



PLANNING MALAYSIA:

Journal of the Malaysian Institute of Planners

VOLUME 23 ISSUE 2 (2025), Page 100 – 114

INVESTIGATING THE IMPACT OF LONG AND SHORT-TERM NATURAL RESOURCE RENTS ON ECOLOGICAL FOOTPRINTS: EVIDENCE FROM INDONESIA

Zahria Zurrah¹, Suriani Suriani², Muhammad Abrar³ and Jumadil Saputra^{4,5,6}

^{1,2,3,5}Faculty of Economics and Business

UNIVERSITAS SYIAH KUALA, BANDA ACEH, INDONESIA

⁴Faculty of Business, Economics and Social Development

UNIVERSITI MALAYSIA TERENGGANU, TERENGGANU, MALAYSIA

⁶Faculty of Business and Social Sciences

UNIVERSITAS DIAN NUSANTARA, DAERAH KHUSUS IBUKOTA JAKARTA,
INDONESIA

Abstract

This study examines the relationship between economic growth and environmental sustainability in Indonesia, focusing on the validity of the Environmental Kuznets Curve (EKC) hypothesis and the impact of various factors on a country's ecological footprint. Although extensive research has explored the connection between carbon emissions and economic growth, the specific roles of economic growth, mineral rent, forest rent, and human capital in determining the ecological footprint in Indonesia remain understudied. This study aimed to investigate two primary aspects. First, it examines the EKC hypothesis in Indonesia using a cubic representation of economic growth, which offers a more nuanced understanding of the relationship between environmental degradation and economic expansion than the traditional inverted U-shaped EKC curve. Second, it analyses the long-term and short-term effects of mineral rent, forest rent, and human capital on the ecological footprint using an Autoregressive Distributed Lag (ARDL) model. Data for the study variables were collected from Indonesia for the period 1991Q1-2021Q4. The ARDL findings revealed that human capital and forest rent contribute to improving Indonesia's ecological footprint. Conversely, mineral rents demonstrate the potential for reducing environmental impacts over time. The results indicate an N-shaped Environmental Kuznets Curve, illustrating the relationship between the ecological footprint and economic growth. This research has significant policy implications for Indonesian decision makers, emphasising the need for efficient transformation of non-renewable resources into a sustainable, eco-friendly environment. Additionally, this study highlights the importance of continuously enhancing environmental awareness and implementing educational reforms to achieve long-term sustainability benefits.

Keywords: Ecological footprint, Environmental Kuznets curve, Mineral rent, Forest rent, Human capital.

² Corresponding author. Email: suriani@usk.ac.id

INTRODUCTION

Indonesia has adopted the Sustainable Development Goals (SDGs) framework, aiming for achievement by 2030, making sustainable development crucial. This concept balances socio-economic growth and environmental preservation, though economic priorities often overshadow environmental concerns, leading to increased production, consumption, and environmental degradation (Shahbaz et al., 2019). The Environmental Kuznets Curve (EKC) theory, first proposed by Grossman & Krueger (1991), suggests an inverted U-shaped relationship between economic growth and environmental quality. Initially, economic expansion worsens environmental conditions, but over time, technological advancements and awareness reduce ecological strain (Aytun et al., 2024).

Many studies explore environmental quality determinants, often using CO₂ emissions as a pollution measure (Adebayo, 2020; Idroes et al., 2024). Others analyse sulfur dioxide (SO₂) (Sinha & Bhattacharya, 2017) and nitrogen dioxide (NO₂) (Alola et al., 2023). This study utilises the ecological footprint, a comprehensive measure of environmental impact, to validate the EKC hypothesis. The ecological footprint assesses human demand for natural resources and is widely recognised in empirical research (Balsalobre-Lorente et al., 2024). Given its significance, numerous studies have examined its determinants (Bello et al., 2018; Ozcan et al., 2019; Ragmoun, 2023), reinforcing its role as a crucial indicator of environmental degradation.

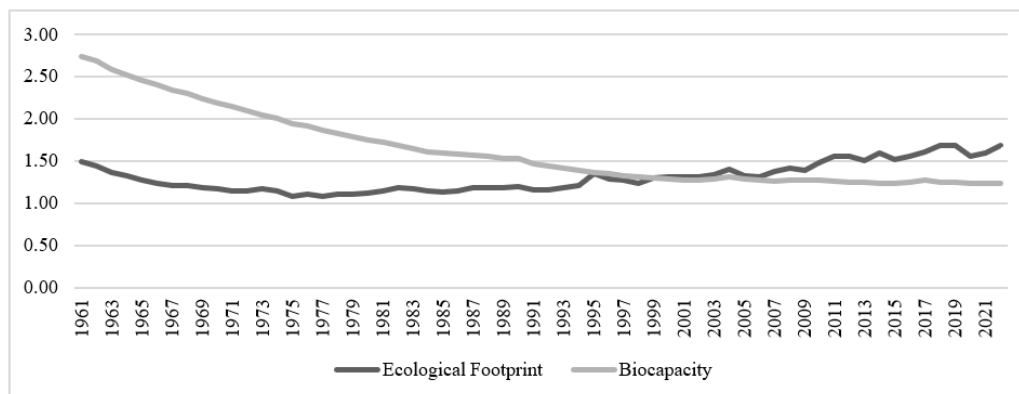


Figure 1: Ecological footprint in Indonesia (Global hectares per person). Source: Global Footprint Network

