SSRG International Journal of Civil Engineering
ISSN: 2348-8352/ https://doi.org/10.14445/23488352/IJCE-V13I4P109

Volume 13 Issue 4, 127-133, April 2026

Original Article

Strategy for Spatial Integration and Sustainable Mining Through SWOT Analysis in North Kolaka Regency

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Received: 08 January 2026 Revised: 10 February 2026 Accepted: 10 March 2026 Published: 28 April 2026

Abstract *- Mining in Indonesia continues to grow, supported by environmental and spatial planning policies, and social issues arise. This study aims to develop a model for implementing spatial and environmental strategies, social, and sustainable development policies in North Kolaka Regency. A descriptive qualitative approach using SWOT analysis as the main framework, accompanied by semi-structured interviews and a review of sectoral and spatial policy documents. The findings explain. The study's findings pinpoint effective geographic information system technology and compliance with zoning regulations as critical for monitoring environmental management. Weaknesses remain in the form of very limited community participation and weak law enforcement. There are opportunities in the form of improved government policies, technological innovation, and increased social awareness, while threats remain in the form of public criticism and unstable commodity prices. This study recommends a multi-aspect and multi-actor policy integration model to achieve sustainable mining development in North Kolaka Regency.*

Keywords *- Environmental, Sustainable mining, Spatial policy, Integration, SWOT analysis.*

1. Introduction

Global mining continues to grow in various countries. Many impacts of this project lead to sustainable development in the mining sector. Between 2001 and 2020, mining activities resulted in the loss of 1.4 million hectares of forest cover spread across Indonesia, Brazil, and Russia. Globally, 7.5% of active mining activities overlap with protected areas, including 4.6% in protected forests (ICMM, 2025). A total of 21% has an impact on social conflicts due to mining.

North Kolaka Regency, located in Southeast Sulawesi, is a regency with potential natural resources and minerals such as nickel and other metals. The obstacles are that mining activities are not based on the North Kolaka Regency Spatial Plan. Many legal and illegal mining permits are located in forest areas and overlap with other agricultural areas. Law enforcement is still weak, human resource capacity is limited, budgets are limited, and geospatial applications have not been maximized. The importance of research on strategies to integrate and implement multiple aspects through a SWOT approach for governance policies, economic growth, and sustainable mining in North Kolaka Regency. Through SWOT, researchers can systematically map internal and external factors influencing policy to environmental and competitive sustainability in the mining sector [1, 2]. However, sustainability also requires strategies and mitigation measures, as well as compliance with the requirements of a sound environmental impact analysis in mining [3-5]. Amoah and Eweje [3] identified collaboration regulations as a barrier to sustainability [6]. This research is important for integrating spatial planning aspects, particularly zoning regulations, into mining sector policy. This study contributes to spatial management and sustainable mining sector policy.

2. Literature Review

Skills are needed to compete and play a role in achieving sustainability. Competitiveness can arise from good business management [7]. Sustainability and competitiveness can be applied in various aspects [8, 9]. Company management supported by good internal development of human resources also encourages sustainable competitive advantage [10, 11]. Competitive companies are also characterized by their response to environmental changes [11, 12]. Overall, the synthesis between sustainable practices and strategic management creates competitive and resilient advantages [13, 14].

2.1. Environmental Impact

Pre-operational activities are the first step towards reducing the environmental impact of mining activities and achieving sustainability [5]. Companies are also a key factor in implementing pre-operational mining mitigation strategies,

as this is the first step in preventing future ecological damage [5]. In many cases, mining companies also integrate sustainability practices [15]. Integrating sustainability into regional strategic planning can promote competitiveness and a sense of sustainable responsibility [16, 17].

2.2. Strategic Spatial Planning and Sustainable Development

Improvements in environmental, social, and economic sustainability can be achieved through the strategic role of spatial planning [18, 19, 23-25]. It is indeed crucial that sustainable development goals are integrated into spatial planning [19].

2.3. SWOT Method for Spatial Planning Policy

The SWOT analysis method is a method for determining strategies and policies in various sectors, especially the mining sector [26-28]. This method also determines various risks, issues, and project problems from the outset for a good strategy [29].

