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MODELING IMPACT OF MINING ACTIVITIES ON PEOPLE'S ECONOMIC DEVELOPMENT: CASE EVIDENCE FROM: MIYOVE SECTOR, GICUMBI DISTRICT, RWANDA

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Abstract:
This study examines the impact of mining activities on economic development in Miyove Sector, Gicumbi District. Using a sample of 120 respondents from a population of 20,223, findings reveal that mining significantly contributes to local livelihoods. Employment generation is the most notable benefit, with 78% of households engaged in mining-related work. Respondents also highlighted job creation (42.1%), income growth (26.3%), and infrastructure development (24.6%) as major outcomes. However, environmental challenges such as water pollution (44.7%) and soil erosion (30.7%) remain pressing concerns. The study concludes that while mining fosters economic empowerment, sustainable practices are essential to mitigate ecological risks.

Keywords: mining undertakings, people's economic development

Mining is a cornerstone of global economic activity, supplying raw materials essential for industrialization, infrastructure, and consumer goods. In Africa, countries such as South Africa, Zambia, and the Democratic Republic of Congo rely heavily on mining revenues, though the sector often faces governance and environmental challenges. Rwanda's mining industry, rich in tin, tantalum, tungsten, and gold, has become a key driver of economic diversification. In Gicumbi District's Miyove Sector, tin mining has created jobs

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and improved household incomes, contributing to poverty reduction. Yet, these gains are tempered by environmental degradation, land-use conflicts, and health risks. This study investigates how mining activities influence economic development in Miyove, balancing benefits against challenges.

1.1 Purpose of the Study

The purpose of the study was to assess the impact of mining activities on the economic development of the people of Gicumbi district, Miyove sector. It aims to assess the direct and indirect economic contribution of mining to the local community, including employment generation, revenue generation through taxes and royalties.

1.2 Research Objectives

The specific objective of this research is to:

a) To analyze the impact of mining activities on local livelihoods in Miyove Sector, focusing on employment opportunities, income generation, and household welfare.
b) To examine the contribution of mining to community development**,** including infrastructure improvements, access to services, and social transformation.
c) To evaluate the relationship between mining activities and economic development**,** identifying both the positive outcomes and the environmental or social challenges that accompany mining in the region.

2. Literature Review

2.1 Definition of Key Terms and Concepts

2.1.1 Mining

Mining is the process of removing valuable minerals or other geological materials from the Earth. Usually, ore bodies, lodes, veins, seams, reefs, or deposits include these minerals. The cost of personnel, machinery, and energy required to extract, process, and transport the materials from the mine to producers who can use them determines whether mining these deposits for raw materials is economically feasible (MINIRENA, 2013).

Mining is the act of collecting a naturally occurring resource from the earth in order to make money (Nsabimana, 2018). According to Perks (2016), the operation of mines is the definition of mining. The five stages of mining include exploration, development, exploitation, reclamation, and prospecting.

Although the mining sector has the ability to aid in economic growth, it also poses environmental problems, such as the depletion of wetland resources (Sjoblom, 2003).

2.1.2 Mining Activities

According to Akong (2015), mining activities mean all activities on a facility which are directly in furtherance of mining, including activities before, during and after mining.

Mining operations generate a variety of contaminant-filled effluents, which have a detrimental impact on the quantity and quality of wetland resources and frequently cause significant contamination (Jucan, 2023).

2.1.3 Economic Development

Development is a long-term, gradual change brought about by an overall increase in the rate of savings and population, whereas development is a discontinuous, spontaneous shift in the stationary state that permanently modifies and displaces the prior equilibrium state (Szirmai, 2005).

According to Tadaro (1977), "*economic development deals with the problem of underdeveloped countries, whereas economic growth deals with the problems of developed countries*."

According to Cyphez *et al.* (2004), "*economic growth means more output. Economic development is the technical and institutional setup by which such output is produced and distributed*."

Economic development refers to social, economic, and other transformations that support economic expansion. While economic development cannot be quantified with precision, economic growth may be assessed (Gillis *et al.*, 1996).

2.2 Impact of Mining Activities

Mining activities supply the manufacturing sector with metals and minerals; it has aided in development. (Singh *et al.*, 2016). The benefits (such as the generation of jobs) outweigh the drawbacks because so many industries rely on mining (Narrei & Ataeepour, 2021). Singh *et al.* (2016) claim that because mining promotes community growth, improves infrastructure, and makes it easier for spin-offs to be established, it is essential to the maintenance of social development. But mining operations also have detrimental effects on the environment and society.

