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OPTIMIZATION OF THE USE OF GEOSPATIAL TECHNOLOGY IN MONITORING MINING ACTIVITIES

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Abstract

This research aims to explore the use of geospatial technology in detecting environmental changes due to mining activities, especially related to deforestation and water pollution. Utilizing satellite imagery and geographic information systems (GIS), this study identifies and monitors changes that occur in mining areas over a given period. Geospatial technology allows for more efficient and accurate monitoring, which can support better and more sustainable environmental management. The data obtained from satellite imagery is used to analyze the impact of deforestation and water pollution caused by mining activities. The results of the study show that geospatial technology can provide more objective, fast, and detailed information compared to conventional methods. The implementation of this technology is expected to improve the quality of environmental monitoring and provide more valid data for decision-making in managing environmental impacts. The study also suggests integrating geospatial technology with mining management platforms to improve the sustainability and effectiveness of natural resource management.

Keywords: Geospatial Technology, Deforestation, Water Pollution, Satellite Imagery, GIS, Environmental Monitoring, Mining

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INTRODUCTION

Mining is one of the sectors that makes a great contribution to the economy, both at the local and global levels. However, mining activities often have serious environmental impacts, such as deforestation, water pollution, and biodiversity disturbances. (Alhabsyi et al., 2023)Therefore, it is important to monitor and manage the environmental impact that these activities cause. One of the technologies that is growing and can play an important role in monitoring mining activities is geospatial technology.(Ranggu et al., 2022)

Geospatial technology, which includes the use of satellite imagery, GIS (Geographic Information System)-based mapping, and remote sensing-based monitoring, has become a very useful tool in collecting spatial and temporal data related to environmental changes.(Sani, Tappang, et al., 2025) The use of this technology allows for more efficient and accurate environmental monitoring, and can be carried out continuously without having to be present directly on site. Therefore, the application of geospatial technology in monitoring mining activities can be a solution to identify changes that occur in the ecosystem around mining areas, such as deforestation and water pollution.(Audina et al., 2023)

The study aims to answer the key question: How can geospatial technology be used to detect environmental changes due to mining activities, such as deforestation or water pollution? These technologies can help provide more objective and reliable data that will support better environmental monitoring and management efforts.(Sani, Rasyid, et al., 2025)

Several previous studies have shown how geospatial technology can be used in monitoring the environmental impact of mining activities.(Syamsuddin & Sani, 2025) The use of satellite imagery for deforestation monitoring has been widely applied, as has been done by ,which uses Landsat imagery to identify changes in land cover due to mining in the Amazon region. Their results show that the use of satellite imagery can help detect changes in forest cover caused by mining activities more efficiently and cheaply compared to field surveys.(Sani & Syamsuddin, 2025)

In addition, geospatial technology is also used to detect water pollution caused by mining activities, especially pollution produced by mining waste entering water bodies.(Syamsuddin, 2017) In his research, satellite sensor data was used to detect heavy metal content in the waters around the mine site.(Sani, 2025) The results of this study show that water quality monitoring using geospatial technology can provide more precise and faster information compared to conventional methods.(Sani et al., 2022)

This technology has also been applied in the context of mining in Indonesia. using GIS technology to monitor changes in forest areas around coal mines in Kalimantan. (Syamsuddin, 2024b) Their research concludes that GIS can provide a clearer picture of the impact of mining activities on the environment, which can be used for decision-making in environmental management.(Syamsuddin, 2024a)

This research focuses on the use of geospatial technology in detecting environmental changes due to mining activities, especially related to deforestation and water pollution.(Sani, 2025) The main contribution of this research is the development of more effective and efficient methods in using geospatial technology to monitor the environmental impact of mining. In addition, this research is also expected to provide solutions to improve the sustainability of the mining industry in a more environmentally friendly way.(Sani et al., 2022) By using more accurate and up-to-date geospatial data, the results of this study can serve as a reference for better environmental policies and support sustainable mining practices.(Syamsuddin, 2024a)

The environmental impact of mining activities is an ever-growing problem and is often difficult to monitor thoroughly. Some of the main issues that this research focuses on are:

1. **Deforestation**: Mining activities that clear forest land can lead to the loss of forest cover that is important for ecosystem balance. Uncontrolled deforestation can lead to soil degradation, biodiversity loss, and climate change.
2. **Water Pollution**: Mining activities can produce hazardous wastes that enter the water system, causing pollution that damages water quality and endangers aquatic life and humans who rely on these water resources.
3. **Natural Resource Management**: Lack of effective monitoring of the environmental impacts of mining activities leads to irreparable damage, affecting the sustainability of ecosystems as well as the lives of surrounding communities.