Current research has examined the environmental impact of mining, mining company management, and the role of spatial planning, but has not yet comprehensively analyzed the implementation of spatial planning with a strategic approach to sustainable mining development. While multiple studies on mining look at social and ecological impacts, spatial planning is still underrepresented in policy documents for the advancing mining-related economic development, environmental sustainability, and social issues in mining development, both globally and nationally. Mining in Indonesia has not yet effectively addressed the above issues, resulting in numerous problems related to spatial planning, legal concerns, and unsustainable development in the mining sector. Therefore, it is important to integrate these issues into the policy implementation strategy. This research is novel in its integration of spatial aspects, legal, and unsustainable development issues in the mining sector amid vast mineral resources and urgent economic growth into the dimension of spatial planning through a SWOT strategy approach to produce mining development implementation policies in North Kolaka Regency.

The purpose of this study is to achieve a sustainable mining development spatial planning implementation strategy for North Kolaka Regency using the SWOT method to formulate governance policies for sustainable mining in North Kolaka Regency. This is hoped to assist in innovation for the policy strategy of sustainable mining development in Indonesia.

3. Methodology

This research approach uses descriptive qualitative analysis with the SWOT analysis method to determine opportunities, weaknesses, strengths, and threats, and to determine sustainable mining sector development policy strategies in North Kolaka Regency. This approach was chosen because it solves complex problems involving many actors.

3.1. Study Location

This research takes place in North Kolaka Regency, Province of Southeast Sulawesi, with a total population of 370,695. From the population, 15 people were recruited for the research sample. The following are the reasons for the research site selection: (a) the regency has significant nickel mining potential with 20 companies holding mining permits [31]; (b) there are still issues of illegal mining and conflicts of interest between the community, companies, and the local government.

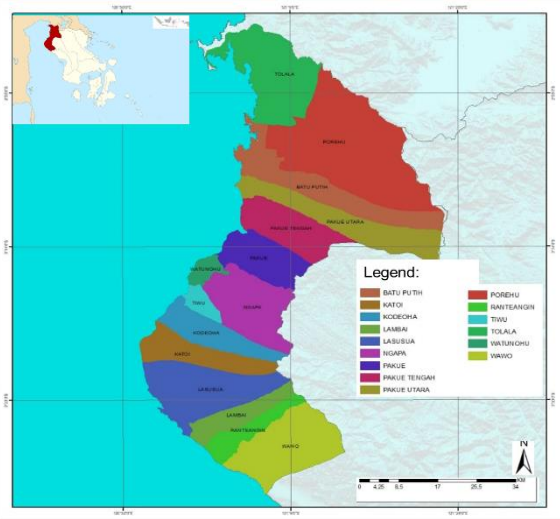

Fig. 1 Research location [31]

3.2. Data Collection

The data collection process and techniques are as follows: (a) Interviews were conducted with the community, village and sub-district authorities, the North Kolaka Regency Environment Agency, Spatial Planning Agency and Licensing Agency, and the Southeast Sulawesi Provincial Mining Agency, using a semi-structured instrument to gather data on social issues and problems, the status of illegal mining activities, efforts and policies to address illegal mining, and mining control efforts; (b) Review of regional policy documents, collection of licensing documents at the Licensing Agency, spatial planning documents for North Kolaka Regency, and environmental documents at the Environmental Agency of North Kolaka Regency.

3.3. Method of Analysis

After completing the data collection process, the next stage involved identifying the SWOT matrix using the interview data gathered from the community, community institutions, mining companies, village and sub-district governments, as well as the Spatial Planning Agency and Mining Agency. The above data was analyzed in terms of internal and external factors, and analyzed descriptively.

- Strengths: compliance with zoning regulations, project monitoring, and community participation.
- Weaknesses: violations of spatial planning, weak implementation and supervision, low community participation, and lack of concern from the private sector.
- Opportunities: external opportunities include pro-sustainability national initiatives and government regulatory support, private investment and regional economic growth, and heightened public awareness of spatial planning.
- Threats: external threats include poor mining governance, overlapping land use, and weak law enforcement. Changes in the price of mining commodities and regional dependence on economic growth.

3.4. Ethical Considerations

This research process was conducted ethically with the consent of the informants for interviews, the data was kept confidential, and permission for research was obtained from the North Kolaka government agency.

3.5. Research Limitations

This study emphasises the strategic identification of SWOT policies in the research area of North Kolaka Regency, which cannot be compared with other areas because it is not a comparative study.

However, this study serves as a reference and comparison for the sustainable development framework in the mining sector.

4. Results and Discussion

Table 1 EFAS and IFAS analysis obtained from interviews with the community, government, and companies, as well as policy document analysis in the mining sector.