According to Asif and Chen (2016), by using environmental management techniques (such as life cycle assessment, cleaner production technologies, and multi-criteria decision analysis) to enhance environmental performance, the mining industry can contribute to sustainable development.

Although expectations and sentiments within local cultures can change over time, the mining sector is often viewed unfavorably (Amos, 2018). Only 20% of residents who live close to mining areas believe that mining is a beneficial thing, according to Yang and Ho (2019). The study encompassed several elements of investigation, such as land subsidence, environmental degradation, employment opportunities, and land expropriation. The effects of the mining sector on the environment and public health have been the subject of numerous studies (Vélez-Torres *et al.*, 2018; Salem *et al.*, 2018). But in

addition, the neighbourhood's digital and physical infrastructure, vital services, and social events are funded by the mining sector.

Human well-being and the continued existence of society rely on mining activities, whose extraction offers both opportunities and challenges. Long-term barriers include environmental concerns and the need for mining operations not to endanger the health and welfare of their workers or the local population. One commonly mentioned objective is to minimize the remnants of mining activities in the environment, local people's lifestyle, and ecosystem (Asif and Chen, 2016).

Mining jobs often aid in the transition of local societies from a subsistence to a cash economy. The fact that mining frequently pays relatively more than other businesses means that those who have previously had paid employment may fare better. Localisation initiatives or corporate training that promotes local employees into higher positions within a company, particularly in developing countries, may result in wage increases. On the other hand, compared to prior mines, modern mines usually have far higher levels of production since they utilize small but highly skilled worker groups (Yang and Ho, 2019).

Although mineral development has the potential to greatly upset existing societies as well as build new ones, it may also bring prosperity to those that already exist. In rural and previously underdeveloped areas, new projects can offer jobs, economic activity, roads, schools, and health clinics. However, the benefits may not be distributed equally, and for others, they may not be sufficient compensation for the loss of their livelihoods and the harm they have caused to their environment and culture. Social discontent and perhaps violent confrontation can result from mining if communities believe they are receiving unfair treatment or insufficient compensation (Acheampong, 2004).

2.3 Evaluating the Role of Economic Development

The contribution of mining activities to economic development is immense. Mining is a vital component of human growth since it generates money (Acheampong, 2004). The Industrial Revolution, the infrastructure of the present Information Age, and the Iron and Bronze Ages were all made possible by the mining industry, which was also essential in the growth of civilisation. Over 6 billion tons of raw materials worth several trillion dollars were generated by the mining sector in 2001 (Mbendi, 2004). The worldwide mining scene is dominated by traditional mining nations, including the United States, Canada, Australia, South Africa, and Chile. The primary source of foreign exchange earnings in the nation is mining, which also contributes to community development in mining areas, generates direct and indirect jobs, and provides the government with significant money (Kanyangira, 2013).

People can gain from enormous financial flows and compensation when a large mine is established, and this can act as a catalyst for development and transformation. People in areas that were previously on the outskirts of the cash economy may see a change in their social and economic base as a result of these financial movements. The

methods of payment and their application are critical in figuring out how mining could facilitate sustainable development at the community level (Awaar, 2006).

Mining is one way for locals to enter the cash economy, and it typically generates chances for subsistence-level labor. The fact that mining frequently pays relatively more than other businesses means that those who have previously had paid employment may fare better. Localization initiatives or corporate training that promotes local employees into higher positions within a company, particularly in developing countries, may result in wage increases. On the other hand, contemporary mines usually produce at far higher levels than older mines since they utilize small but highly skilled worker groups (Mbendi, 2015).

2.4 Challenges Faced by People Living Around Mining Sites

Mining has been blamed for detrimental and depressing effects on a global scale. The majority of countries have an abundance of mineral resources, but there has not been much development because mining causes issues with wastewater disposal, erosion, sinkholes, deforestation, biodiversity loss, significant water resource consumption, and dammed rivers and ponded water resources of peat and geothermal energy. Miners and the people around mining sites still live in extreme poverty worldwide. In Rwanda, several studies, research, and surveys in mining communities have revealed that environmental problems such as land degradation, pollution and others are associated with mining activities (Rwanda Mining Profiles, 2008).

