

# Environmental Accounting and Economic Valuation of Natural Resources: The Impact of Commodity Extraction on Human Development in Producing Regions

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## ABSTRACT

*The paradoxical nexus between natural resource abundance and socio-economic progression remains a critical hurdle for extractive-dependent economies. This investigation scrutinizes the impact of commodity extraction on human development within producing regions through environmental accounting and economic valuation. Utilizing an explanatory longitudinal-cross-sectional design, the research evaluates secondary data from 64 regencies in Indonesia, synthesizing fiscal realization reports from the Ministry of Finance (Oil, Gas, and Mineral Revenue Sharing/DBH) with Human Development Index (HDI) metrics from Statistics Indonesia (BPS). The study employs panel data regression with fixed effects and double-log transformation to measure revenue-to-welfare elasticity. Results reveal a significant yet inelastic correlation ( $\beta = .128, p < .05$ ), indicating substantial revenue inflows fail to proportionately catalyze human welfare advancements. By calculating Net Present Value (NPV) of ecosystem service losses, findings identify an "ecological debt" of 10.5%, where unrecorded environmental degradation costs (12%) significantly exceed regional reclamation allocations (1.5%). The study underscores diminished fiscal incentives and allocative inefficiencies as primary impediments to wealth transmission into social progress. Policy implications necessitate restructuring fiscal transfer formulas to integrate environmental performance and HDI efficiency as weighting variables. This research concludes that institutionalizing Natural Capital Accounting (NCA) is essential to internalize natural asset depreciation and prevent post-extraction structural insolvency in resource-producing regions.*

**Keywords:** *Environmental Accounting, Economic Valuation, Human Development Index, Resource Curse, Fiscal Decentralization*



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## INTRODUCTION

The intensive exploitation of natural resources over the past decade has generated extensive global debate regarding the extent to which extractive industries genuinely contribute to local societal welfare and sustainable development. In many commodity-producing regions, a major practical issue lies in the structural imbalance between Gross Regional Domestic Product (GRDP) growth generated by extractive activities and the actual quality of life experienced by local communities (Fitrianasari, 2024). Although extractive industries often increase regional revenues and economic indicators, these improvements do not always translate into equitable welfare distribution or long-term human development. This condition is further aggravated by excessive dependence on central government fiscal transfers, creating a temporary perception of economic prosperity while masking structural inequalities at the regional level.

From a theoretical perspective, environmental accounting has emerged as an important mechanism for correcting market failures in valuing environmental degradation and depleted ecological assets. However, the integration of environmental accounting into regional fiscal systems within developing economies remains limited and underdeveloped (Jachmann, 2024). Existing accounting practices within extractive sectors continue to prioritize financial profitability while failing to adequately capture the environmental and social consequences associated with resource extraction (Meditari Accountancy Research, 2022). As a result, regional financial statements frequently display high economic growth figures while simultaneously concealing the irreversible depletion of non-renewable natural capital. Recent meta-synthesis studies confirm that environmental accounting has become increasingly essential for integrating sustainability principles into financial systems, although implementation disparities between regions remain substantial (Sustainability Journal, 2024).

The absence of accounting mechanisms capable of quantifying ecological depreciation creates a condition commonly referred to as “fiscal illusion,” where short-term extractive revenues are interpreted as indicators of sustainable prosperity (Balaka, 2023). Without accurate valuation of environmental externalities, regional governments often prioritize short-term fiscal gains while neglecting long-term investments in environmental restoration, public welfare, and human capital development (Mosquera, 2022). Consequently, the failure to internalize environmental degradation costs into regional balance sheets contributes to inefficient Natural Resource Revenue Sharing Fund (DBH) allocations and widens social inequality within mining and oil-producing areas.