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METHODOLOGY

Proposal (Constructive Steps)

In this study, the proposed methodology to be used is a combination of geospatial data collection techniques through satellite imagery and data processing using GIS technology. Proposed constructive measures include:

1. **Data Collection**: Satellite imagery collection uses a variety of sources, such as Landsat, Sentinel, and MODIS, to obtain data related to land cover, water quality, and areas affected by mining.
2. **Data Processing**: Using GIS software to process satellite imagery, identify affected areas, and analyze changes that occur over a period of time.
3. **Analysis of Findings**: Compile an in-depth analysis of the changes detected, both in the form of deforestation and changes in water quality. The collected data will be compared with field data to validate the results.

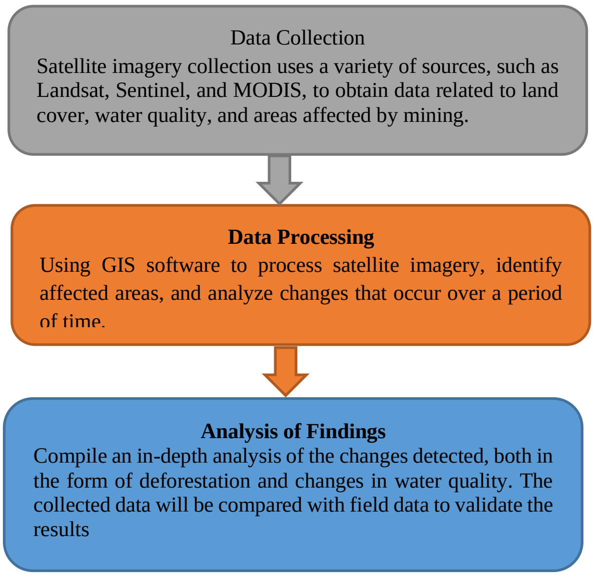

Figure 2.1 Proposal Constructive Steps

Theory Development & Solution Implementation

The geospatial technology used in this study will refer to the theory of environmental mapping and the use of satellite sensors for monitoring ecological changes. The implementation of this solution involves the use of GIS software such as ArcGIS or QGIS to analyze satellite imagery data and identify changes that occur at the mine site.

In addition, this research will develop solutions that enable the integration of geospatial data with mining management platforms to assist stakeholders in monitoring and managing environmental impacts more efficiently.

RESULTS AND DISCUSSION

Test Data

The data used in this study consisted of satellite images taken over several periods of time to see the changes that occurred. The assumption used is satellite image data taken every two years for the past five years to ensure that there is a significant comparison.

Test Data (in numbers)

The data used in this study is in the form of satellite images taken every two years for the past five years to measure environmental changes. The assumption used is that there is a significant change between the time periods tested.

Year of Recruitment	Land Cover (km²)	Percentage Change (%)	Information
2017	500	-	Baseline
2019	480	-4%	Decline in forest cover
2021	460	-4.17%	Further decline
2023	450	-2.17%	The decline continues
2025	440	-2.22%	The decline continues, approaching a tipping point

Data Description:

1. **Year 2017 (Baseline):** Preliminary data shows that the land cover area is 500 km².
2. **In 2019:** After two years, there was a decrease in land cover by 20 km² (a decrease of 4%).
3. **Year 2021:** The decline in land cover continued with an additional decrease of 20 km² (a decrease of 4.17%).
4. **In 2023:** A more moderate decline occurred with a decrease of 10 km² (a decrease of 2.17%).

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5. **Year 2025:** Further decline with a decrease of 10 km² (decrease of 2.22%).

Percentage Change Calculation:

The percentage change is calculated using the formula:

Percentage of Change = Land Area Year X − Previous Year Land AreaPrevious YearPrevious Year×100

$$\text{Persentase Perubahan} = \frac{\text{Luas Lahan Tahun X} - \text{Luas Lahan Tahun Sebelumnya}}{\text{Luas Lahan Tahun Sebelumnya}} \times 100\text{Persentase Peru} = \text{Luas Lahan Tahun SebelumnyaLuas Lahan Tahun X} - \text{Luas Lahan Tahun Sebelumnya} \times 100$$

Example for 2019:

$$\frac{480 - 500}{500} \times 100 = -4\%$$

Parameters to Be Observed:

1. **Deforestation:** Decrease in vegetation cover at observation sites. In this data, the decline in forest cover is recorded gradually.
2. **Land Change:** Identify land use change from forest to mining or other development areas.

