

# The Management Standards of Hazardous and Toxic Waste in Mining According to Law Number 32 of 2009 and Its Implications on Health and Environmental Well-being

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**Abstract.** The annual increase in B3 mining waste, which includes hazardous materials, poses a growing environmental threat due to rising mining demands for both domestic and international markets. Failure to implement an effective waste management system could lead to severe environmental disasters. B3 mining waste results from mining operations and companies, exhibiting explosive, flammable, reactive, toxic, infectious, corrosive, and radioactive properties, causing pollution and health degradation. Environmental quality deterioration jeopardizes human and wildlife survival, necessitating stringent environmental protection and management measures, as outlined in Law No. 32 of 2009 on Environmental Protection and Management, further detailed in Presidential Regulation No. 22 of 2021. This paper employs a normative legal research approach using secondary data sources such as books, journals, and online media, along with primary legal sources like the UUD 1945 Constitution, laws, and presidential regulations, analyzing the data qualitatively.

**Keywords:** Hazardous Waste, Living Environment, Standart Management

## 1 Introduction

The environment and living organisms mutually depend on and influence each other. The environment encompasses all external factors that affect an organism, including both living (biotic factors) and non-living variables (abiotic factors). The environment, as a spatial entity that encompasses all objects, forces, conditions, living organisms, including humans and their behaviors, impacts the natural world. In ecological science, nature is perceived as a web of interconnected life systems.[1] According to expert Munadjat Danusaputro, the environment or the living environment includes all objects, forces, conditions, including humans and their behaviors, that exist within the space where humans reside and influence the sustainability and well-being of humans and other living entities. Indonesia, as a legal state based on Pancasila and the 1945 Constitution, aims to achieve the welfare, peace, harmony, and order of national and state life, as well as communal law and the equal status of citizens.[2]

Meanwhile, Otto Soemarwoto defines the living environment as the space occupied by a living creature, along with living and non-living entities within it. In Law Number 32 of 2009 Article

(1) on Environmental Protection and Management, the living environment is defined as a spatial unit encompassing all objects, forces, conditions, living organisms, including humans and their behavior, which influence nature itself, the sustainability of life, and the well-being of humans and other living beings.

Indonesia is renowned for its abundant natural resources, making it one of the world's largest mining producers.[3] The mining sector has rapidly grown, significantly contributing to the country's revenue. However, apart from contributing to social and economic progress, mining activities also pose health and environmental challenges.[4] In every mining activity, environmental pollution occurs, affecting water, air, and soil, often through mining waste.[5] According to the Indonesian dictionary (KBBI), waste is the byproduct of production processes, materials with no value, or damaged/defective items in the production process. Mining waste refers to the disposal or waste generated from mining company activities.[6]

Waste with characteristics such as explosiveness, flammability, reactivity, toxicity, infectiousness, corrosiveness, and the presence of radioactive substances falls under the category of hazardous and toxic waste (B3).[7] Based on the Indonesian Government Regulation Number 27 of 2020 on the Management of Specific Waste, hazardous and toxic substances (B3) are materials, energy, and/or other components that, due to their properties, concentration, and/or quantity, whether directly or indirectly, can contaminate and/or damage the environment, endanger human and other living beings' health and well-being, and their survival.

Despite existing laws and regulations, many actions in society still contradict these legal rules, causing concerns and losses for the community.[8] Consequently, various types of crimes occur, and some individuals do not hesitate to take lives for specific purposes. Criminal law serves as a means for the state to respond to reprehensible behavior, with the criminological premise that sanctions have a deterrent effect on offenders. The proliferation of hazardous waste pollution has become a contentious issue in Indonesia. Numerous regions across the country, such as Banten, DKI Jakarta, West Java, East Java, North Sulawesi, South Sumatra, Riau, and Kalimantan, frequently experience cases of illegal disposal of hazardous waste, inadequate temporary storage of hazardous waste, leaking storage facilities, excessive storage capacity, and negligence in hazardous waste management.

Data from the Ministry of Environment and Forestry indicates that by 2009, there were approximately 1.12 million square meters of land contaminated with hazardous and toxic waste (B3), equivalent to around 111.72 hectares, with an estimated weight of 1.24 million tons of waste and contaminated soil. As of July 2019, there were 40 emergency cases of B3 waste management at the enterprise and activity levels, with 10 of these cases handled by the Ministry of Environment and Forestry, while the rest were managed by the responsible parties under the supervision of local government authorities. In 2020, the amount of B3 waste further increased to 200 million tons. The rising quantity of B3 waste signifies an escalating potential for environmental disasters if proper waste management systems are not implemented.[9]

This reality contradicts Indonesia's Constitution, the 1945 Constitution, in Article 28H Paragraph (1), which states, "Every person has the right to a prosperous life, both physically and mentally, to reside, and to have a good and healthy environment, as well as the right to obtain health services." In Law Number 17 of 2023 concerning health, it is also stated that the state ensures the right of every citizen to achieve a good, healthy, and prosperous life, both physically

and mentally, to fulfill the national objectives of protecting all Indonesian citizens and their descendants to advance the general welfare, as mandated in the 1945 Constitution of the Republic of Indonesia. Health problems and disorders in the community can reduce productivity and incur losses for the state. Therefore, there is a need for more comprehensive government oversight and intervention in the management of B3 waste to create a healthy environment.