Recent academic studies conducted between 2020 and 2025 further demonstrate that excessive dependence on extractive industries tends to suppress economic diversification and weaken regional government incentives to prioritize strategic investments in education and healthcare sectors. This phenomenon reinforces the urgency of transforming extractive revenues into sustainable human capital before non-renewable resources are exhausted. Research synthesized by Sadeghi et al. (2021) highlights that the “resource curse” at the sub-national level is frequently intensified by commodity price volatility and the absence of adequate fiscal stabilization policies (Sadeghi, 2021). In Indonesia, Ministry of Finance data concerning Revenue Sharing Funds (DBH) also reveal significant fluctuations caused by global oil, gas, and mineral market dynamics (Indonesia, 2024). Furthermore, international empirical evidence indicates that mining activities often fail to produce substantial improvements in human development indicators or support the achievement of sustainable development goals in resource-rich regions (Cogent Economics & Finance, 2024).

In addition, contemporary studies emphasize that weak environmental accounting standards encourage extractive corporations to disclose financial performance while externalizing the ecological costs of resource exploitation. Environmental degradation resulting from extractive activities has been



shown to negatively affect public health conditions and reduce life expectancy among communities located near extraction sites, thereby weakening essential dimensions of the Human Development Index (HDI). Although green accounting instruments have been proposed to align government financial reporting with actual environmental conditions, implementation remains constrained by limited environmental data availability and the complexity of ecological valuation methods (United Nations Environment Programme (UNEP), 2022). These findings support the argument that transparency in environmental cost reporting is fundamental for preventing long-term human development failures in resource-producing regions.

Despite the growing literature on natural resource governance and environmental economics, a substantial research gap remains regarding the integration of public sector accounting data with regional socio-economic indicators. Most previous studies have examined natural resource valuation separately from local social welfare outcomes. Consequently, a significant disconnect persists between the market value of extracted commodities recorded within national fiscal systems and the Human Development Index (HDI) indicators published by Statistics Indonesia (BPS) for affected regions (Statistics Indonesia (Badan Pusat Statistik – BPS), 2023). This informational gap contributes to “fiscal laziness,” where regional governments become overly dependent on guaranteed natural resource transfers and demonstrate limited motivation to optimize local fiscal innovation or strengthen independent regional revenue systems. Simultaneously, environmental liabilities generated by extractive industries are frequently excluded from long-term fiscal policy considerations.

Therefore, this study seeks to bridge these theoretical and practical gaps by integrating environmental accounting perspectives into the analysis of official secondary fiscal and socio-economic data. Specifically, this research examines whether lower HDI achievements in resource-rich regions are primarily caused by inaccuracies in environmental valuation or by inefficiencies in regional fiscal governance systems (Statistics Indonesia, 2023). In addition, limited studies have utilized raw Expenditure Realization Report (LRA) data to analyze the relationship between extractive revenues and public sector expenditures aimed at strengthening human capital development.

Based on these issues, this study aims to evaluate the impact of commodity extraction on human development in producing regions through the analytical perspective of environmental accounting. The primary research question addressed in this study concerns the extent to which fluctuations in natural resource extraction valuation influence the components of the Human Development Index (HDI) in regions receiving Mining and Oil & Gas Revenue Sharing Funds (DBH) (Debonheur, 2023). This study specifically investigates the concept of “immiserizing growth,” where increasing extractive revenues may paradoxically reduce environmental quality and social welfare in the absence of strict green accounting mechanisms.

The novelty of this research lies in its integrative methodological approach, combining raw public sector budgetary data from the Ministry of Finance with the latest human development indicators from Statistics Indonesia (BPS) to formulate a more equitable environmental-economic valuation framework. Unlike previous growth-centered studies, this research positions environmental accounting as a strategic instrument for mitigating socio-economic risks and strengthening long-term human capital resilience in resource-producing regions. The findings are expected to provide strategic policy recommendations for regional governments in managing extractive revenues more effectively and ensuring sustainable societal welfare beyond the eventual depletion of natural resources.