The ecological footprint reflects human dependence on natural resources to meet needs. These resources significantly contribute to Indonesia's economic growth. However, Indonesia faces an ecological deficit due to importing biocapacity, liquidating national ecological assets, or emitting more carbon dioxide than its ecosystems can absorb. Despite Law No. 32/2009

mandating sustainable economic growth, implementation remains challenging. Natural resource rents drive excessive resource use and production, expanding the ecological footprint. While resource rents provide short-term economic gains, they can hinder long-term growth and sustainability (Hoang et al., 2023; Tabash et al., 2022). Mineral and forest rents, key sustainability concepts, must balance resource extraction with environmental and social interests (Wang & Wang, 2024). Minerals are vital for construction, manufacturing, energy, and agriculture (Nassani et al., 2021), but depletion leads to economic instability and ecosystem degradation. Similarly, rising forest rents cause deforestation, biodiversity loss, and climate change (Usman et al., 2023; Suriani et al., 2023, 2024).

The impact of human capital on the environment remains debated. Traditional human capital theory (Danish et al., 2019) links it to skills, education, and productivity. Education fosters awareness of sustainable technologies and renewable energy, influencing behaviours that enhance energy efficiency and resource conservation (Bano et al., 2018; Zallé, 2019). Thus, human capital plays a crucial role in mitigating environmental degradation. This study advances prior research by analysing environmental degradation and economic growth from a unique perspective. First, it focuses on the ecological footprint, offering a broader measure of human reliance on natural resources beyond air pollution. A larger ecological footprint in developing countries like Indonesia often correlates with declining environmental quality. Second, it examines Indonesia's ecological footprint over the past 30 years regarding human capital, forest rent, and mineral rent. Third, Indonesia, a country with one of the world's highest ecological footprints (Global Footprint Network), is the focal point. Limited research has explored the simultaneous relationship between ecological footprint, natural resource rents, human capital, and economic growth in Indonesia.

Fourth, the study applies the Environmental Kuznets Curve (EKC) hypothesis, utilising cubic GDP terms to assess the ecological footprint-economic growth connection. On the basis of these aspects, the study addresses two key questions: (1) Does Indonesia's economic growth reduce environmental pollution? (2) Do natural resource rents (mineral and forest rents) and human capital mitigate or worsen Indonesia's environmental challenges? This research aims to contribute in two ways. First, it examines the Kuznets curve, using ecological footprint as the dependent variable. Second, it employs time-series data, which differs from conventional cross-section or panel data studies on the EKC hypothesis. Time-series analysis provides a deeper understanding of pollution trends across economic development stages. Third, it assesses the impact of mineral rent, forest rent, and human capital on environmental degradation, especially when natural resource dependence is high. By providing insights into these relationships, this study enhances the literature on

sustainability, economic growth, and environmental management in Indonesia, ultimately guiding policy decisions toward sustainable development.

RESEARCH METHODOLOGY

The study employs time series data from 1991Q1 to 2021Q4 in Indonesia, and the analysis period is related to the availability of mineral rent, forest rent, and human capital data. Ecological footprint data is collected from the Global Footprint Network. The World Development Indicator database provides economic development, forest rent, and mineral rent information. The Penn World Table, which calculates human capital using the human capital index, is the source of human capital data. Table 1 defines the variables used in the analysis.

Table 1: Description of Studied Variables

Variable(s)	Symbol(s)	Measurement(s)	Data Source(s)
Ecological Footprint	ECF	Ecological footprint (global hectares per capita)	Global Footprint Network
Economic Growth	GDP	GDP per capita (constant 2010 US dollars)	World Development Indicator
Mineral Rent	MRR	Mineral resource rent (percentage of GDP)	World Development Indicator
Forest Rent	FRR	Forest resource rent (percentage of GDP)	World Development Indicator
Human Capital	HC	Measured by human capital index	Penn World Tables

This study evaluates the validity of the EKC hypothesis and the relationship between ecological footprint, mineral rent, forest rent, and human capital in Indonesia from 1991Q1 to 2021Q4. Environmental impact is proxied by ecological footprint. Following Charfeddine & Mrabet (2017), some research variables were converted from logarithms to natural logarithms because of issues with normality. The following model investigated the relationship between ecological footprint and other variables.

$$ECF_t = \delta_0 + \delta_1 LGDP_t + \delta_2 LGDP_t^2 + \delta_3 LGDP_t^3 + \delta_4 MRR_t + \delta_5 FRR_t + \delta_6 HC_t + \varepsilon_t \quad (1)$$

Where ECF represents ecological footprint (per capita), GDP per capita or LGDP, is the natural logarithm of economic growth, $(LGDP)^2$ is square of the logarithm of economic growth, $(LGDP)^3$ is cubic of the logarithm of economic

growth, mineral rent (MRR) is expressed as a percentage, forest rent (FRR) as a percentage, and human capital (HC) as determined by the human capital index, which takes into account years of education and results from different educational levels. This study investigates the cubic growth of the economy as it aims to explore the more complex environmental Kuznets curve hypothesis. For this purpose, if the slope coefficient for economic growth is as follows ($\delta_1 > 0$; $\delta_2 < 0$; $\delta_3 > 0$), showing an N-shaped relationship consistent with the EKC hypothesis (Arshad Ansari et al., 2020).

