

Energy Consumption and Environmental Degradation in Iraq: The Role of Renewables, Electricity, Fossil Fuels, and Natural Resources

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The present research explores the impact of various factors, including electrical energy consumption, fossil fuel energy, renewable energy consumption, and natural resource sufficiency, on environmental degradation in Iraq, using data from the World Development Indicator database from 2000 to 2021. The study utilizes the Fully Modified Ordinary Least Squares (FMOLS) method to analyze the relationship among variables and diagnostic testing for heteroskedasticity and serial correlation. The results show that electrical energy consumption positively and significantly impacts environmental degradation, while natural resource sufficiency negatively influences environmental degradation. Moreover, the study examines the moderating effect of natural resource sufficiency, revealing its significant influence on the linkage between renewable energy consumption and environmental degradation. However, no significant moderating effect is observed for electrical and fossil fuel energy consumption. The research sheds light on the importance of energy consumption and natural resources when addressing environmental issues.

Keywords: Environmental degradation, Fossil fuel, Renewable energy consumption, Natural resources, Electrical energy, Iraq

1. Introduction

According to global reports, Iraq has been termed as the fifth major country sensitive to climate issues and environmental degradation (IOM, 2022). In recent years, the climate-related challenges faced by the country pushed it to the edge of utmost failure. Rapid urbanization in the wake of industrialization demands more sustainable choices and resources to execute sustainable energy

projects. According to Al-Yasiri (2021b), post-2003 environmental pollution in Iraq is a serious concern as it impacts the physical and social resources. The consideration for sustainable measures is the prerequisite for sustainable energy consumption in that region. It is also revealed that energy waste and depletion are becoming a significant threat to sustainable energy growth and development (Al-Yasiri, 2021a). Through surveys and studies, it has occurred that the rapid population and

urbanization in Iraq led to increased economic and social activities. With the increase in such activities, energy consumption is becoming manifold (Akadiri et al., 2019). The inefficiency and unavailability of sustainable

resources led the production centers to choose feasible and economical energy alternatives. However, the government took significant sustainable initiatives/ practical action and medium-term measures to boost the Iraq energy sector.

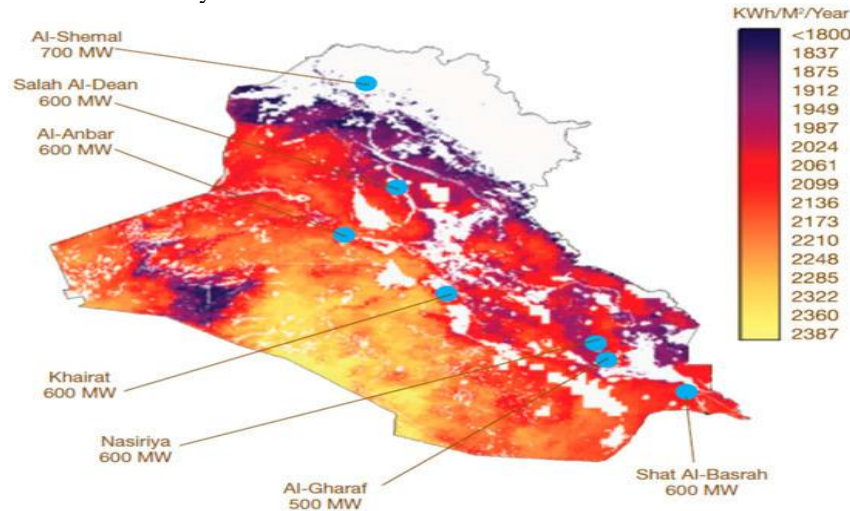


Figure 1. Suggested fossil fuel power plants, according to the Ministry of Electricity
Source: (Al-Kayiem & Mohammad, 2019)