Environmental health, according to HAKLI (Association of Indonesian Environmental Health Experts), is a condition of the environment that can maintain a dynamic ecological balance between humans and their surroundings to support the quality of a healthy and happy human life. The goals of environmental health are twofold: first, to reduce or modify the hazards in the environment to safeguard human health and well-being, and second, for the prevention and efficient regulation of various environmental sources to improve human health and well-being while avoiding the hazards of diseases.[10]

In line with its objectives, environmental health aims to establish a harmonious condition of all environmental factors, where human physical development is benefited, human health and life expectancy are preserved and enhanced.[11] Therefore, in this discussion, the author will address how the standards for managing mining hazardous and toxic waste (B3) are established based on Law Number 32 of 2009 and how B3 mining waste impacts the health and the environment to maintain the quality of public health and restore a healthy environmental function for all living beings on Earth.

## **2 Method**

The research method employed in this study is normative legal research, with the collection of secondary data derived from books, journals, and information from online media.[12] Primary legal data sources consist of the 1945 Constitution, laws, and government regulations. Subsequently, data analysis is carried out using a qualitative method grounded in behavioral sciences and other social sciences to understand the interaction between humans and their environment.[13] This writing is a literature review that delves into the standards for managing mining hazardous and toxic waste (B3) based on Law Number 32 of 2009, as well as the impact of B3 mining waste on health and the environment.

## **3 Result and Discussion**

### **3.1 Management Standards for Hazardous and Toxic Mining Waste (B3)**

Mining activities consist of various stages, including exploration, exploitation, processing of mining products, and the use of mining results.[14] At each stage, there will be waste generated from the mining process, known as mining waste. Mining waste contains hazardous materials that can lead to environmental pollution and pose health risks if not properly managed and processed. Some of these hazardous materials include heavy metals, metalloids, radioactive waste, acidic water, and process chemicals.[3] Mining B3 waste refers to the waste generated from mining processes that can have negative impacts on the environment if its concentration or quantity exceeds environmental quality standards. Environmental quality standards refer to the limits or levels of living organisms, substances, energy, or components that exist or must exist, and the permissible presence of polluting elements within a particular environmental

resource.[15] As such, mining activities should comply with the appropriate management standards for hazardous and toxic waste, as specified in Law Number 32 of 2009 concerning Environmental Protection and Management.

- Waste management aims to prevent and mitigate environmental pollution and damage caused by waste from business activities and/or projects. It also involves the restoration of the quality of the polluted environment with the hope that it can be reused according to its intended purpose.[16] Therefore, the management and treatment of mining waste typically require oversight from local governments and experts in the field to prevent further environmental damage. B3 management activities include reduction, storage, collection, transport, utilization, processing, and/or disposal. The implementation of these activities is regulated by Presidential Regulation No. 22 of 2021 on Environmental Protection and Management Implementation.
- Reduction of B3 Waste: This activity involves the waste generator reducing the quantity and/or hazardous properties and/or toxicity of B3 waste before it is produced by a business or activity.
- Storage of B3 Waste: It entails temporary storage of B3 waste by the waste generator.
- Collection of B3 Waste: This is the process of collecting B3 waste from the waste generator before it is delivered to B3 waste utilizers, processors, and/or disposers.
- Utilization of B3 Waste: It refers to the reuse, recycling, and/or recovery of B3 waste with the aim of transforming it into products that can be used as substitutes for raw materials, auxiliary materials, and/or environmentally safe fuel.
- Processing of B3 Waste: This is the process of reducing and/or eliminating hazardous and/or toxic properties.
- Disposal of B3 Waste: It involves placing B3 waste in storage facilities with the intention of not endangering human health and the environment.

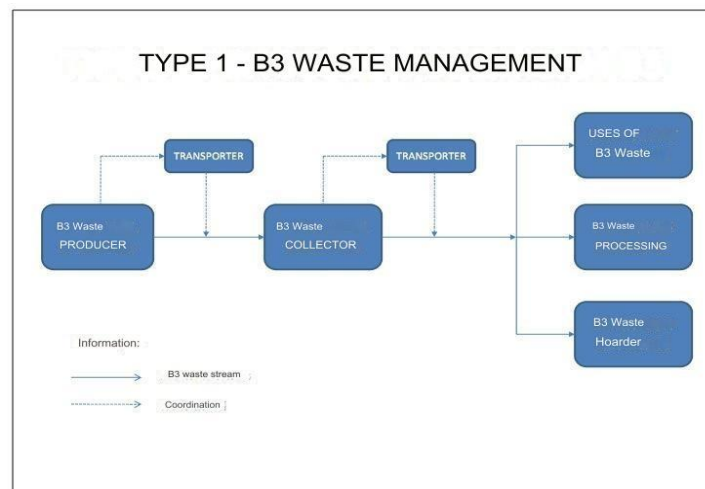


Figure 1. B3 Waste Management Perpetrators from Andi Wahyudin, B3 Waste Management Mechanism