Following Arshad Ansari et al. (2020), Cai & Magazzino (2019) and Sun et al. (2023), this study employs time series approaches in the form of unit root tests to examine integration ordering using the ADF test. The unit root indicates which technique is suitable for further empirical investigation (Huang et al., 2020). After examining the unit root qualities, cointegration analysis is undertaken to analyse long-term equilibrium relationships and estimate long- and short-run effects. The ARDL methodology needs stationary variables at I(0) or I(1), and the current research fits these criteria. We utilise the following model within the ARDL framework to study the relationships between variables.

$$\begin{aligned}
 \Delta ECF_t = & \beta_0 + \sum_{k=1}^{\rho} \beta_{1k} \Delta (ECF)_{t-k} + \sum_{k=0}^{\rho} \beta_{2k} \Delta (LGDP)_{t-k} \\
 & + \sum_{k=0}^{\rho} \beta_{3k} \Delta (LGDP)_{t-k}^2 + \sum_{k=0}^{\rho} \beta_{4k} \Delta (LGDP)_{t-k}^3 \\
 & + \sum_{k=0}^{\rho} \beta_{5k} \Delta (MRR)_{t-k} + \sum_{k=0}^{\rho} \beta_{6k} \Delta (FRR)_{t-k} \\
 & + \sum_{k=0}^{\rho} \beta_{7k} \Delta (HC)_{t-k} + \delta_1 (ECF)_{t-1} + \delta_2 (LGDP)_{t-1} \\
 & + \delta_3 (LGDP)_{t-1}^2 + \delta_4 (LGDP)_{t-1}^3 + \delta_5 (MRR)_{t-1} \\
 & + \delta_6 (FRR)_{t-1} + \delta_7 (HC)_{t-1} + \varepsilon_t
 \end{aligned} \tag{2}$$

The lag length is denoted by ρ in equation (2), the error term by ε_t and the first difference operator by Δ . The first section uses the symbol. The short-term relationship is articulated by the symbol (Σ) in the first portion, while the long-term relationship is stated in the second part by the coefficients δ_1 to δ_7 . In the following phase, we run various diagnostic tests to determine the likelihood of heteroskedasticity, normality, and serial correlation, as well as the commonly used CUSUM and CUSUMsq tests to ensure parameter stability.

RESULTS AND DISCUSSION

Table 2 presents descriptive statistics revealing that the average economic growth is significantly high at 6.408065, ranging from 5.950 to 6.900. This indicates a substantial impact of economic growth on Indonesia's ecological footprint throughout the analysis period. The ecological footprint (ECF), which indicates environmental damage, ranges from a minimum of 0.290 to 0.430. Mineral rent (MRR) and forest rent (FRR) increase from 0.030 and 0.100, respectively, to 0.690 and 0.510. Human capital (HC) increases from 0.480 to 0.610 from 1991Q1 to 2021Q4.

Table 2: Result of Descriptive Statistics

Statistics	ECF	LGDP	MRR	FRR	HC
Mean	0.351	6.408	0.212	0.189	0.559
Median	0.345	6.335	0.190	0.150	0.570
Minimum	0.290	5.950	0.030	0.100	0.480
Maximum	0.430	6.900	0.690	0.510	0.610
Std.Dev.	0.0378	0.288	0.150	0.088	0.036

The stationarity test results utilising the Augmented Dickey-Fuller (ADF) method are shown in Table 3. The time series variable FRR is integrated at the I(0) level, as shown by the unit root test results, while ECF, LGDP, LGDP², LGDP³, MRR, and HC are integrated at the I(1). These findings suggest that the time series variables have a varied order of integration. Given the heterogeneous order of integration in the time series data, employing the ARDL model in this investigation is appropriate.

Table 3: Result of Stationary Testing using Augmented Dickey-Fuller.

Variable	At Level		At First Difference	
	t-Statistic	Prob.	t-Statistic	Prob.
ECF	-3.3125*	0.0692	-	-
LGDP	-2.1371	0.5196	-3.5961**	0.0344
LGDP ²	-2.0087	0.5903	-3.6466**	0.0301
LGDP ³	-1.8859	0.6556	-3.7038**	0.0259
MRR	-1.8083	0.6947	-3.4787**	0.0465
FRR	-3.5548**	0.0383	-	-
HC	-0.2373	0.9915	-8.4541***	0.0000

Note: *, **, and *** are significance levels at 10 %, 5 %, and 1 % respectively.

The cointegration test findings in Table 4 demonstrate that the long-term link is obvious in the model. Since the F-statistic of the model is bigger than the crucial value at the 5% level, we cannot reject the presence of a long-term link. Therefore, we may proceed with estimating both the long-term and short-term associations.