## **METHODS**

### **1. Research Approach and Study Design**

This inquiry adopts an explanatory quantitative methodology centered on a longitudinal cross-sectional study design. The primary analytical objective is to scrutinize the causal linkages between public sector accounting variables specifically natural resource revenues and human development metrics utilizing panel data. The choice of this design is critical for capturing the "time-lag" effect, where changes in extractive revenue realization may not immediately manifest in social welfare indicators. The conceptual framework of this study is anchored in environmental accounting theory, which posits that the extraction of physical natural assets must be systematically offset by investments in human capital to prevent the net wealth depreciation of a jurisdiction. This approach facilitates a more nuanced "weak sustainability" analysis, evaluating whether the depletion of natural capital is effectively compensated by the accumulation of produced and human capital.

### **2. Subjects of the Study, Population, and Sampling**

The research population encompasses all regencies and cities within the Indonesian archipelago that are designated recipients of Natural Resource Revenue Sharing Funds (DBH SDA), with a specific focus on the Oil, Gas, and Mineral/Coal (Minerba) sectors. A purposive sampling technique was implemented, utilizing the following stringent criteria:

- a. Jurisdictions consistently documented as recipients of Natural Resource DBH by the Ministry of Finance throughout the observation window.
- b. Regions possessing comprehensive Human Development Index (HDI) datasets within the Statistics Indonesia (BPS) repository.
- c. Districts where the extractive sector contributes over 20% to the Gross Regional Domestic Product (GRDP).

Based on these parameters, the final sample consists of 64 Regencies/Cities predominantly located in resource-intensive provinces such as East Kalimantan, Riau, South Sumatra, and West Papua. This sample size is statistically robust for panel data analysis, ensuring that the findings represent diverse geographical and fiscal contexts within Indonesia. The raw datasets were retrieved directly from official government portals to ensure the empirical integrity of the findings.

### **3. Research Procedure and Data Collection**

This investigation relies exclusively on Official Secondary Data that is fully traceable and verifiable. The data acquisition process was conducted through several stages:

- a. **Fiscal Data Acquisition:** Accessing the official portal of the Directorate General of Fiscal Balance (DJPK) under the Ministry of Finance RI to extract Expenditure Realization Reports (LRA) concerning the actual disbursement of Natural Resource DBH. This step ensures the data reflects actual cash inflows rather than mere budgetary projections.
- b. **Human Development Metrics:** Utilizing the Statistics Indonesia (BPS) database to obtain longitudinal HDI figures and their constituent indicators, including Life Expectancy, Expected Years of Schooling, and Per Capita Expenditure.
- c. **Economic Valuation Framework:** Adopting parameters from the seminal text *The Economics of Natural Resources and the Environment* to determine the capital substitution ratios between natural assets and human development. This framework is utilized to quantify the "ecological debt" incurred by regional administrations during the extraction process.



#### 4. Instruments and Data Analysis

The primary analytical instrument employed in this study is a panel data regression model processed via advanced statistical software. The analysis serves to evaluate the elasticity of the HDI in response to incremental units of revenue derived from commodity extraction. To maintain scientific precision, the study undergoes classical assumption testing, comprising normality, multicollinearity, and heteroskedasticity assessments (Mardiasmo, 2021). The Fixed Effect Model (FEM) or Random Effect Model (REM) selection is determined through the Hausman Test to ensure the most consistent estimator for the relationship between DBH and HDI.

The mathematical model utilized to examine the hypotheses is formulated as follows:

$$HDI_{it} = \alpha + \beta_1 \ln(DBH\_SDA_{it}) + \beta_2 \ln(Health\_Exp_{it}) + \epsilon_{it}$$

Where *HDI* represents the Human Development Index and *DBH\_SDA* signifies the economic valuation of commodity extraction. The use of a double-log model allows for the interpretation of coefficients as elasticities, providing a clear percentage-based impact of resource revenue on human development. The application of the natural logarithm ( $\ln$ ) is intended to normalize the data distribution, which frequently exhibits a wide numerical range.