To combat the environmental challenges, aptitude towards renewable, electrical, and fossil fuel energy get support from the ecological actors and policymakers. With the growth and performance of different industrial sectors, the debate shifted towards the challenges and opportunities of these resources in the long term. The past literature on sustainable energy consumption highlights the major limitations and benefits of adopting renewable energy methods. The study by Semenova, Al-Dirawi, and Al-Saadi (2022) highlighted the environmental challenges from the perspective of fragile economies in the Middle East. Resource management and the adoption of environmental/sustainable technologies are one of the major limitations in fragile economic states. In such a context, Iraq faces hurdles in ensuring sustainable tools' availability. Moreover, the optimal utilization of natural resources is also one of the strategic factors in deciding the success of sustainable energy source adoption. Tafieeq, Hayder, and Ali (2022) emphasized that considering environmental quality is essential by minimizing energy consumption or adopting sustainable alternatives. The potential of biomass to maximize the bioenergy yield and curb environmental issues is one of the most debatable topics in Iraq (Alhassany et al., 2022). The distribution, accessibility, and availability of resources are the turning point in sustainable energy consumption.

To develop long-term sustainable energy plans, it is important to understand the limitations and opportunities these methods provide. The past literature covered the sustainability energy issues and environmental degradation, but none of the studies considered multiple renewable resources at once in relation to the climate cause. In such context, the researcher identified the research gap and filled it by examining the role of renewable energy resources, electrical, and fossil fuel energy consumption on environmental degradation. Besides the researcher also analyzes the moderating role of

natural resource sufficiency. The quantitative research method is adopted to examine the relationship between selected factors. By contributing to the previous research stream, the present study will hold significant value for environmental policymakers and experts. Moreover, the study's findings will assist energy experts in assessing the limitations and opportunities available for a better climate cause. The paper proceeds in an organized manner. The introduction section is followed by an extensive review of the previous literature studies. Next, the methodological choices of the research will be explained and justified. The results will be analyzed and discussed. Based on the findings, a conclusion will be drawn along with future indications and recommendations.

2. Literature Review

2.1 Theoretical Framework

There are different theories present in the literature providing a theoretical base for the concepts of energy, its consumption, and its effect on the environment, like climate theory, the theory of energy efficiency (Mahlia, Masjuki, & Choudhury, 2002), the energy consumption modeling (Dietmair & Verl, 2008), and the most popular EKC hypothesis (Saqib et al., 2022). This study has approached the most applied foundation EKC for its conceptual base. The EKC hypothesis was first developed by (Kuznets, 1955, 2019), it was the first assertion regarding the connection between carbon dioxide emission and its determinants, and based on this idea, Kuznets developed the EKC hypothesis contending the negative influence of Co₂ emission on the environmental growth. Despite its old theoretical conception, it still possesses significance in the 21st-century era, and several studies have used it in their work.

A study (Tenaw & Beyene, 2021) has investigated the drawbacks and issues in environmental sustainability based on the relationship of the EKC hypothesis and

concluded significant results. A systematic review (Mahmood et al., 2023) has argued about the EKC hypothesis's validity in China and revealed the significance of this hypothesis 4.46 times higher than its non-significance. Authors (Bibi & Jamil, 2021) have investigated the link between air pollution and economic growth based on the conception of the EKC hypothesis, and they provided the importance of this concept for testing the association of different environmental factors and their impact on its depletion.

2.2 Impact of energy resources on environmental degradation

Environmental degradation has been defined as the presence or absence of naturally favorable resources that emulsify or retard the natural socio-economic development process, and the main issues that come under environmental degradation were mentioned as degradation of land, dropping rate of biodiversity, resource reduction, and poor public health (Ray & Ray, 2011). Several studies have targeted energy resource consumption on environmental degradation and have provided their contributions to the literature.

Naradda Gamage, Hewa Kuruppuge, and Haq (2017) investigated the role of energy resource consumption and tourism development in the prevention of environmental degradation, and they manifested in their discussion to find ways to create and adopt renewable energy resources for the mitigation of Co2 emissions with the increase in tourism and for the depletion of their natural environment. A renewable energy source has been examined to check whether it has a controlled effect on environmental degradation, and it has been called a safe, cheap, and clean energy source that has a negative association with increasing environmental degradation (Ozcan, Tzeremes, & Tzeremes, 2020). Electricity is an ancient source of energy, and it also comes at some cost. For this confirmation, a recent study (Rahman, 2020) has investigated electricity consumption, economic growth, and globalization for the emission of Co2 in most electricity-consuming countries, and it has revealed the significant influence of electricity consumption on Co2 emission in these countries.

