increase in the concentrations of suspended particles in the air above the levels specified by the World Health Organization, and this means an increase in air pollution, which leads to the presence of risks to public health
2018	Ali, O. A. and Kadhim, K. J. [7]	Estimation of the Effect of Wastewater Pollution	of Tigris River/ Wasit Governorate	Weighted Least Squares	the Effect of Wastewater Pollution

2019	Ismail and Abdulkhaliq [19]	Estimate water quality index using data obtained from 22 camps in six districts in Duhok city for 6 months from March to August for 2018	Duhok	-The algorithms of artificial intelligence -Nonlinear prediction -Application of Adaptive Neuro Fuzzy Inference System (ANFIS) for modeling the estimation of water quality index.	The model has the strength to predict the water quality index (WQI) for Duhok camps with acceptable accuracy, and it dose useful and good for estimate WQI.
2019	Salwan et al. [26]	Evaluate 25 important factors affecting water quality during years 2017-2018.	The Tigris River	multivariate analysis - discriminant analysis - multiple linear regression analysis (MLRA)	The discriminant analysis reduced the data about the pollution sources` inputs and gives the significant factores (T, BOD5, EC, Mg, DO, Tur, Na, and COD) which discriminate between the moderate and hot seasons during the year.
2020	Aswad, et al. [10]	Investigating and analysis trends of average monthly and annual rainfall for Sinjar district. for the years 1940-2010	Sinjar	Linear regression Mann-Kendall test trend analysis Sen's slope estimator Time series	The annual trend analysis confirms a decreasing trend, while the analysis of the monthly precipitation trend in Sinjar region had a varied trend in the rainy months, as well as the results showed an upward trend for October and April and a downward trend for the rest of the months.
2020	Chabuk et al. [12]	Evaluate water quality of the Tigris River by applying the water quality index method and GIS software.	The Tigris River	The weighted arithmetic method was used to compute the water quality index (WQI)	The results showed that the regression prediction for all parameters gave the accepted values of the coefficient of determination (R^2). Moreover, the water quality of the Tigris River downstream of the Tigris River has deteriorated, especially at Al-Azizia in the wet and dry seasons, and the deterioration has clearly increased in Al-Qurna (Basra Governorate) in southern Iraq.

2020	Hamza and Alwan [18]	to Predicting of the Amount of Solid Waste for Baghdad Governorate From 2008 - 2018	Baghdad	Box and Jenkins methodology	he best predictive model for this data was reached, which is the ARIMA model (1,0,0)
2020	Ali, O. A. and Abbas M. A. [6]	Estimate Segmented Regression Model for the Bed load Transport of Tigris River with Change Point of Water Discharge Amount	Tigris River - Baghdad City	Proposing Robust IRWS Technique to Estimate Segmented Regression Model .	the Bed load Transport of Tigris River with Change Point of Water Discharge Amount
2021	Jabbar and Mohammed[21]	Forecasting of air pollution with NO2 gas in Baghdad using the time series for the period 2015-2017 at a weekly rate of 157 observations.	Baghdad	Use of the Box & Jenkins method, Auto Regressive Integrated Moving Average (ARIMA).	1- The time series of the variables is stationary. 2- The appropriate model for the NO2 data is ARIMA (1.0.0).
2021	Al-Sahlani and Al-Yaseri[4]	Analysis of the urban environment of the city of Shatrah, southern Iraq	Shatrah, southern Iraq	adopting the method of factor analysis and prediction models	A variable (the urban style) was chosen to predict the environmental quality of life in the city of Shatrah
2022	Hamdan and Hameed [16]	Studying the factors that cause an increase in environmental drought in Iraq for the period 1990-2020In the city of Amarah- Maysan, southern Iraq,	Iraq	Simple linear regression Correlation coefficients	1- There is a strong correlation between the values of the dryness coefficient and the amounts of precipitation, temperatures and relative humidity recorded at the Amarah station. 2- The highest value of the drought coefficient calculated according to the Demarton equation was (9.16) during the month of January. 3 - The lowest value of the drought coefficient calculated according to the Demarton equation was (33.2) during the month of May. 0 4- There is a variation in the type of humid climate according to the Demarton equation during the months of January, March, November and December. 5- There is a discrepancy in the type of climate according to the Demarton equation between the semi-arid climate during each of the months (February, April) and the dry climate during the months of May and October
2023	Mohammed and Dhaidan [24]	Prediction of Well Logs Data and Estimation of Petrophysical Parameters of Formation, Nasiriya Field[22]	Nasiriya Field	Artificial Neural Network (ANN)	The ANN gives a valid accuracy and data fitting in clean and non-heterogeneous formations compared with higher heterogeneity that contain more than one type of lithology.

5. Conclusions

1. The statistical models performance an important implement for observing environmental systems.
2. Through all the reference reviews, it can be noted that the statistical tools that were used to find solutions to the problems of the Iraqi environment were 70% of them around the Factor Analysis, which includes the Principal Components Analysis (PCA)
3. The years 2015, 2016, 2017, 2020 was the years that dealt the most with Iraqi environmental research, which used statistical methods as a tool to solve its problems.
4. Baghdad was the most environmentally researched city.
5. There are no studies in the research literature dealing with floods or sea level.

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استعمال الأساليب الإحصائية في حل مشكلات البيئة العراقية

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المستخلص

يستعرض هذه البحث اغلب الأدوات والطرائق والأساليب الإحصائية التي استعملت في مجال البيئة التي تخص الواقع العراقي وساهمت في تحسين الواقع البيئي وحل مشكلاته لكافة الجوانب البيئية بما يخدم التخطيط البيئي الاستراتيجي لحماية بيئة العراق وجعلها ملائمة للعيش أكثر على نحو يساعد أصحاب القرار بتقديم الاجراء المناسب من اجل بيئة أكثر ازدهارا وتقدما من الأساليب الإحصائية الانحدار الخطي والمربعات الصغرى الموزونة والتحليل العاملي وأدوات السلاسل الزمنية والشبكات العصبية الاصطناعية والأسلوب الضبابي وغيرها

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