Table 4: Result of Cointegration Analysis using ARDL Bounds Testing Approach

Model	Long-run result		
	Lower bound	Upper bound	Significance level
Fc (lgdp, lgdp ² , lgdp ³ , mrr, frr, hc)	2.53	3.59	10%
F = 7.152208	2.87	4	5%
	3.19	4.38	2.5%
	3.6	4.9	1%

The ARDL results in Table 5 indicate that economic growth, forest rent, and human capital drive environmental degradation, while mineral rent enhances environmental quality in the long run. Natural resource rents impact the environment differently based on resource type and extraction methods. In Indonesia, forest rent increases ecological footprints over time, as forest exploitation surpasses regeneration capacity. This aligns with Zhang & Zhang (2023), who found a negative environmental impact of natural resources in developing countries, particularly due to deforestation. However, Bilgili et al. (2023) argue that forest rent mitigates environmental harm in the MENA region, while mineral rent exacerbates it. Mineral rent negatively correlates with ecological footprints in the long run, suggesting that revenues from mineral resources can fund sustainable mining practices, thereby reducing environmental damage.

He et al. (2024b) describe mineral rent as a tax that ensures fair corporate contributions for resource extraction, minimising long-term harm. Kang et al. (2023) also found that mineral rent lowers ecological footprints in the U.S. because mining often occurs in isolated areas, reducing its environmental impact. Human capital increases Indonesia's short- and long-term ecological footprint, suggesting weak environmental education. This aligns with Nathaniel (2021), who found ASEAN's human capital lacks environmental conservation awareness, similar to Zia et al.'s (2021) findings in China. Danish et al. (2019) also link human capital to a higher ecological footprint in Pakistan due to limited environmental knowledge. However, Nathaniel (2021c) suggests that educated human capital fosters sustainability through efficient resource use, energy conservation, and green technology adoption. Sahoo & Sethi (2021) emphasise that populations with higher human capital indices are more environmentally conscious and take measures to protect the ecosystem.

Table 5: Result of ARDL Estimations

Variable(s)	Coefficient	Std. Error	t-Statistic	Prob.
Short-run results				
D(ECF(-1))	0.3943***	0.0845	4.6675	0.0000
D(ECF(-2))	0.1237	0.0878	1.4089	0.1631
D(ECF(-3))	0.2611***	0.0878	2.9732	0.0040
D(LGDP)	-33.1502	51.2526	-0.6468	0.5198
D(LGDP(-1))	-137.1707**	57.1292	-2.4011	0.0189
D(LGDP(-2))	-45.6964	59.0028	-0.7745	0.4411
D(LGDP(-3))	-197.0605***	52.8914	-3.7257	0.0004
D(LGDP2)	4.7334	7.8915	0.5998	0.5505
D(LGDP2(-1))	21.3795**	8.8089	2.4270	0.0177
D(LGDP2(-2))	7.142042	9.1054	0.7844	0.4354
D(LGDP2(-3))	30.6183***	8.1708	3.7473	0.0004
D(LGDP3)	-0.2209	0.4042	-0.5467	0.5862
D(LGDP3(-1))	-1.1079**	0.4518	-2.4522	0.0166
D(LGDP3(-2))	-0.3697	0.4674	-0.7909	0.4315
D(LGDP3(-3))	-1.5825***	0.4198	-3.7689	0.0003
D(LGDP3(-4))	-0.0001	0.0005	-0.2102	0.8341
D(LGDP3(-5))	0.0004	0.0005	0.8411	0.4030
D(LGDP3(-6))	0.0007	0.0005	1.3524	0.1804
D(LGDP3(-7))	-0.0011**	0.0004	-2.5949	0.0114
D(MRR)	0.0066	0.0151	0.4401	0.6612
D(MRR(-1))	0.0292*	0.0154	1.9006	0.0613
D(MRR(-2))	-0.0029	0.0144	-0.2057	0.8375
D(MRR(-3))	0.0319**	0.0139	2.2999	0.0243
D(MRR(-4))	0.0293**	0.0140	2.0902	0.0401
D(HC)	0.3879***	0.1338	2.8999	0.0049
D(HC(-1))	-0.7895***	0.1745	-4.5240	0.0000
D(HC(-2))	-0.6509***	0.1719	-3.7867	0.0003
D(HC(-3))	-0.5974***	0.1691	-3.5326	0.0007
D(HC(-4))	-0.6612***	0.1644	-4.0211	0.0001
D(HC(-5))	-0.4213***	0.1589	-2.6498	0.0099
D(HC(-6))	-0.1218	0.1525	-0.7986	0.4271
D(HC(-7))	-0.1812	0.1492	-1.2143	0.2285
D(HC(-8))	0.3110**	0.1417	2.1948	0.0314
CointEq(-1)*	-0.4928***	0.0669	-7.3607	0.0000
Long-run results				
LGDP	57.1883***	17.610	3.2474	0.0018
LGDP2	-9.4639***	2.7541	-3.4363	0.0010
LGDP3	0.5210***	0.1439	3.6209	0.0005
MRR	-0.0629***	0.0161	-3.9142	0.0002
FRR	0.1426***	0.0519	2.7473	0.0076
HC	1.9873***	0.3745	5.3057	0.0000

Variable(s)	Coefficient	Std. Error	t-Statistic	Prob.
Diagnostic Tests				
Jarque-Bera	0.113751[0.944712]			
LM test	0.5098			
Breusch-Pagan-				
Godfrey	0.6784			
Ramsey	0.7361			

Note: *, **, and *** are significance levels at 10 %, 5 %, and 1 %, respectively.