Studies have encountered the interconnection of energy consumption, economic growth, and environmental degradation, and the combined pattern working of economic growth and energy consumption have emerged and stated a good approach for the prevention of environmental degradation (Ozcan, Tzeremes, & Tzeremes, 2020). The leading cause of the increase in environmental degradation has been noticed in the use of non-renewable energy sources that return nothing to the environment; a recent study studied the influence of energy resources consumption on Co2 emission (Khan, Khan, & Rehan, 2020) and based on their results they have raised the concept to use environment-friendly renewable energy resources to save the environment from further damage and depletion. In literature, the environmental Kuznets curve [EKC] approach has been widely applied in the conception of environmental degradation, and a recent study has investigated the economic complexity, globalization, and

renewable and non-renewable energy both on the environment degradation as Co2 emission, and they highlighted the positive significance of renewable energy resources on the prevention of Co2 emission, and indirect support for the environmental safety (Pata, 2021).

There is another safe source of energy that is energy by fossil fuels, and for the importance of this energy source, a very recent study has targeted the second-highest carbon-emitting country to focus on making policies and projects for the implementation of non-fossil fuel-based and renewable energy resources for the reduction in the rate of environmental degradation (Kartal et al., 2022). Another study has highlighted the importance of fossil fuel energy and has investigated its decreasing effect on environmental degradation reduction in SAARCE countries (Rani et al., 2022). In their findings, they discussed the increasing correlation between fossil fuel energy and environmental degradation and called the policymakers to make strategies for reducing environmental pollution and depletion. The literature has highlighted the status of non-renewable resources and the significance of renewable resources, providing the researcher with enough knowledge to develop the following hypothesis for testing within Iraq:

H1: Energy sources have a significant favorable influence on environmental degradation.

2.3. The moderating role of natural source efficacy

The natural sources' efficacy and efficiency have been investigated in several past studies. A report has addressed the urgency of the policies and considerable steps for the increase in the natural resources to balance the current destruction caused by the mass human population and their degrading activities (Ekins et al., 2016). The expansion in the human volume has depleted natural resources at alarming rates, and measurements were required to prevent the world from entering an irreversible hazardous situation.

In India, the ports have been used as the primary source of transportation, and it has been observed that port activities have been damaging the water environment by disposing of waste material and toxins in water and have compared the successive rate of some of the implemented preventive measures against pollution (Sharma & Das, 2020). The rate of investment for the ecological abundance have been analyzed with the current natural resources, foreign investment, and human capital, and it has been narrated the positive role of natural resources and human capital for the increase and prevalence of ecological footprint (Zafar et al., 2019).

A recent study has investigated the relationship between the natural resources' abundance and environmental degradation by controlling economic growth (Ahmed et al., 2020), and they have found fruitful and prospective influences for decreasing environmental degradation and have the promotive ability for the ecological footprint and the development of natural resources. Another study (Ahmed et al., 2020) has investigated the ecological footprint with the factors of natural resources, economic growth, and technology; the finding of the analysis revealed that all natural resources, technological

innovation, and economic growth have significant correlations in the long run. According to these recent studies, natural resources have been called a key base for improving the environment and abundance of ecology. Different countries have investigated their natural resources, and every country has encountered the need to increase the ecological sources and the lack of policies and awareness for the environment-friendly energy sources and to raise the human capital for the abundance of natural resources, and the same has been stated in a study conducted in Japan (Adebayo & Kirikkaleli, 2021). In developing countries like Iraq, the concept of environment management accounting has been examined in the Iraqi

industries to analyze companies' decisions about preserving natural resources and the environment (Falih Chichan & Alabdullah, 2021). This recent study has reflected that there is no awareness of environmental degradation and the value of natural resources in Iraq, reflecting a considerable gap in the literature about the neglect of researchers and practitioners for the safety of natural resources. The following hypothesis has been designed to estimate the level of awareness about natural resources exactly:

H2: *Natural resource efficiency have a moderating role in the relationship between energy resources and environmental degradation.*

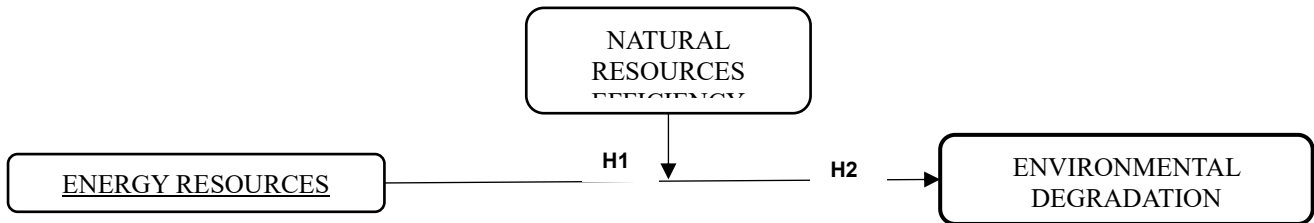


Figure 2: The empirical model for hypothesis testing.

3. Methods

3.1. Research Design

The present research has adopted a “secondary quantitative research design” to study the relationship among variables. There are multiple benefits of this method as it enhances the probability of the result’s accuracy to a great extent. Data collected from reputable and authentic sources increases the result’s quality and increase the level of authenticity. The present research has been conducted to study environmental degradation through renewable, fossil fuel energy and electrical energy consumption. For this purpose, the role of natural resource sufficiency has also been studied.

3.2. Data Collection

The present research has targeted the “world development indicator” to get the data regarding variables of this study,

such as environmental degradation, renewable, fossil fuel energy, electrical energy consumption and natural resource sufficiency. According to (Harris, Schiantarelli, & Siregar, 2000; Swanson, 2006), the world development indicator is a database of the global economic conditions across six different dimensions, including people, states, environment, economy, markets and global linkages etc. Therefore, high-quality and globally comparable statistics are present on WDI, due to which researchers prefer to assess the issues and concepts of global development through this source. In the present research, data regarding these variables in Iraq has been collected from 2000-2021.

3.3. Variables Description

The Description of variables, along with their abbreviation, status in the study and sources from where data regarding these variables have been collected, is presented below:

Table 1: Variables Description

Variables	Status of Variables	Description	Source
Environmental degradation	Dependent Variable	Environmental degradation is the deterioration of the environment through resource depletion such as water, soil and air; the damage to the ecosystem and the extinction of wildlife are the result of environmental degradation (Howard, 1991)	WDI
Renewable Energy Consumption	Independent variable	Renewable energy consumption can be defined as the energy consumption of energy from renewable means, including wind, soil, hydro, marine, biogas, waste and liquid biofuels etc. (Sadorsky, 2009).	WDI
Fossil Fuel Energy	FFE	Fossil fuel energy includes natural gas, oil and coal which are non-renewable resources which are formed when animals and plants are dead and are buried by rock layers gradually (Martins, Felgueiras, & Smitková, 2018).	WDI
Electric energy consumption	EEC	The quantity of electrical energy that has been consumed in a specific time period is called electric energy consumption (Nizami & Al-Gami, 1995).	WDI
Natural Resource sufficiency	NRS	The sufficient amount or the existence of natural resources in a nation adequately is the natural resource sufficient (Aage, 1984).	WDI

3.4. Econometric model

The present research has applied a series of different tests to conduct the data analysis. In the first step, the test for descriptive statistics has been performed to

assess the characteristics of data, the minimum, maximum and mean values, along with the values of Jarque-Bera probability to assess the data normality. In the second step researcher performed a unit root test leading to the FMOLS test, and in the last section, tests

for serial correlation along with heteroscedasticity have also been performed.