In Rwanda, mining started in the early 1930s, and since then, the mining sector has undergone wide reforms and is now Rwanda's second-largest export revenue earner in the country. In 2017, the sector generated $373.4 Million of foreign exchange. Rwanda's mineral resources include coltan, wolfram, peat (used for electricity generation or processed as an alternative for firewood), gold and nickel. In addition to this, the country has other precious stones such as amphibolite, granites, quartzite, volcanic rocks, clay, sand and gravel (Kanyangira, 2013)

2.5 Mining in Rwanda Economy

Rwanda produces eight thousand to nine thousand tons of mineral compounds annually; the quantity of money earned relies on the dynamics of the market pricing. More lately, the potential for gold extraction and export has been apparent. Approximately 9% of the tantalum used worldwide in the production of electronics is produced in Rwanda, making it one of the leading manufacturers of the metal. Furthermore, Rwanda is currently home to two tin and gold refineries, both of which are equipped to process substantial volumes of minerals from the nation and the surrounding area. As a participant in the internationally recognized iTSCi program, Rwanda has a mineral tagging and sealing scheme that guarantees that the origins of the minerals can be tracked in order to prevent the financing of conflict, violations of human rights (Kanyangira, 2013):

The 3T belt, which stretches from the eastern Democratic Republic of the Congo (DRC) through Rwanda and into southwest and northern Burundi, is responsible for producing 3 percent of the world's tin, 2% of its tungsten, and 51% of its tantalum (of which Rwanda produces 28%) in 2013. The majority of these products are shipped as mineral concentrates, specifically wolframite (tungsten), tantalite19 (tantalum), and cassiterite. Rwanda produces niobium, some gold and gemstones, and a variety of building minerals mostly for domestic markets (e.g., limestone used in cement manufacturing, clay bricks, stone aggregate) in addition to the 3T minerals.

Like its neighbours, Rwanda's 3T mineralization, is largely associated with granites hosted within the Kibaran belt rocks formed approximately 1.3 billion years ago. The 3Ts in the access to electricity (National Institute of Statistics of Rwanda, 2018).

In a district with a high population density and a strong reliance on subsistence agriculture, mining coexists with agricultural land and human housing. 5.3% of adults in the district over 16 work in the mining and quarrying sector, and the expansion of this business has an effect on social structure and land usage (National Institute of Statistics of Rwanda, 2018)

3. Material and Methods

The total size of this 120 comprises 100 people, 14 miners, and 6 administrative staff. The sampling process is based on the solvency method, which is summarised as:

The formula is:

$$n = \frac{N}{1 + N\left(e^2\right)}$$

Where:

n = sample size,
N = Population,
ẽ = Margin error, which is equal to 10.

Category of the study	**Total population**	**Sample**	**Sample size**
Peoples	20203	$n = \frac{N}{1 + N\left(e^2\right)}$ $n = \frac{20203}{1 + 20203\left(0.1^2\right)} = \frac{20203}{1 + 20203(0.01)} = 99.5 = 100$ (Simple random sampling techniques)	100
Miners	14	Purposive sampling techniques	14
Local leaders	6	Purposive sampling techniques	6
Total	**20223**		**120**

3.1 Data Analysis

Microsoft Excel was also a tool to be used during the period of conducting research for this study.

3.2 Results and Discussion

3.2.1 Respondents' Distribution by Sex

Table 1: Distribution of Respondents by Sex

Sex	Effective	Percentage (%)
Female	50	43.9
Male	64	56.1
Total	**114**	**100.0**

Source: Primary data, July 2024.

This table shows that the vast majority of respondents are male, which represents 56.1% of the respondents, while the female is 43.9% of the respondents.

This shows us that it is the majority of males who provided us with the information during our investigation. The remaining percentage shows that the female has not been neglected in the institution.

Table 2: Distribution of the Respondents by Age

Age	Number of respondents	Percentage (%)
Between 15-20	8	7.0
Between 21-25	17	14.9
Between 26-30	44	38.6
Above30	45	39.5
Total	**114**	**100.0**

Source: Primary data, July 2024.

3.2.2 Identification of Respondents by Marital Status

Table 3: Identification of Respondents by Marital Status

Marital status	Effective	Percentage (%)
Single	50	43.9
Married	62	54.4
Divorced	0	0,0
Widow	2	1.8
Total	**114**	**100.0**

Source: Primary data, July 2024.