We further observe the presence of EKC for ecological footprint in Indonesia from the positive/negative coefficients of LGDP/LGDP2/LGDP3 in Table 5. The examination of results indicates an N-shaped correlation between economic growth and ecological footprint. The N-shaped EKC curve illustrates that ecological footprints undergo three phases: "increase, decrease, and increase" in response to economic expansion (Nugraha et al., 2024). In addition, Shahbaz & Sinha (2019) posit that when $\delta_2 > 0$, $\delta_3 < 0$, and $\delta_4 > 0$, the correlation between environmental degradation and economic growth exhibits an N-shaped curve (Figure 2).

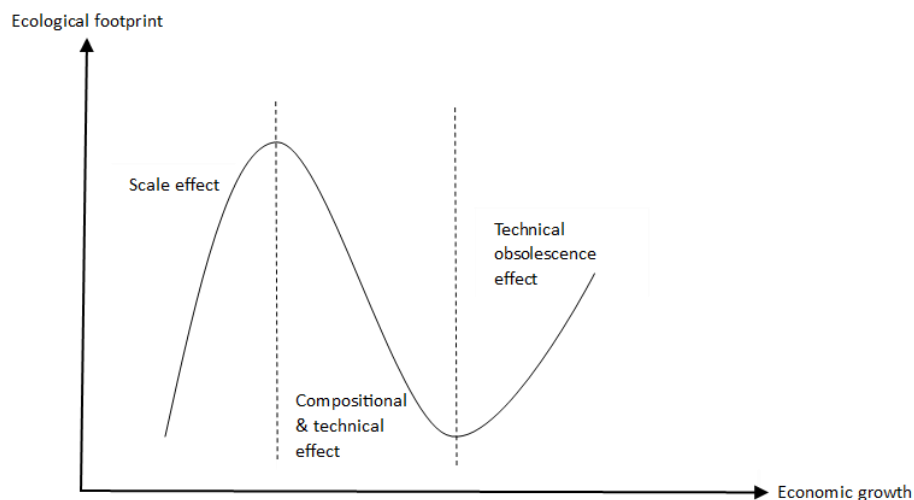


Figure 2: N-shaped relationship between GDP and environmental degradation

Source: Barış-Tüzemen et al., (2020) and Zhang (2021)

The study reveals a transition from scale effects to composition and technique effects through changes in energy consumption patterns. This contrasts with Rahman et al. (2024), who found that Indonesia rejects the Environmental Kuznets Curve (EKC) as air pollution rises with economic growth. However, Alam et al. (2016) observed that Indonesia follows the EKC for CO₂ emissions

in both the short and long term. The N-shaped EKC suggests that pollution may resurge at advanced economic stages if innovation lags behind economic growth (Álvarez-Herránz et al., 2017). This model indicates that pollution declines initially but rises again with further progress (Wang et al., 2024). Theoretical research suggests the N-shaped EKC emerges when environmental protection efforts and clean technologies slow down. Based on findings, the N-shaped EKC is supported, implying that pollution decreases alongside economic success in the second phase, albeit with a relatively low coefficient.

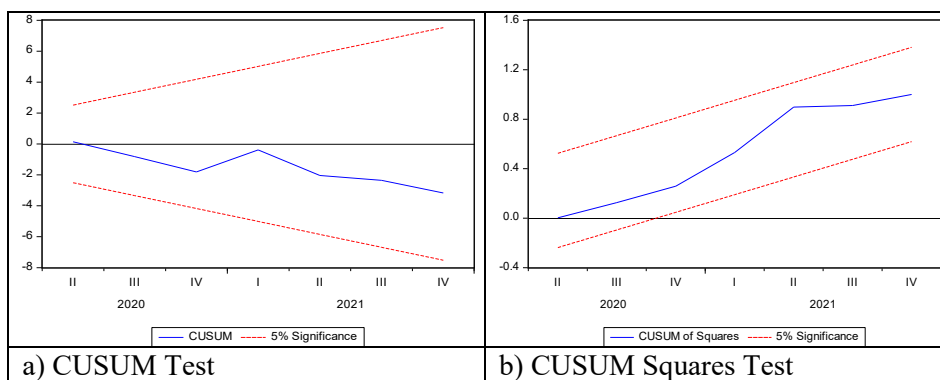


Figure 3: Result of CUSUM and CUSUM Squares Test

The findings of the diagnostic tests for normality, serial correlation, and heteroscedasticity, shown in Table 5, indicate that this research model is stable. Additionally, the CUSUM and CUSUM Squares plots in Figure 3 are within the required 5 percent boundaries, confirming model stability.