3.4.1. Group Unit root test

A unit root test examines whether a time series variable is non-stationary, and this can be done through the auto-regressive model. This test has been applied in the present research and holds greater significance as it investigates whether a time series variable entails a unit root. The null hypothesis is usually defined as the existence of a unit root, and the substitute hypothesis is “stationary, trend stationary or explosive root”, depending on the test being conducted (Choi, 2001). In the present research unit root test has been performed in two phases. Firstly the researcher tested the lag length selection based on 0 to 1, whereas in the second phase, the researcher selected an automatic lag length from 0 to 3.

$$\Delta y_{i,t} = a_i + \rho y_{i,t} - 1 + \sum_{j=1}^{pi} a_j \Delta y_{i,t-j} + \varepsilon_{i,t}$$

3.4.2. Fully modified ordinary least square FMOLS

In the second step, the researcher aimed to analyze the association among variables as the researcher has studied the impact of environmental degradation in Iraq on renewable, fossil fuel energy, electrical energy consumption and natural resource sufficiency. For this purpose, FMOLS has been applied by the researcher. According to Bashier and Siam (2014), the fully modified ordinary least square method is adopted to develop new techniques for assessing the “co-integrating coefficients”.

FMOLS takes into consideration the nuisance parameters and the auto-correlations, and the phenomenon of heteroscedasticity of the residuals.

$$\beta_{NT}^* - \beta = \left(\sum_{t=1}^N L_{22t}^{-2} \sum_{t=1}^T (\chi_{nt} - \bar{\chi}_U)^2 \right) \sum_{t=1}^N L_{11t}^{-1} L_{22t}^{-1} \left(\sum_{t=1}^T (\chi_{at} - \bar{\chi}_t) \mu_{it}^* - T \hat{\gamma}_t \right)$$

Where,

$$\begin{aligned} \mu_t^* &= \mu_t - \frac{\hat{L}_{21t}}{\hat{L}_{tt2}} \Delta \chi_t, \hat{\gamma}_t \\ &= \hat{\Gamma}_{21t} \hat{\Omega}_{21t}^0 - \frac{\hat{L}_{21t}}{\hat{L}_{tt2}} (\hat{\Gamma}_{22t} + \hat{\Omega}_{22t}^0) \end{aligned}$$

4. RESULTS

Table 2 presents the descriptive statistics for all variables analyzed in this study. The majority of the variables in the study have normal distributions. The kurtosis coefficients for all variables are greater than 1, indicating leptokurtic distributions. Furthermore, the high coefficient of Jarque-Bera (JB) and the probability value of JB statistics for ED indicate the rejection of the null hypothesis of normal distribution. Therefore, ED has non-normal distribution. However, EPC has a p-value greater than 0.05, indicating normal distribution. Similarly, the small JB coefficients of FFE, REC and TNR confirm that the series is normally distributed. In conclusion, the skewness, kurtosis, and Jarque-Bera statistics collectively indicate that all variables, except ED and the interacting term TNR*REC, in this study do follow a normal distribution.

Table 2: Descriptive Summary of the Variables

	ED	EPC	FFE	REC	TNR	TNRXEPC	TNRXFFE	TNRXREC
Mean	3.341865	718.8942	66.84078	1.026818	47.52372	36914.62	3467.057	50.89668
Median	3.509095	878.9786	97.33914	1.020000	46.91325	51264.24	4590.693	36.73004
Maximum	4.347264	1334.177	99.72154	2.560000	65.31850	73557.90	6430.431	163.1410
Minimum	0.000000	0.000000	0.000000	0.000000	27.41701	0.000000	0.000000	0.000000
Std. Dev.	0.865040	528.1732	46.74670	0.687600	9.669061	27092.34	2502.734	43.29428
Skewness	-2.671041	-0.502960	-0.779169	0.710974	0.129086	-0.508507	-0.577987	1.488108
Kurtosis	11.30609	1.545362	1.609331	2.863712	2.806687	1.564547	1.615941	4.518485
Jarque-Bera	89.40150	2.867196	3.998845	1.870466	0.095354	2.836939	2.980906	10.23336
Probability	0.000000	0.238449	0.135413	0.392494	0.953442	0.242084	0.225271	0.005996
Sum	73.52102	15815.67	1470.497	22.59000	1045.522	812121.6	76275.26	1119.727
Sum Sq. Dev.	15.71418	5858306.	45890.34	9.928677	1963.306	1.54E+10	1.32E+08	39362.29
Observations	22	22	22	22	22	22	22	22