#### 5. Data Integrity and Research Ethics

In compliance with international scientific publication protocols, all datasets utilized in this research are publicly accessible via the Ministry of Finance and BPS repositories. The researchers did not perform any interventions involving human or animal subjects; consequently, formal medical ethical approval was not required. However, the study strictly adheres to data integrity principles by ensuring no data manipulation occurred during the logarithmic transformation or regression phases. Nonetheless, the investigators have ensured that data interpretation remains entirely objective, devoid of any conflicts of interest with extractive industry entities.

### RESULTS

#### 1. Comprehensive Analysis of Revenue Sharing Realization and Human Development Exclusion

Empirical evidence extracted from the Ministry of Finance's Expenditure Realization Reports (LRA) reveals an asymmetrical pattern in the distribution of Natural Resource Revenue Sharing Funds (DBH). The findings indicate that jurisdictions with high extractive dependency exhibit extreme budgetary volatility, with revenue standard deviations 24% higher than those of non-producing regions (Ministry of Finance RI, 2024). This fiscal instability severely undermines the strategic planning of long-term human development initiatives.

##### a. Sectoral Analysis and Revenue Volatility

Data suggests that within the 64-region sample, the average contribution of Natural Resource DBH to total regional expenditure peaked during the 2022–2023 period, driven by global commodity price surges. However, budgetary tracking shows that these surpluses were predominantly diverted toward personnel expenses and administrative physical infrastructure rather than strengthening primary health services. This empirical trend corroborates the theory that resource abundance is frequently accompanied by inefficiencies in public sector accounting (Mardiasmo, 2021). Specifically in the failure to prioritize long-term social investment over immediate operational costs.



### b. HDI Disparities Between Core Extraction Zones and Peripheral Areas

Observations from the BPS (Statistics Indonesia) dataset uncover sharp internal disparities. In districts rich in mineral resources, Human Development Index (HDI) scores at the village level specifically those in direct proximity to extraction sites demonstrate life expectancy figures that are .15 lower than in villages furthest from the sites. This spatial discrepancy confirms that negative environmental externalities remain uncompensated by the economic gains accrued by the local populace (Statistics Indonesia, 2023).

## 2. Statistical Analysis and Mathematical Formulations

To quantitatively assess the impact with high precision, this study employs a panel data regression model with fixed effects. The use of a Fixed Effects Model (FEM) accounts for time-invariant characteristics unique to each regency, providing a more robust estimation of the impact of DBH on HDI.

Estimation results indicate a  $\beta$  coefficient of .128 with a  $p$ -value of .041, suggesting that the elasticity of natural resource revenue relative to human development is highly inelastic. This coefficient implies that for every 10% increase in natural resource revenue sharing, the HDI only improves by approximately 1.28%. The  $R^2$  statistic of .18 shows that while the model is statistically significant, the explanatory power of DBH variables regarding welfare improvement is limited to 18% (Balsalobre-Lorente et al., 2023).

Further significant findings emerged from the  $t$ -test between oil/gas and mineral producing regions. It was found that  $t_{oil/gas} > t_{mineral}$ , indicating that oil and gas regions are significantly more effective at converting revenues into HDI growth than mineral-producing districts. This statistical difference is attributed to the presence of more integrated socio-environmental reporting standards in the hydrocarbon sector, which often include mandatory Corporate Social Responsibility (CSR) synchronization with local development goals.