CONCLUSION

Indonesia must understand the Environmental Kuznets Curve (EKC) to address its ecological footprint. This study examines EKC validity and the effects of mineral rent, forest rent, and human capital on Indonesia's ecological footprint using the ARDL test. Findings indicate an N-shaped EKC, suggesting that environmental degradation may persist if green innovation fails to counterbalance economic expansion. Economic growth, forest rent, and human capital increase the ecological footprint, while mineral rent reduces it in the long run. These findings offer key policy insights. First, Indonesia must reduce reliance on forests and minerals by investing in research, development, and technology to enhance energy efficiency and sustainability. Second, resource exploitation, from extraction to production, contributes to environmental damage.

Imposing proportional taxes on mined resources can mitigate these effects. Third, the government should promote renewable energy while

discouraging environmentally harmful resource use. Raising public awareness and implementing stricter standards can support this transition. This study has limitations. It does not explore broader economic factors such as international trade and financial development. Additionally, it focuses on mineral and forest rent, excluding natural gas, coal, and oil rent. Future research should incorporate these variables for a more comprehensive analysis.

ACKNOWLEDGEMENTS

The authors would like to thank LPPM USK's support and Directorate General of Higher Education, Research, and Technology (DIKTI) Indonesia funding (Grant No. 094/E5/PG.02.00.PL/2024) through the PTM-DRTPM scheme.

REFERENCES

- Adebayo, T. S. (2020). Revisiting the EKC hypothesis in an emerging market: an application of ARDL-based bounds and wavelet coherence approaches. *SN Applied Sciences*, 2(12). <https://doi.org/10.1007/s42452-020-03705-y>
- Ahmed, Z., Asghar, M. M., Malik, M. N., & Nawaz, K. (2020). Moving towards a sustainable environment: The dynamic linkage between natural resources, human capital, urbanisation, economic growth, and ecological footprint in China. *Resources Policy*, 67, 101677. <https://doi.org/10.1016/j.resourpol.2020.101677>
- Alam, M. M., Murad, W., Noman, A. H. M., & Ozturk, I. (2019). Relationships among Carbon Emissions, Economic Growth, Energy Consumption and Population Growth: Testing Environmental Kuznets Curve Hypothesis for Brazil, China, India and Indonesia. <https://doi.org/10.31235/osf.io/8hq6z>
- Alola, A. A., Udemba, E. N., Iwuagwu, C., & Abdallah, I. (2023). Assessing the human development aspects of CO, PM2.5, PM10, NOX, and SO2 in the United States. *Heliyon*, 9(7), e18072. <https://doi.org/10.1016/j.heliyon.2023.e18072>
- Álvarez-Herránz, A., Balsalobre, D., Cantos, J. M., & Shahbaz, M. (2017). Energy Innovations-GHG Emissions Nexus: Fresh Empirical Evidence from OECD Countries. *Energy Policy*, 101, 90–100. <https://doi.org/10.1016/j.enpol.2016.11.030>
- Ansari, M. A., Haider, S., & Khan, N. A. (2020). Environmental Kuznets curve revisited: An analysis using ecological and material footprint. *Ecological Indicators*, 115, 106416. <https://doi.org/10.1016/j.ecolind.2020.106416>
- Aytun, C., Erdogan, S., Pata, U. K., & Cengiz, O. (2024). Associating environmental quality, human capital, financial development and technological innovation in 19 middle-income countries: A disaggregated ecological footprint approach. *Technology in Society*, 76, 102445. <https://doi.org/10.1016/j.techsoc.2023.102445>
- Balsalobre-Lorente, D., Nur, T., Topaloglu, E. E., & Evcimen, C. (2024). Assessing the impact of the economic complexity on the ecological footprint in G7 countries: Fresh evidence under human development and energy innovation processes. *Gondwana Research*, 127, 226–245. <https://doi.org/10.1016/j.gr.2023.03.017>