The industrial position of the company is placed at coordinates (2,95 Figure 2. 2,87), specifically in the fifth quadrant depicted in (2,95 Figure 2) as follows, according to the computation above.

Table 1. IFAS and EFAS

IFAS			
Description	**Weight**	**Average**	**Score**
Strengths: Compliance with the spatial planning of North Kolaka Regency, use of GIS technology, and supervision of mining companies	0,757	3,26	2,470
Weaknesses: Weak community participation in villages and subdistricts, suboptimal coordination between the government, private sector, and community, and a lack of GIS technology in villages and subdistricts.	0,243	1,96	0,477
Total	1.000	-	2.947
EFAS			
Opportunities: public awareness, local government policy support	0,624	3.01	1,876
Threats: social conflict, uncertain commodity prices, weak law enforcement	0,376	2.64	0,995
Total	1.000	-	2.871

EFAS\IFAS	**Strong**	**Medium**	**Weak**
High	**I**	**II**	**III**
Medium	**IV**	**V**	**VI**
Low	**VII**	**VIII**	**IX**

Description

- IFAS Total:
  Strong = 3,0-4,0
  Medium = 2,0-2,99
  Weak = 1,0-1,99
- EFAS Total:
  High = 3,0-4,0
  Medium = 2,0-2,99
  Low = 1,0-1,99

Fig. 2 Internal and external quadrant matrix

Table 2. SWOT matrix for mining development policy

	Strength (S)	**Weakness (W)**
	1. Compliance with spatial planning and zoning regulations 2. Company efforts in spatial planning and zoning violations in forest and mining areas 3. North Kolaka Regency spatial planning policy with regional long-term plans 4. Use of GIS in agencies, villages, and subdistricts 5. Use of GIS technology for spatial and environmental monitoring. 6. Company policies on carbon emissions.	1. Some areas do not have adequate access to advanced monitoring technology 2. Coordination between stakeholders is sometimes less than optimal. 3. The company consistently reduces its carbon footprint and is committed to sustainability. 4. CSR programs can support good relationships. 5. Zoning violations have been detected in certain areas that do not comply with regulations. 6. The community's understanding of their rights in mining regulations is still lacking.
Opportunities (O)	**Strategi S-O**	**Strategi W-O**
1. Government policy in the utilization of mining space 2. Increase in mining investment 3. Raising social awareness in the village 4. Government incentives for environmentally friendly technology 5. Strict law enforcement 6. Community participation in decision-making	1. Regional government policies that support the sustainable management of mining areas 2. Increasing the use of GIS technology in the mining sector 3. Enhancing CSR activities 4. Government incentive efforts for environmentally friendly technology 5. Aligning planning policies and law enforcement	1. Increasing access to GIS technology in the Village 2. Optimizing coordination among stakeholders 3. Incentives for environmentally friendly technology 4. Enhancing CSR programs in the Village 5. Developing more environmentally friendly investments in the mining sector
Threats (T)	**Strategi S-T**	**Strategi W-T**
1. Fluctuations in mining commodity prices. 2. There is still much public opposition to mining. 3. Public concerns about health due to mining. 4. Operational costs in law enforcement. 5. GIS technology that has not been implemented. 6. Regulations are not strict in the mining sector.	1. Tighten zoning and mining area regulations 2. Promote the benefits of GIS technology in villages 3. Strengthen oversight and transparency of companies and the government 4. Good transparency 5. Internal supervision by the North Kolaka Regency government and mining companies	1. Improve coordination between actors and GIS technology to monitor the environment 2. Increase community participation to reduce public protests 3. Reduce social conflicts through justice, welfare, and public health 4. Enhance the use of GIS in villages and sub-districts 5. Improve fair CSR programs

The results of the identification in Table 2 regarding mining development and spatial planning policies can be addressed if an integrated strategy is implemented.

The integrated policy strategy consists of: (a) strengthening and implementing spatial planning in North Kolaka Regency as a guideline for controlling illegal mining; (b) empowering self-governing institutions and village governments in disseminating information about the benefits of GIS; (c) encouraging community participation in preventing social conflicts; and (d) providing fair distribution of CSR.