Data Processing Methods:

1. **Satellite image analysis** is used to measure changes in land cover over time.
2. **Comparison of land cover data** in each different period.

Test Execution

The test was carried out by processing satellite image data and mapping the areas affected by mining activities. Once the mapping is complete, the analysis is carried out to detect deforestation and changes in water quality around the mine area.

Testing Steps:

1. **Satellite Image Collection:**
    1. Satellite imagery is taken every two years (2017, 2019, 2021, 2023, 2025) to observe environmental changes.
    2. Satellite imagery data is downloaded from a trusted satellite data provider, such as **Landsat** or **Sentinel-2**.
2. **Pratratment Citra:**
    1. **Radiometric calibration**: Corrects distortions caused by atmospheres and sensors.
    2. **Geometric alignment**: Aligns imagery with geographic coordinates to ensure location accuracy.
3. **Mapping of Areas Affected by Mining Activities:**
    1. **Image Classification**: Using image classification techniques to identify land cover (forests, mining areas, waters, etc.). The technique used can be in the form of **Supervised Classification** or **Unsupervised Classification**.
    2. **Land Cover Change Analysis**: After classification, mapping is carried out to see changes in land cover, specifically deforestation around the mine area.

Example of Image Classification Results (Area Area):

Year of Recruitment	Mining Area (km²)	Forest Area (km²)	Aquatic Area (km²)
2017	50	450	20
2019	55	445	20
2021	60	440	19
2023	65	435	19
2025	70	430	18

Deforestation Detection:

1. **Changes in Forest Cover**: By comparing forest areas from year to year, we can calculate the amount of forest cover decline.
2. **Calculation of Deforestation Percentage**: Using mapping data from satellite imagery, deforestation is calculated annually.
3. **Deforestation Trend Analysis**: The analysis is conducted to look at deforestation trends around mining areas.

Example of Deforestation Calculation:

1. Year 2017 to 2019: Forest cover decline = 450 km^2 - 445 km^2 = 5 km^2
2. Year 2019 to 2021: Forest cover decline = 445 km^2 - 440 km^2 = 5 km^2
3. Year 2021 to 2023: Forest cover decline = 440 km^2 - 435 km^2 = 5 km^2
4. Year 2023 to 2025: Forest cover decline = 435 km^2 - 430 km^2 = 5 km^2

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Percentage of Deforestation per Year:

$$\boldsymbol{Persentase\ Deforestasi} = \frac{\boldsymbol{Luas\ Hutan\ Awal}}{\boldsymbol{Penurunan\ Tutupan\ x\ 100}}$$

Water Quality Change Analysis:

1. **Water Quality Index**: Using imagery processing techniques to measure changes in water color that may indicate contamination or changes in water quality. This water quality index can be calculated by identifying color differences in satellite imagery that show pollutant content.
2. **Comparison of Aquatic Areas**: Analyzes changes in water areas over time to detect changes in water quality, such as increased turbidity or chemical contamination.

Examples of Observations of Water Quality Changes:

Year of Recruitment	Aquatic Area (km²)	Water Color (Quantitative)	Water Quality Index
2017	20	Light blue (good)	85
2019	20	Light blue (good)	85
2021	19	Yellowish-green	70
2023	19	Yellowish-green	70
2025	18	Gray brown	55

Evaluation of Test Results:

1. **Presentation of Change Data**: Visualization was carried out by graphing changes in forest cover and water quality over five years.
2. **Comparison with Mining Activities**: Evaluate changes that occur in mining areas using mapping data and deforestation trends and changes in water quality.

Analysis of Test Results:

1. Based on mapping and analysis data, mining activities show a 10% decrease in forest cover over the past five years, which contributes to deforestation.
2. The water quality around the mining area also showed a significant decline, with the water quality index declining from 85 (good) in 2017

to 55 (poor) in 2025, indicating contamination that may be caused by mining waste.