Table 3 presents the results of unit root tests for panel data conducted at both the level and in the first difference. Determining the stationarity of variables is crucial when analyzing time series data, and the study utilized various tests, including Levin-Lin-Chu (LLC) test, Im-Pesaran-Shin (IPS) test, Fisher-ADF test, and Fisher-PP test. The null hypothesis of these tests assumes that all series are non-stationary, which implies that the series has a unit root, while the alternative hypothesis suggests that all

series are stationary. The acceptance or rejection of the null hypothesis depends on the probabilities and statistics obtained from the tests relative to a 10% threshold level. At the level, it was found that the variables are non-stationary based on insignificant probabilities, indicating the presence of a unit root. Nonetheless, at the first difference, all variables were found to be stationary, providing evidence that the null hypothesis cannot be accepted.

Table 3: Unit Root Test

Method	At Level		At first difference	
	Statistic	Prob.**	Statistic	Prob.**
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	0.28838	0.6135	-8.62114	0.0000
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.00079	0.5003	-6.32504	0.0000
ADF - Fisher Chi-square	14.3175	0.5751	77.3916	0.0000
PP - Fisher Chi-square	11.3517	0.7873	81.5255	0.0000

The study employed FMOLS to capture the effect of the explanatory variables, electrical energy consumption (EPC), fossil fuel energy (FFE), renewable energy consumption (REC), and natural resource sufficiency (TNR), on environmental degradation (ED). The past value of ED, at t-1, has a negative impact on ED in Iraq. However, with a p-value of 0.74, the association is regarded as insignificant. Secondly, EPC is revealed to have a positive impact on ED in Iraq and with a p-value of 0.08, the relationship between EPC and ED is significant at a 10% significant level. The third result shown in Table 4 is the association between FFE and ED.

FFE negatively affects ED; nevertheless, with a p-value greater than 0.1, the impact is not significant. REC also has a negative influence on ED. With a p-value of 0.9962, the relationship between REC and ED is not significant. Lastly, the study analyzed the role of natural resources in predicting ED in Iraq. TNR negatively impacts ED, as shown in the table below, and the result is significant at a 10% significance level. At t-1, the lagged value of TNR positively influences ED. With a p-value below 0.05, TNR significantly influences ED at a 5% significance level. The R-squared value is 0.32, indicating that the independent variables account for 32.7% of the movement in ED.

Table 4: FMOLS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ED(-1)	-0.237431	0.700898	-0.338752	0.7402
EPC	0.003261	0.001718	1.898542	0.0800
FFE	-0.041266	0.023512	-1.755118	0.1028
REC	-0.001778	0.364262	-0.004880	0.9962
TNR	-0.049540	0.026314	-1.882639	0.0823
TNR(-1)	0.086924	0.037287	2.331200	0.0365
C	2.734174	2.967431	0.921394	0.3736
R-squared	0.326595	Mean dependent var		3.306309
Adjusted R-squared	0.015792	S.D. dependent var		0.900210
S.E. of regression	0.893074	Sum squared resid		10.36855
Long-run variance	0.537786			