5. Discussion

One primary approach is to increase the utilization of government policies that support sustainable spatial management, as well as the use of Geographic Information System (GIS) technology to facilitate investment in the mining sector [32]. The implementation of a spatial information system can support environmental monitoring and sound planning [23]. Corporate Social Responsibility (CSR) assistance activities focused on promoting social sustainability [34]. Government and private incentives, especially environmentally friendly technologies, support sustainable development [35, 36]. The use of technology in the

region can ensure the implementation of spatial management systems [37]. Promoting the benefits of GIS information technology by the government through incentives to companies and communities via CSR programs can encourage social.

Within the framework of threat analysis, efforts to maintain compliance with zoning regulations in the North Kolaka Regency spatial plan and existing environmental regulations in the mining sector are very important to reduce the impact of commodity price fluctuations and potential public protests [38]. The utilization and application of GIS technology for spatial planning can be an effective tool for mediating, providing information, and education to the community [33] so that social conflicts can be reduced, and transparency of information in the field and government data in the operationalization of mining companies does not have a significant impact on public health.

The Weaknesses-Threats strategy is designed to mitigate weaknesses while addressing threats. Improving coordination and enhancing technology access in remote areas is imperative to ensure that all mining-affected regions are recognized and involved in spatial dialogue [35]. Increasing community participation in public consultations will greatly assist in alleviating potential protests or opposition to mining activities, as well as improving health management to positively influence company-community relations. This includes more focused CSR management on social and environmental impacts to ensure that the needs and expectations of local communities are adequately met [39].

The SWOT results show the strategic form of the main strengths, namely, compliance with spatial planning regulations and community participation, while weaknesses include weak supervision and low community involvement. These findings are consistent with those of prior works, which highlight space-based governance [23, 33]; this research advances by combining GIS with CSR to address social conflict. These are important for resolving social problems in mining areas and promoting social cohesion in the community. The (W-T) strategy encourages stakeholder coordination and affordable access to technology in sub-districts. This study also encourages the important practical implications of integrated policies between spatial planning, GIS technology, and the fair and equitable distribution of CSR programs in mining conflict areas to strengthen sustainable mining governance in the North Kolaka Regency.

6. Conclusion

The government is still not sufficiently involved in addressing issues of justice and social conflict in the mining sector. Various government policies still favor certain groups and, of course, companies in dealing with issues in the mining sector, especially illegal mining in North Kolaka Regency. Policies that favor these groups will lead to an increase in social conflict. The government's efforts to implement the North Kolaka Regency spatial plan and promote environmental monitoring by utilizing GIS technology to oversee the management of mining areas in North Kolaka Regency.

The negative impacts include a lack of coordination between government agencies, companies, and communities in North Kolaka Regency, limited GIS technology in village and subdistrict devices, and a lack of social responsibility. External findings include the company's strategy to promote mining policies and the North Kolaka Regency government's policy to encourage sustainable development, promote incentive policies for the use of GIS technology in institutional devices throughout villages and sub-districts, and raise public awareness of the dangers of illegal mining activities to the environment and surrounding communities. Therefore, strategies and policies to minimize problems and social impacts require legal certainty, social justice, and community welfare in mining areas. Communication and coordination between actors involved in mining, the procurement of GIS technology and equipment, and the improvement of CSR programs in villages and subdistricts in North Kolaka Regency are very important.

Acknowledgments

We would like to express our gratitude to the North Kolaka Regency Government and the Bosowa University Postgraduate Programme for their assistance in conducting this study.

References

[1] Luthfi Marfungah et al., “Implementing Spatial Planning based on Environmental Sustainability in the Mining Area,” *International Journal of Humanities Education and Social Sciences (IJHESS)*, vol. 3, no. 4, pp. 2118-2135, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[2] Yuliia Lazarenko et al., “Gaining a Competitive Advantage Through Sustainability Strategy: Managerial Applications for the Mining Sector,” *E3s Web of Conferences*, EDP Sciences, vol. 278, pp. 1-8, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[3] Prince Amoah, and Gabriel Eweje, “Impact Mitigation or Ecological Restoration? Examining the Environmental Sustainability Practices of Multinational Mining Companies,” *Business Strategy and the Environment*, vol. 30, no. 1, pp. 551-565, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[4] Yuli Prasetyo Adhi, Iga Gangga Santi Dewi, and Bambang Eko Turisno, "Ecological Impacts and Socio-Legal Infrastructure as an Approach to Environmental Management in Ex-Mining Land Reclamation," *International Journal of Sustainable Development and Planning*, vol. 17, no. 7, pp. 2279-2285, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[5] Zhisheng Huang, "The Potential and Models of Agricultural Utilization of Reclaimed Mine Land," *International Journal of Education and Humanities*, vol. 15, no. 3, pp. 281-285, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[6] H. Fajri et al., "Mining Tourism: A Sustainable Ex-Mining Management Strategy in Sawahlunto City," *Iop Conference Series: Earth and Environmental Science*, vol. 1422, no. 1, pp. 1-6, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[7] Hanqing "Chevy" Fang, Josip Kotlar, and James J. Chrisman, "Family Control and Sustainable Competitive Advantage," *Family Business Review*, vol. 38, no. 2, pp. 84-120, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[8] Sumaryo et al., "Sustainable Green Intangible Asset, Financial Performance, and Sustainable Competitive Advantages," *Calitatea*, vol. 25, no. 199, pp. 193-204, 2024. [CrossRef] [Google Scholar]