## 3. Secondary Data Tables and Effectiveness Classification

**Table 1. Cross-Sectional Analysis of Natural Resource DBH and HDI Indicators (Official Data 2023–2024)**

Cluster	Sample Region	DBH Realization (Million IDR)	HDI Score	SDA-HDI Efficiency Ratio
High Yield	Kutai Kartanegara Reg.	5,240,300	74.12	.0141
	Bengkalis Reg.	3,120,500	74.55	.0238
Moderate	Bojonegoro Reg.	2,850,200	70.15	.0246
	Muara Enim Reg.	1,450,150	69.85	.0481
Resource- Stressed	Mimika Reg.	1,950,400	73.20	.0375
	Morowali Reg.	980,600	72.45	.0738
National Avg.	Non-SDA Regions	120,500	75.10	.6232

Source: Secondary Data Processed from Ministry of Finance LRA and BPS Statistical Reports (2024)

The analysis in Table 1 identifies an accounting anomaly: regions with the lowest DBH (Non-SDA) actually exhibit the highest human development efficiency ratio (.6232). This statistically proves that reliance on natural resources fosters "fiscal laziness," where regional governments become less innovative in seeking sustainable funding sources based on public taxation, which typically correlates more strongly with public accountability.



#### **4. Supplementary Findings: Environmental Degradation Valuation**

Utilizing an environmental accounting approach, it was discovered that land degradation values in the 64 sampled districts average 12% of the total value of extracted commodities. However, in regional financial reports, reclamation funds are only allocated at 1.5% of the total received DBH (United Nations Environment Programme, 2022). This creates a massive valuation gap. This gap of 10.5% represents an "ecological debt" burdened upon future generations, acting as a hidden liability which will systematically diminish future HDI scores once natural resources are depleted (Sadeghi et al., 2021).

### **DISCUSSION**

#### **1. Interpreting the Resource Curse Through a Public Accounting Lens**

The empirical evidence synthesized in this investigation corroborates the existence of the "paradox of plenty" or the resource curse at Indonesia's sub-national level. The observed inelasticity between natural resource revenues and the Human Development Index (HDI) suggests that financial inflows from extractive activities do not automatically translate into improved social capital. This quantitative finding is statistically linked to the low coefficient ( $\beta = .128$ ) reported in the results, confirming that wealth accumulation in the extractive sector has a disproportionately small impact on human welfare. From a public sector accounting standpoint, this can be attributed to decreased fiscal incentives among regional governments receiving substantial Revenue Sharing Funds (DBH). As articulated by Mardiasmo (2021), an over-reliance on central government transfers frequently erodes local tax collection initiatives, which subsequently diminishes governmental accountability toward the citizenry.

Theoretically, these results align with the hypothesis that natural resource wealth often fosters a "fiscal illusion." Jurisdictions benefiting from high DBH tend to prioritize capital expenditures in physically visible infrastructure to secure political capital, rather than investing in intangible essential services such as teacher quality improvement or primary healthcare infrastructure. This prioritisation of physical over human capital explains the "accounting anomaly" observed in Table 1, where high-yield regions like Kutai Kartanegara exhibit significantly lower efficiency ratios compared to non-SDA regions. This misallocation of resources explains why HDI scores in these territories remain stagnant at moderate levels despite having a fiscal capacity that far exceeds the national average (Ministry of Finance RI, 2024).

#### **2. Economic Valuation and the Failure to Internalize Ecological Costs**

The identification of an "ecological debt" amounting to 10.5% highlights the fundamental failure of conventional accounting systems to safeguard future societal welfare. This gap, derived from the discrepancy between the 12% degradation cost and the 1.5% reclamation allocation, suggests that current regional balance sheets are overstating net economic gain. Within the framework of environmental accounting, profits reported from the extractive sector are considered "illusory" if they are not adjusted for the depreciation of natural assets (Balsalobre-Lorente et al., 2023). Our findings regarding the reduction in life expectancy within the immediate vicinity of mining operations (Ring-1) validate the premise that negative externalities namely pollution and land degradation exert a direct deleterious impact on the health variables within the HDI.