Table 5: Moderation Analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ED(-1)	0.212168	0.613990	0.345556	0.7368
EPC	0.012593	0.009004	1.398712	0.1921
FFE	-0.135000	0.096005	-1.406178	0.1900
REC	3.875453	1.725728	2.245691	0.0485
TNR	0.062603	0.060209	1.039759	0.3229
TNR(-1)	0.075679	0.031464	2.405278	0.0370
TNRXEPC	-0.000204	0.000171	-1.195469	0.2595
TNRXFFE	0.001958	0.001789	1.095024	0.2992
TNRXREC	-0.071217	0.029984	-2.375168	0.0389
C	-3.776647	3.940835	-0.958337	0.3605
R-squared	0.447139	Mean dependent var		3.306309
Adjusted R-squared	-0.050436	S.D. dependent var		0.900210
S.E. of regression	0.922632	Sum squared resid		8.512507
Long-run variance	0.289929			

Subsequently, the study examined the moderating effect of TNR between energy consumption and ED. The outcomes are displayed in Table 5, presenting the results of long-run estimations with the inclusion of TNR as a moderator. The empirical findings showed that with the inclusion of moderating terms, the variables EPC does not maintain its level of significance. Additionally, there is a change in the sign of the coefficient and significance of REC. This change in sign and significance indicates that TNR plays a crucial role in influencing the impact of REC on ED. The presence of TNR is decreasing the positive association

between REC and ED. However, TNR does not significantly moderate the association between other forms of energy and ED. With the inclusion of the moderator, the R-squared value increased to 44.7%.

Diagnostic tests, such as Heteroskedasticity and serial correlation tests, are conducted to assess the reliability of the results obtained from the FMOLS model. These tests help ensure the validity and accuracy of the model's outcome. In the given models, no issues of autocorrelation were observed, as indicated by the acceptance of the null hypothesis in the "Breusch–Godfrey Serial Correlation LM Test" shown in Table 7. Additionally, the evaluation of heteroskedasticity using "Engle's ARCH test" in Table 8 revealed the absence of any heteroskedasticity problem.

Table 7: Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.590818	Prob. F(2,12)	0.5692
Obs*R-squared	1.882494	Prob. Chi-Square(2)	0.3901

Table 8: Heteroskedasticity Test: ARCH

F-statistic	0.036231	Prob. F(1,18)	0.8512
Obs*R-squared	0.040176	Prob. Chi-Square(1)	0.8411

5. DISCUSSION

The study considered the significance of different energy consumption methods on environmental degradation. Due to the rising concerns about environmental threats and climate issues, energy consumption behaviors have been criticized worldwide. In the Middle East, the global bodies, i.e., the UN, actively supported Sustainable development goals and responsible production and consumption. Despite the measures taken by Iraq's government, sustainable energy measures are unsatisfactory in this region. The researcher, therefore, analyzed the role of renewable, electrical, and fossil fuel energy consumption on environmental degradation. The researcher has applied FMOLS to analyze the association between variables.

The assessment of co-integrating coefficients presents the association between variables by including natural resource sufficiency as a factor. The results indicate the negative role of natural resource sufficiency in determining the environmental degradation in Iraq. It is consistent with the previous studies, i.e., Zaidi et al. (2019) highlighted that the natural resource abundance reflects the country's self-sufficiency and strengthens the motive to enhance sustainable practices within different sectors. The abundance of natural resources leads to positive financial development. The boost in economic performance thus stabilizes production activities and makes them more sustainable, resulting in less environmental degradation. It is also confirmed by Litvinenko and Sergeev (2019), who associated natural resource management with sustainable innovations. The link between the two thus determines the outcomes of environmental measures and observation. Ahmad et al. (2020) identified a strong relationship between natural resources, human capital, consumption behavior, and a sustainable environment. It is revealed that natural resource sufficiency is significant, but the natural resource rent is negatively associated with the ecological footprint. In such case, the economic growth

and unsustainable utilization of natural resources contribute to the environmental degradation.