[9] Veronika Tarnovskaya, *Sustainability as the Source of Competitive Advantage. How Sustainable is it?*, Emerald Publishing Limited, vol. 37, pp. 75-89, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[10] Latoya Newell Burke, and Yvette Holmes, "The Role of Human Resources Management in Sustainable Competitive Advantage," *International Journal of Applied Research in Business and Management*, vol. 4, no. 2, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[11] Lei Xi, Caichao Liu, and Yu Sun, "Promotion Path and Application of Enterprises Sustainable Competitive Advantage: Perspective of TMT Behavior Integration," *Mathematical Problems in Engineering*, vol. 2022, no. 1, pp. 1-11, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[12] Paweł Cegliński, "The Relations Between Dynamic Capabilities and Core Competencies. The Case Study of Uzdrowisko Ciechocinek S.A.," *Journal of Positive Management*, vol. 13, no. 1, pp. 96-110, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[13] Arizal Liwafa, Bagong Suyanto, and Zuyyinna Choirunnisa, "Sustainable Competitive Advantage: A Literature Review and Future Research," *RSF Conference Series Business Management and Social Sciences*, vol. 3, no. 3, pp. 428-439, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[14] Ulrich Lichtenthaler, "Explicating a Sustainability-based View of Sustainable Competitive Advantage," *Journal of Strategy and Management*, vol. 15, no. 1, pp. 76-95, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[15] E. Lopes et al., "Mine Closure Commencing Alongside Business Analysis," *Proceedings of the 16th International Conference on Mine Closure*, Australian Centre for Geomechanics, Perth, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[16] Ivan Miroshnykov et al., "Ensuring the Environmental Sustainability of Molybdenum Ore Mining," *Iop Conference Series: Earth and Environmental Science*, vol. 1457, no. 1, pp. 1-11, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[17] Gianna S. Himmelsbach et al., "Exploring the Impact of Mining on Community Health and Health Service Delivery: Perceptions of Key Informants Involved in Gold Mining Communities in Burkina Faso," *International Journal of Environmental Research and Public Health*, vol. 20, no. 24, pp. 1-21, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[18] Anna Martyka, Dorota Jopek, and Izabela Skrzypczak, "Analysis of the Sustainable Development Index in the Communes of the Podkarpackie Voivodeship: A Polish Case Study," *Sustainability*, vol. 14, no. 16, pp. 1-23, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[19] Roland Zinkernagel, and Lena Neij, "Localizing SDGs: The Case of City Planning in Malmö," *Frontiers in Sustainable Cities*, vol. 5, pp. 1-11, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[20] Miranda Dandoulaki et al., "Disaster Risk Management and Spatial Planning: Evidence from the Fire-Stricken Area of Mati, Greece," *Sustainability*, vol. 15, no. 12, pp. 1-24, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[21] Tianbin Mao, and Qian Li, "The Impact of Sustainable Development and Spatial Rationality Planning of Urban Buildings Under the Guidance of Local Government Policies: Environmental Policy and Green Building Design Principles," *Lex Localis - Journal of Local Self-Government*, vol. 22, no. 1, pp. 197-216, 2024. [CrossRef] [Google Scholar] [Publisher Link]

[22] Martina Carra et al., "Widespread Urban Regeneration of Existing Residential Areas in European Medium-Sized Cities-A Framework to Locate Redevelopment Interventions," *Sustainability*, vol. 15, no. 17, pp. 1-23, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[23] Lauren Andres et al., *Planning for Sustainable Urban Livelihoods in Africa*, 1st ed., The Routledge Handbook on Livelihoods in the Global South, Routledge, 2022. [Google Scholar] [Publisher Link]