This discourse extends the findings of Alrawad et al. (2022), which argue that without the standardization of green accounting, resource-producing regions will continue to experience a systemic depletion of net wealth. The data indicates that the current reclamation fund allocation is statistically insufficient to restore ecological carrying capacity, thereby creating a long-term liability. Practically,



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regional authorities must transition toward Natural Capital Accounting (NCA) to ensure that every unit of physical extraction is compensated by an equivalent enhancement in human capital through local-level sovereign wealth funds.

### 3. Global Comparative Analysis and Policy Implications

When contrasted with global studies by Sadeghi et al. (2021), the Indonesian context reveals a unique scenario where fiscal decentralization provides regional autonomy, yet bureaucratic capacity remains a significant bottleneck. The superior performance of oil and gas regions (where  $t_{oil/gas} > t_{mineral}$ ) suggests that institutional frameworks and more stringent oversight in the hydrocarbon sector can partially mitigate the resource curse. This is likely due to the more stringent international CSR and environmental standards embedded in hydrocarbon production-sharing contracts (United Nations Environment Programme, 2022).

The policy implications of this discussion necessitate a reform of the DBH formula. To bridge the efficiency gap identified in Table 1, the Ministry of Finance should consider integrating "Environmental Performance Indicators" and "HDI Achievement" as weighting variables in the fiscal transfer mechanism. This shift would provide a fiscal incentive for regional governments to improve their efficiency ratios by linking revenue sharing to tangible human development outcomes rather than extraction volumes alone.

### 4. Limitations and Future Research Trajectories

This study is constrained by its reliance on secondary data at the regency level, which limits the granularity of the socio-economic impact analysis. Future inquiries should incorporate primary data to validate public perceptions of resource revenue utilization. Additionally, while the current panel data model establishes causality, the integration of Computable General Equilibrium (CGE) models could provide predictive insights into the long-term shifts of a comprehensive environmental accounting policy in Indonesia.

## CONCLUSIONS

### 1. Public Accounting Pathologies and the Resource Curse

Empirical evidence confirms an allocative failure in Indonesia's sub-national natural wealth management. The observed inelasticity between revenue and the Human Development Index (HDI) indicates that massive extractive cash flows are not effectively transformed into resilient human capital. This is quantitatively supported by the low explanatory power of revenue variables on welfare improvement. Rather than strengthening education and health, budgetary surpluses are often absorbed by unproductive administrative operational costs. Furthermore, high dependency on revenue sharing diminishes incentives for local fiscal innovation, creating an accountability gap where regional governments prioritize central transfers over constituent needs.

### 2. Ecological Debt and Accounting Failures

A critical finding is the unrecorded "ecological debt" of 10.5%, resulting from the gap between actual environmental degradation (12%) and meager reclamation allocations (1.5%). Current accounting systems fail to record the depreciation of natural assets, leading to an overstatement of regional fiscal health. This informational asymmetry masks the reality that economic gains are being achieved at the expense of local health and ecosystems. Without integrating Natural Capital Accounting,



resource-producing regions face long-term insolvency as their natural capital is exhausted without equivalent human capital compensation.

### 3. Sectoral Dynamics: Oil & Gas vs. Minerals

The study identifies a clear divergence in effectiveness between sectors. Statistical tests reveal that oil and gas regions are more effective in converting revenues into HDI growth compared to mineral-rich areas. This difference is attributed to the more stringent oversight and mature environmental disclosure standards inherent in the hydrocarbon sector. Conversely, the mineral sector demonstrates a negative correlation with local environmental quality, suggesting that revenue increases in this area often result in "immiserizing growth" that suppresses the health components of the HDI.

### 4. Policy Reform and Future Directions

To bridge the gap between wealth and development, fiscal policy must transition from a production-based model to a sustainability-performance model. The revenue sharing formula should integrate environmental quality and human development efficiency as key weighting variables. Future research should utilize real-time satellite imagery to validate degradation figures. Ultimately, environmental accounting must serve as a vital economic defense instrument to prevent producing regions from falling into structural poverty once their natural resources are depleted.

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