The researcher also examines the moderating impact of natural resource sufficiency associated with renewable energy, fossil fuel, and electrical energy consumption. The results indicate a significant role of renewable energy consumption in relationship with environmental degradation in the presence of energy sufficiency as moderating variable. The results are consistent with the findings of previous research studies. [Usman, Alola, and Sarkodie \(2020\)](#) identified a dynamic role of renewable energy in environmental sustainability. By providing empirical evidence, it is confirmed that renewable energy consumption, along with economic growth, slowdown environmental degradation and lowers the ecological footprint. The results also identified a strong moderating effect of energy resource efficiency between renewable energy consumption and environmental degradation. The strong nexus between these factors is examined by [Sharif et al. \(2020\)](#), who identified a negative association between renewable energy consumption and environmental degradation in countries like Japan, the USA, and South Korea, but the results are contrary in the context of India, Russia, Indonesia. It implies that the regional energy consumption behavior determines the relationship between two. Apart from the renewable energy consumption, energy resource sufficiency have no moderating effect between the environmental degradation and other energy consumption patterns.

5.1 Conclusion

Environmental degradation has become one of the most debatable topics in global sustainable practices. The sustainable development goals directed the energy consumption behavior towards the prevalence of sustainable aptitude for longer. Besides the growing awareness of sustainable energy consumption, the governments in the Middle East took collective measures to ensure sustainable energy projects. The efforts in the form of measures, actions, and policies significantly reduce the environmental impacts of energy consumption. With the contemporary trend of sustainable energy in Iraq, the researcher considered the impact of renewable, electrical, and fossil fuel energy. The quantitative research method was adopted, and the data from 2000-2021 was collected from the World Development Indicator. The researcher utilized Fully Modified Ordinary Latest Squares to analyze the relationship between selected variables. The results indicate that electrical energy consumption has a significant positive impact on environmental degradation. It implies that electrical energy consumption has certain setbacks, which keeps its utility restricted to certain areas. On industrial and larger agricultural levels, the adoption of such measures has severe ecological footprints. The results also indicate that natural resource sufficiency negatively influences environmental degradation. The moderating results of the study showed that natural resource sufficiency significantly influences the relationship between renewable energy consumption and environmental degradation. While on the other hand, no significant moderation is observed between electrical and

fossil fuel energy consumption and environmental degradation.

5.2 Research Implications

The present study contributes significant knowledge to the contemporary research debate on environmental degradation and sustainability issues. On the basis of their findings, the study is valuable on both theoretical and practical grounds. Theoretically, the study will be significant in establishing a strong theoretical base for the understanding of these factors. The researchers can utilize this data to address the research problem in multiple contexts. By identifying and covering the research gaps, the study holds significance in the current research debate on environmental values and sustainable energy consumption.

Practically, the findings will be valuable to the relevant stakeholders, i.e., the energy sector's policymakers, energy analysts, environmental experts, and lawmakers. The data provided in this study will be helpful to the energy sectors in analyzing the variance between energy resource choice and its impact on overall sustainable performance. For the environmentalist, the study holds significance as it provides the limitations and opportunities of each energy consumption method in relation to environmental degradation. The individual analysis and impact of each method were made by the researcher, which provides an in-depth look into consumption behaviors and responsible environmental changes.

5.3 Limitations and Recommendations

Despite covering multiple issues related to environmental degradation, the present study has certain limitations. The methodological choices of the researcher restrict the findings of the research study. The quantitative approach has been utilized, and the data was obtained from secondary sources. The findings extracted on the base of secondary data have certain setbacks which limit the scope of the study. As environmental degradation and energy consumption are becoming a problem of each working sector, the qualitative analysis of the issues from the relevant bodies, i.e., energy and resource management authorities and environmentalist experts, can provide a broader outlook on the issues.

Regarding the research problem, the regional focus was on Iraq. As the issue is examined in the context of Iraq, the findings are harder to apply in any other country context. To expand the scope of the study, it is therefore recommended that future researchers analyze these issues in the context of countries having similar economic and agro backgrounds. The analysis this way would be more significant in understanding the regional connectivity of the Middle East in respect of environmental stability and sustainability. Lastly, the energy methods which are taken into consideration include renewable energy, fossil fuel, and electrical energy. For the last few years, solar energy methods have been supported by the government, which provides an opportunity for researchers to analyze the association between solar energy production and environmental degradation in the context of Iraq.

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