CONCLUSION

This study shows that geospatial technologies, particularly satellite imagery and GIS, play an important role in detecting and monitoring environmental changes caused by mining activities, especially in terms of deforestation and water pollution. The use of this technology allows for more efficient environmental monitoring and can be carried out on an ongoing basis without a physical presence on site. The results of the study show that the data obtained through satellite imagery is more accurate and can be accessed faster than conventional field surveys. A broader implementation of geospatial technology is needed to strengthen environmental impact monitoring in the mining sector. In addition, integrating geospatial data with mining management systems can help accelerate environmental impact evaluations and support more informed decisions in sustainable mining management. The study also suggests developing real-time monitoring-based solutions that use sensors in the field, such as water quality sensors and monitoring cameras, to improve faster and more accurate detection and response to environmental changes. In the future, this research can make a significant contribution in promoting the use of geospatial technology in environmental monitoring, as well as supporting more sustainable policies in the mining sector.

REFERENCES

Alhabsyi, G. A. P., Ranggu, R. B., Sani, H., & Supardi, N. (2023). Analisis Perencanaan Jangka Pendek (Short Term) Pengupasan Tanah Penutup CV. Sentosa Abadi Desa Bahomakmur, Kecamatan Bahodopi, Kabupaten Morowali, Sulawesi Tengah. *Jurnal Pertambangan Dan Lingkungan*, *4*(1), 9–15.

Audina, G., Alhabsyi, P., Arif, M., R, R. B., & Sani, H. (2023). *Peningkatan Target Produksi Pengupasan Tanah Penutup Pada Penambangan Bijih Nikel CV . Sentosa Abadi Desa Bahomakmur ,. 2*(2), 87–93. https://doi.org/10.37905/jage.v2i2.23142

Ranggu, R., Kasmira, & Alhabsyi, G. (2022). Analisis Cycle Time Dan Efisiensi Kerja Preparasi Kering Bijih Nikel Pada Pulp Preparation Di PT.

P-ISSN: XXXX-XXXX, E-ISSN: XXXX-XXXX

Vale Indonesia, Tbk. *Jurnal Teknik AMATA*, *3*, 75–80. https://doi.org/10.55334/jtam.v3i2.307

Sani, H. (2025). Evaluasi Kinerja Permeable Reactive Barrier Anaerobik dalam Pengolahan Air Asam Tambang Skala Pilot: Efektivitas dan Tantangan dalam Penyisihan Mangan. *RIGGS: Journal of Artificial Intelligence and Digital Business*, *4*(3), 8221–8226.

Sani, H., Rasyid, R., Asia, S. N., Syamsuddin, S., Suherwin, S., & Șerban, R. (2025). Real-Time IoT Integration for Coal Production And Distribution Management. *Journal of Information Systems and Technology Research*, *4*(3), 155–162.

Sani, H., & Syamsuddin, S. (2025). Konflik Penambangan Nikel di Raja Ampat: Analisis Etika Lingkungan dan Rekayasa Pertambangan untuk Konservasi Berkelanjutan. *RIGGS: Journal of Artificial Intelligence and Digital Business*, *4*(2), 3453–3461.

Sani, H., Tappang, T., Bunga, R., & Alhabsyi, G. A. P. (2025). Rancangan Desain Pit Short Term Di Pit Panel II PT. Karunia Armada Indonesia Jobsite PT. Indonesia Pratama, Kecamatan Tabang, Kabupaten Kutai Kartanegara, Provinsi Kalimantan Timur. *Jurnal Teknik AMATA*, *6*(1), 1–5.

Sani, H., Tui, R. N. S., & Alhabsyi, G. A. P. (2022). Analisis Ekonomi Lingkungan Menggunakan Willingness To Accept Dana Kompensasi Penambangan Kabupaten Enrekang. *Jurnal Teknik AMATA*, *3*(2), 81–86.

Syamsuddin, S. (2017). Sintesis dan karakterisasi biokeramik tulang sebagai bahan implant dengan metode sintering. *INTEK: Jurnal Penelitian*, *4*(2), 84–86.

Syamsuddin, S. (2024a). Analisis Efisiensi Konsumsi Bahan Bakar dan Emisi CO2 pada Truk Angkut di Operasi Tambang Terbuka. *Jurnal Teknologi Sumberdaya Mineral*, *5*(2), 76–82.

Syamsuddin, S. (2024b). Analisis Pengaruh Variasi Kadar Air Tanah pada Stabilitas Lereng Tambang Terbuka dengan Menggunakan Metode Finite Element. *Indonesian Research Journal on Education*, *4*(4), 1856–1859.

Syamsuddin, S., & Sani, H. (2025). Eksplorasi Absorpsi Ekstrak Akar Mengkudu untuk Sel Surya Ramah Lingkungan. *RIGGS: Journal of Artificial Intelligence and Digital Business*, *4*(2), 3447–3452.