[24] Eugene Eremchenko et al., "Sustainable Development: Understanding the Least Resource Base," *Geography Environment Sustainability*, vol. 14, no. 1, pp. 25-32, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[25] Paolo Picchi et al., "Deploying Ecosystem Services to Develop Sustainable Energy Landscapes: A Case Study from the Netherlands," *Smart and Sustainable Built Environment*, vol. 11, no. 3, pp. 422-437, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[26] Sujan Raj Paudel, and Prajita Thapa, "Impact of Environmental, Social, Governance Factors on Consumers' Behavior in the Light of Digital Transformation," *Journal of Service, Innovation and Sustainable Development*, vol. 6, no. 1, pp. 87-107, 2025. [CrossRef] [Google Scholar]

[27] Ernani Hadiyati, and Ferdian Hendrasto, "Entrepreneurial Marketing Strategy of Micro, Small and Medium Enterprises in Pandemic Covid-19 Era," *International Journal of Economics and Business Administration (IJEBA)*, vol. 9, no. 2, pp. 178-191, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[28] Ceyda Aksoy Tırmıkçı, "Emerging Strategies for the Sustainable Development of Solar Energy Sector in Turkey: A SWOT Analysis," *Research Square*, pp. 1-17, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[29] Favourite Mhlongo, "Pervasive Skills and Accounting Graduates' Employment Prospects: Are South African Employers Calling for Pervasive Skills When Recruiting?," *Journal of Education (University of KwaZulu-Natal)*, vol. 80, pp. 49-71, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[30] Pamela L. Krahl et al., "Training Occupational and Environmental Medicine (OEM) Residents at the Uniformed Services University," *Journal of Occupational and Environmental Medicine*, vol. 63, no. 5, pp. 403-410, 2021. [CrossRef] [Google Scholar] [Publisher Link]

[31] Ilham Yahya et al., "Integrated Impact of Zoning Compliance, Monitoring, Participation, Multi-Stakeholder Support, and Technology Support on Spatial Policy Implementation and ESG Sustainability in the North Kolaka Mining Sector," *International Journal of Sustainable Development and Planning*, vol. 20, no. 10, pp. 4421-4428, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[32] Yosoon Choi, Jieun Baek, and Sebeom Park, "Review of GIS-based Applications for Mining: Planning, Operation, and Environmental Management," *Applied Sciences*, vol. 10, no. 7, pp. 1-25, 2020. [CrossRef] [Google Scholar] [Publisher Link]

[33] Artur Krawczyk, "Mining Geomatics," *ISPRS International Journal of Geo-Information*, vol. 12, no. 7, pp. 1-20, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[34] Michal Apollo et al., "Geodata in Science-A Review of Selected Scientific Fields," *Acta Scientiarum Polonorum: Formatio Circumiectus*, vol. 22, no. 2, pp. 17-40, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[35] Debao Yuan et al., "Application of Optimized Grey-Markov Model to Land Subsidence Monitoring with InSAR," *IEEE Access*, vol. 10, pp. 96720-96730, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[36] Vanessa Assumma et al., "Evaluation of Ecosystem Services in Mining Basins: An Application in the Piedmont Region (Italy)," *Sustainability*, vol. 14, no. 2, pp. 1-25, 2022. [CrossRef] [Google Scholar] [Publisher Link]

[37] Mohamed Ali, Ahmed Abd El-Aziz, and Mohamed Elwageeh, "Optimization of Escape Routes During Mine Fire using GIS," *Mining Technology: Transactions of the Institutions of Mining and Metallurgy*, vol. 132, no. 1, pp. 54-64, 2023. [CrossRef] [Google Scholar] [Publisher Link]

[38] Hualuoye Yang, Declan Redmond, and Brendan Williams, "Starting Again: National Spatial Planning and the Quest for Compact Growth in Ireland," *European Urban and Regional Studies*, vol. 32, no. 3, pp. 261-274, 2025. [CrossRef] [Google Scholar] [Publisher Link]

[39] Ari Agung Nugroho et al., "Analysis of Tin Stock Investment Projections During the Covid-19 Pandemic," *International Journal of Business Technology and Organizational Behavior (IJBTOB)*, vol. 3, no. 1, pp. 56-61, 2023. [CrossRef] [Google Scholar] [Publisher Link]