3.2.3 Distribution of Respondents by the Level of Education

The study also sought to establish the education level of respondents. Table 4 and Figure 4 below show the results.

Table 4: Distribution of Respondents by the Level of Education

Education level	Number of respondents	Percentage (%)
No schooling	6	5.2
Primary	86	75.4
Secondary	20	17.5
Higher education level	2	1.8
Total	**114**	**100.0**

Source: Primary data, July 2024.

Findings on the education level attained by respondents revealed that the majority, 75.4% of respondents, were at the primary level. Those who have university level were represented by 1.8 % of respondents. Therefore, those who completed secondary level only are presented 17.5 % of respondents. Since the majority of the respondents who provided the data for this research were at the primary level, the researcher was assured that they would provide the most accurate answers to various questions of the research.

Table 5: Distribution of Respondents by Period of Living at Miyove Sector

Years	Frequency	Percentage (%)
2 - 4 years	12	10.5
4 - 6 years	26	22.8
Above 6 years	76	66.6
Total	**114**	**100.0**

Source: Primary data, July 2024.

In our research using the table and figure above, we have found that the majority of the respondents are living above 6 years, as presented by 66.6% of respondents, 22.8% of respondents are living at Miyove between 4-6 years, and only 10.5% of respondents are living at Miyove between 2-4 years.

3.2.4 Respondent View About the Impact of Mining Activities on Economic Development at Miyove Sector

The bellow table displays the impact of mining activities on economic development in the Miyove sector.

Table 6: The Impact of Mining Activities on Economic Development at Miyove Sector

Options	Frequency	Percentage (%)
Very Positive	68	59.6
Positive	45	39.5
Neutral	0	0.0
Negative	1	1.0
Total	**114**	**100.0**

Source: Primary data, 2024.

The table above presents the impact of mining activities on economic development very positive that mining activities have an impact on economic development in the Miyove

sector; 59.6% of respondents said that mining has a positive impact on economic development at Miyove. Only 1% of respondents said that there is a negative impact of mining activities on economic development in the Miyove sector.

3.2.5 Benefits of Mining Activities to the Local Community in Miyove Sector

The table and figure show the benefits of mining activities to the local community in the Miyove sector.

Table 7: Distribution of Respondents by Benefits of Mining Activities to the Local Community in Miyove

Benefits	Frequency	Percentage (%)
Job creation	48	42.1
Increased income	30	26.3
Infrastructure development	28	24.6
Business opportunities	6	5.3
Other	2	1.8
Total	**114**	**100.0**

Source: Primary data, July 2024.

In the above table and figure state that 42.1% of respondents state that mining activities play a big role in job creation; 26.3% of respondents said that miming activities play a big role in increased income, 24.6% of respondents agree that mining activities play a big role in infrastructure development; 5.3% of respondents said that mining activities is important in business opportunities only 1.8% of respondents said there are other benefits of mining activities in Miyove sector.

Table 8: Distribution of Respondents by Household Which Has Been Employed by Mining Activity in Miyove Sector

Responses	Frequency	Percentage (%)
Yes	89	78
No	25	22
Total	**114**	**100.0**

Source: Primary data, July 2024.

Table 8 shows the respondents who have been employed by mining activity in Miyove sector. This displays that 78% of respondents have been employed by mining activities, while 22% of respondents have not been employed by mining activities in the Miyove sector.

Table 9: Distribution of Respondents by How Has Mining Employment Affects Your Household Income

Responses	Frequency	Percentage (%)
Increased significantly	34	29.8
Increased moderately	30	26.3
No significant change	25	21.9
Decreased moderately	15	13.2
Decreased significantly	10	8.7
Total	**114**	**100.0**

Source: Primary data, July 2024.

As the table above shows, 56.1% of respondents, indicating that a significant portion of respondents have experienced some level of increase in household income due to mining employment. Another option, at 21.9% of respondents, suggests a quarter of respondents report no change in household income, indicating mining activities have not significantly affected them economically. Lastly, 21.9% of respondents said they have experienced some level of decrease in household income due to mining activities.

3.2.6 Rate of the Contribution of Mining Companies to Community Development

The following table and figure present the rate of the contribution of mining companies to community development.