- Bano, S., Zhao, Y., Ahmad, A., Wang, S., & Liu, Y. (2018). Identifying the impacts of human capital on carbon emissions in Pakistan. *Journal of Cleaner Production*, 183, 1082–1092. <https://doi.org/10.1016/j.jclepro.2018.02.008>
- Barış-Tüzemen, Ö., Tüzemen, S., & Çelik, A. K. (2020). Does an N-shaped association exist between pollution and ICT in Turkey? ARDL and quantile regression approaches. *Environmental Science and Pollution Research*, 27(17), 20786–20799. <https://doi.org/10.1007/s11356-020-08513-w>
- Bello, M. O., Solarin, S. A., & Yen, Y. Y. (2018). The impact of electricity consumption on CO2 emission, carbon footprint, water footprint and ecological footprint: The role of hydropower in an emerging economy. *Journal of Environmental Management*, 219, 218–230. <https://doi.org/10.1016/j.jenvman.2018.04.101>
- Bilgili, F., Soykan, E., Dumrul, C., Awan, A., Önderol, S., & Khan, K. (2023). Disaggregating the impact of natural resource rents on environmental sustainability in the MENA region: A quantile regression analysis. *Resources Policy*, 85, 103825. <https://doi.org/10.1016/j.resourpol.2023.103825>
- Cai, Y., & Magazzino, C. (2019). Are shocks to natural gas consumption transitory or permanent? A more powerful panel unit root test on the G7 countries. *Natural Resources Forum*, 43(2), 111–120. <https://doi.org/10.1111/1477-8947.12169>
- Charfeddine, L., & Mrabet, Z. (2017). The impact of economic development and social-political factors on ecological footprint: A panel data analysis for 15 MENA countries. *Renewable and Sustainable Energy Reviews*, 76, 138–154. <https://doi.org/10.1016/j.rser.2017.03.031>
- Danish, Hassan, S. T., Baloch, M. A., Mahmood, N., & Zhang, J. (2019). Linking economic growth and ecological footprint through human capital and biocapacity. *Sustainable Cities and Society*, 47, 101516. <https://doi.org/10.1016/j.scs.2019.101516>
- Grossman, G., & Krueger, A. (1991). Environmental Impacts of a North American Free Trade Agreement. National Bureau of Economic Research. <https://doi.org/10.3386/w3914>
- Hanif, N., Arshed, N., & Aziz, O. (2019). On interaction of the energy: Human capital Kuznets curve? A case for technology innovation. *Environment, Development and Sustainability*, 22(8), 7559–7586. <https://doi.org/10.1007/s10668-019-00536-9>
- He, Y., Wang, S., & Chen, N. (2024). Mineral rents, natural resources depletion, and ecological footprint nexus in high emitting countries: Panel GLM analysis. *Resources Policy*, 89, 104472. <https://doi.org/10.1016/j.resourpol.2023.104472>
- Hoang, D. P., Chu, L. K., & To, T. T. (2023). How do economic policy uncertainty, geopolitical risk, and natural resources rents affect economic complexity? Evidence from advanced and emerging market economies. *Resources Policy*, 85, 103856. <https://doi.org/10.1016/j.resourpol.2023.103856>
- Huang, Y., Raza, S. M. F., Hanif, I., Alharthi, M., Abbas, Q., & Zain-ul-Abidin, S. (2020). The role of forest resources, mineral resources, and oil extraction in economic progress of developing Asian economies. *Resources Policy*, 69, 101878. <https://doi.org/10.1016/j.resourpol.2020.101878>
- Idroes, G. M., Hardi, I., Rahman, M. H., Afjal, M., Noviandy, T. R., & Idroes, R. (2024). The dynamic impact of non-renewable and renewable energy on carbon dioxide

- emissions and ecological footprint in Indonesia. *Carbon Research*, 3(1). <https://doi.org/10.1007/s44246-024-00117-0>
- Kang, H., Li, L., & Feng, J. (2023). Are natural resources a hindrance to ecological footprint? Mineral rents, energy production, and consumption positions. *Resources Policy*, 86, 104048. <https://doi.org/10.1016/j.resourpol.2023.104048>
- Nassani, A. A., Aldakhil, A. M., & Zaman, K. (2021). Ecological footprints jeopardy for mineral resource extraction: Efficient use of energy, financial development and insurance services to conserve natural resources. *Resources Policy*, 74, 102271. <https://doi.org/10.1016/j.resourpol.2021.102271>
- Nathaniel, S. P. (2021). Environmental degradation in ASEAN: assessing the criticality of natural resources abundance, economic growth and human capital. *Environmental Science and Pollution Research*, 28(17), 21766–21778. <https://doi.org/10.1007/s11356-020-12034-x>
- Nathaniel, S. P., Bekun, F., & Faizulayev, A. (2021). Modelling the Impact of Energy Consumption, Natural Resources, and Urbanization on Ecological Footprint In South Africa: Assessing the Moderating Role of Human Capital. *International Journal of Energy Economics and Policy*, 11(3), 130–139. <https://doi.org/10.32479/ijeep.11099>
- Nugraha, A., Siregar, H., Fahmi, I., Asikin, Z., Indrawan, D., Harianto, H., & Aprilian, S. (2024). Identification of Factors Affecting Net Zero Emission Level in Indonesia. *International Journal of Energy Economics and Policy*, 14(5), 203–210. <https://doi.org/10.32479/ijeep.16644>
- Ozcan, B., Ulucak, R., & Dogan, E. (2019). Analysing long lasting effects of environmental policies: Evidence from low, middle and high income economies. *Sustainable Cities and Society*, 44, 130–143. <https://doi.org/10.1016/j.scs.2018.09.025>
- Ragmoun, W. (2023). Ecological footprint, natural resource rent, and industrial production in MENA region: Empirical evidence using the SDM model. *Heliyon*, 9(9), e20060. <https://doi.org/10.1016/j.heliyon.2023.e20060>
- Rahman, R. A., White, B., & Ma, C. (2024). The effect of growth, deforestation, forest fires, and volcanoes on Indonesian regional air quality. *Journal of Cleaner Production*, 457, 142311. <https://doi.org/10.1016/j.jclepro.2024.142311>
- Sahoo, M., & Sethi, N. (2021). The intermittent effects of renewable energy on ecological footprint: evidence from developing countries. *Environmental Science and Pollution Research*, 28(40), 56401–56417. <https://doi.org/10.1007/s11356-021-14600-3>
- Shahbaz, M., Destek, M. A., Okumus, I., & Sinha, A. (2019). An empirical note on comparison between resource abundance and resource dependence in resource abundant countries. *Resources Policy*, 60, 47–55. <https://doi.org/10.1016/j.resourpol.2018.12.002>
- Shahbaz, M., & Sinha, A. (2019). Environmental Kuznets curve for CO2 emissions: a literature survey. *Journal of Economic Studies*, 46(1), 106–168. <https://doi.org/10.1108/jes-09-2017-0249>
- Sinha, A., & Bhattacharya, J. (2016). Environmental Kuznets curve estimation for NO 2 emission: A case of Indian cities. *Ecological Indicators*, 67, 1–11. <https://doi.org/10.1016/j.ecolind.2016.02.025>