Table 10: Distribution of Respondents by Rate of Contribution of Mining Companies

Rate	Frequency	Percentage (%)
Very high	40	35.1
High	45	39.5
Moderate	20	17.5
Low	8	7
Very low	1	1
Total	**114**	**100.0**

Source: Primary data, July 2024.

The above table states that 35.1% of respondents state that mining companies contribute very high; 39.5% of respondents said that mining companies contribute moderate, 17.5% of respondents dispute that mining companies contribute moderate, remaining respondents, which equal to 8% of respondents, contribute low and very low, respectively.

Table 11: Distribution of Respondents by Environmental Challenges Associated with Mining Activities

Challenges	Frequency	Percentage (%)
Deforestation	8	7.0
Soil erosion	35	30.7
Water pollution	51	44.7
Habit destruction	11	9.6

Other	9	7.9
Total	**114**	**100.0**

Source: Primary data, July 2024.

In the above table state that 7% of respondents state that deforestation is an environmental challenge associated with mining activities. 30.7% of respondents dispute that soil erosion is an environmental challenge associated with mining activities, 44.7% of respondents state that water pollution is an environmental challenge associated with mining activities, 9.6% of respondents state that habitat destruction is an environmental challenge associated with mining activities, and only 7.9% of respondents state that there are other environmental challenges associated with mining activities.

4. Discussion of Findings

Based on the objective of the study, 59.6% of respondents very positive that mining activities has impact on economic development at Miyove sector; 39.5% of respondents said that mining play positive impact on economic development at Miyove, this support by Acheampong, (2004) proved this by saying that mining industry is very important to find out basic needs in human development as a way of getting richness. The mining sector has been a source of civilisation's development civilization based on principal minerals such as iron and bronze ages, the industrial revolution and the infrastructure of today's information age. Results indicate that 42.1% of respondents state that mining activities play a big role in job creation; 26.3% of respondents said that mining activities play a big role in increased income. The role of mining activities in job creation, similar to Britton & Lakhdari (2015), states that mining activities play a crucial role in job creation across different sectors of the economy. Beyond directly employing miners, these activities stimulate employment in support industries like equipment manufacturing, logistics and services.

As a result, indicate that 56.1% of respondents have experienced some increase in household income due to mining employment. 35.1% of respondents state that mining companies contributing very high; 39.5% of respondents said that mining companies contributing moderate, 30.7% of respondents dispute that soil erosion is environmental challenges associated with mining activities, 44.7% of respondents water pollution is environmental challenges associated with mining activities.

4.1 Summary of Findings

Survey findings reveal that 59.6% of respondents view mining's impact on economic development as "very positive," while only 1% perceives it negatively. Employment emerges as the most significant benefit, with 78% of households engaged in mining activities. Job creation (42.1%), income growth (26.3%), and infrastructure development (24.6%) were frequently cited advantages. However, environmental concerns remain prominent: water pollution (44.7%) and soil erosion (30.7%) were identified as major

challenges. These results suggest that while mining has transformed livelihoods in Miyove, its sustainability is undermined by ecological degradation.

5. Recommendations

Mining in Miyove Sector has demonstrated clear benefits for local economic development, particularly through employment creation, income growth, and infrastructure improvements. To maximize these gains, the government should strengthen policies that ensure mining revenues are invested in education, healthcare, and essential services, while also enforcing stricter environmental regulations to mitigate water pollution and soil erosion. Local leaders are encouraged to establish monitoring systems and facilitate dialogue between communities and mining companies, ensuring that development projects funded by mining revenues are inclusive and sustainable. Mining companies, for their part, must adopt responsible practices such as land rehabilitation, fair wages, and corporate social responsibility initiatives that directly benefit residents.

At the community level, households should diversify income sources to reduce dependency on mining and actively participate in decision-making processes related to mining projects. Researchers are also urged to conduct longitudinal studies on the socio-economic and health impacts of mining, providing evidence-based recommendations to policymakers. Collectively, these actions will help balance economic empowerment with ecological preservation, ensuring that mining remains a catalyst for sustainable development in the Miyove Sector and beyond.

6. Conclusion

Mining activities in Miyove Sector have substantially advanced local economic development, particularly through employment and income generation. The majority of respondents recognize mining as a positive force, with tangible benefits in household welfare and infrastructure. Yet, environmental challenges, notably water pollution and soil erosion, threaten long-term sustainability. For mining to remain a catalyst for development, policies must prioritize ecological preservation, community engagement, and equitable distribution of benefits.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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