- Sun, Y., Tian, W., Mehmood, U., Zhang, X., & Tariq, S. (2023). How do natural resources, urbanisation, and institutional quality meet with ecological footprints in the presence of income inequality and human capital in the next eleven countries? *Resources Policy*, 85, 104007. <https://doi.org/10.1016/j.resourpol.2023.104007>
- Suriani, S., Masbar, R., Agustina, M., & Khairul, A. D. (2024). Do Global Green Sukuk affect on Climate Change? Evidence in Issuing Countries. *International Journal of Energy Economics and Policy*, 14(1), 98–107. <https://doi.org/10.32479/ijeep.14987>
- Suriani, S., Masbar, R., Khairul, A. D., Amelia, S. Q., & Asifa, N. (2023). Green Finance and Climate Change Nexus in Indonesia: Autoregressive Distributed Lag Approach. *2023 International Conference on Decision Aid Sciences and Applications (DASA)*, 2, 410–416. <https://doi.org/10.1109/dasa59624.2023.10286724>
- Tabash, M. I., Mesagan, E. P., & Farooq, U. (2022). Dynamic linkage between natural resources, economic complexity, and economic growth: Empirical evidence from Africa. *Resources Policy*, 78, 102865. <https://doi.org/10.1016/j.resourpol.2022.102865>
- Tufa, A., Lemma, B., Yeshitela, K., & Endrias, M. (2022). Community Perceptions Towards the Impacts of Ecotourism Development in The Central Highlands of Ethiopia: The Case of Lake Wanchi and Its Adjacent Landscapes. *Heliyon*, 8, e08924.
- Usman, O., Alola, A. A., Usman, M., & Uzuner, G. (2023). Asymmetric effect of environmental cost of forest rents in the Guinean forest-savanna mosaic: The Nigerian experience. *Environmental Science and Pollution Research*, 30(17), 50549–50566. <https://doi.org/10.1007/s11356-023-25653-x>
- Wang, Q., Li, Y., & Li, R. (2024). Rethinking the environmental Kuznets curve hypothesis across 214 countries: the impacts of 12 economic, institutional, technological, resource, and social factors. *Humanities and Social Sciences Communications*, 11(1). <https://doi.org/10.1057/s41599-024-02736-9>
- Wang, Y., & Wang, R. (2024). Mineral resource rent and sustainable transition: The mediating role of financial development. *Resources Policy*, 89, 104527. <https://doi.org/10.1016/j.resourpol.2023.104527>
- Yilanci, V., & Korkut Pata, U. (2020). Convergence of per capita ecological footprint among the ASEAN-5 countries: Evidence from a non-linear panel unit root test. *Ecological Indicators*, 113, 106178. <https://doi.org/10.1016/j.ecolind.2020.106178>
- Zallé, O. (2019). Natural resources and economic growth in Africa: The role of institutional quality and human capital. *Resources Policy*, 62, 616–624. <https://doi.org/10.1016/j.resourpol.2018.11.009>
- Zhang, H., Chen, T., & Yu, Y. (2023). From finance to sustainability: Understanding the financial development-environment nexus with the environmental Kuznets curve in East-Asia and Pacific economies. *Borsa Istanbul Review*, 23(6), 1448–1457. <https://doi.org/10.1016/j.bir.2023.10.003>
- Zhang, J. (2021). Environmental Kuznets Curve Hypothesis on CO2 Emissions: Evidence for China. *Journal of Risk and Financial Management*, 14(3), 93. <https://doi.org/10.3390/jrfm14030093>

Zahria Zurrah, Suriani Suriani, Muhammad Abrar and Jumadil Saputra
*Investigating the Impact of Long-Term and Short-Term Natural Resource Rents on Ecological Footprints:
Evidence from Indonesia*

- Zhang, Z., & Zhang, C. (2023). Revisiting the importance of forest rents, oil rents, green growth in economic performance of China: Employing time series methods. *Resources Policy*, 80, 103140. <https://doi.org/10.1016/j.resourpol.2022.103140>
- Zia, S., Rahman, M. U., Noor, M. H., Khan, M. K., Bibi, M., Godil, D. I., Quddoos, M. U., & Anser, M. K. (2021). Striving towards environmental sustainability: how natural resources, human capital, financial development, and economic growth interact with ecological footprint in China. *Environmental Science and Pollution Research*, 28(37), 52499–52513. <https://doi.org/10.1007/s11356-021-14342-2>

Received: 1st January 2025. Accepted: 10th March 2025