The Waste Hierarchy Method, as explained in Masrudi Muchtar's book "*Environmental Health Law*" (2016), encompasses various practices for managing hazardous and toxic waste (B3), including recycling, recovery, and reuse. With advancements in technology and human understanding, the management of B3 waste has evolved to focus on its utility and economic value. The Waste Hierarchy Method aims to maximize practical benefits from a product while minimizing waste production. Proper implementation of this method can yield several advantages, including reducing greenhouse gas emissions, cutting down on pollutants, conserving energy, preserving resources, creating job opportunities, and promoting the development of green technologies. Waste management practices based on the waste hierarchy include:

1. **Prevention:** This involves taking measures to reduce the generation of hazardous waste at the source. It aims to minimize waste production by adopting cleaner production methods, optimizing processes, and reducing the use of hazardous substances.
2. **Reduction:** Reduction practices focus on minimizing waste production by using less hazardous materials and improving resource efficiency. It involves redesigning processes and products to reduce the creation of hazardous waste.
3. **Recovery and Recycling:** These methods aim to recover and recycle valuable materials from hazardous waste. Recovery involves extracting useful resources or energy from waste, while recycling focuses on reprocessing materials to create new products. These practices help reduce the demand for new raw materials.
4. **Treatment and Disposal:** When hazardous waste cannot be prevented, reduced, recovered, or recycled, it must be properly treated and disposed of. Treatment methods, such as incineration or chemical processes, aim to reduce the toxicity or volume of waste before disposal in controlled landfills or incineration facilities.

The Waste Hierarchy Method encourages responsible waste management by prioritizing waste prevention and minimization, thereby contributing to environmental protection, resource conservation, and sustainable development. This approach aligns with the principles of environmental health and is vital for ensuring a safe and healthy living environment for communities.

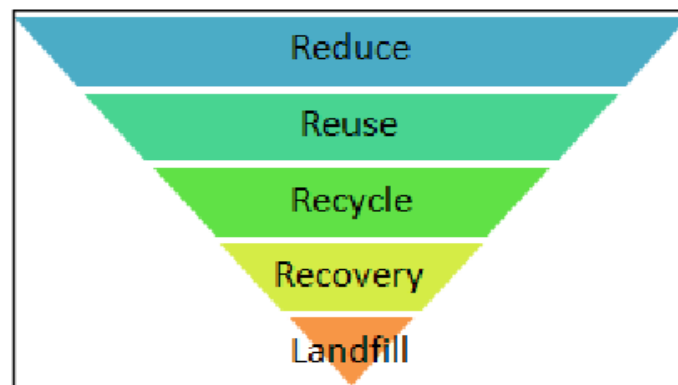


Figure 2: Waste Hierarchy Method Source: Hendra Pratama, Abdul Rauf, Application of Waste Hierarchy on Coal Ash B3 Waste PT. Amnt

"Reduce" involves the reduction of waste or its sources. In this concept, actions are taken to alter the types of materials used in a particular production process, ensuring that the resulting products have the lowest possible toxicity. "Reuse" is an effective waste management strategy involving the reuse of materials, thus preventing them from being disposed of. This process significantly reduces the volume of generated waste while also conserving costs and associated resources related to production. "Recycle" refers to the process of reusing waste materials, transforming them into new products. After waste is processed, it is reintroduced into the production cycle, reducing pollution and conserving energy. "Recovery," also known as the conversion of waste into energy, involves converting waste that cannot be recycled into energy used for industrial purposes, such as electricity and heat. This approach contributes to resource conservation. The final step is "Landfill." When waste can no longer be used, it is disposed of in a landfill. Here are some methods used in managing mining waste:

1. **Installation of Wastewater Treatment Facilities:** Installing wastewater treatment facilities with the aim of eliminating hazardous substances from wastewater. This ensures that the water meets consumption standards and separates contaminants before final disposal. Wastewater treatment in mining involves:
  - The use of pH regulation equipment to raise the pH levels of acid mine water to meet environmental quality standards in the range of 6-9.
  - Utilizing flocculants, coagulants, or water purification equipment to manage Total Suspended Solids (TSS) in wastewater. TSS can cause turbidity, poor solubility, and sedimentation. Processed mining water can be reused for dust control, cooling, and other industrial and agricultural water needs.
2. **Reusing Solid Overburden Waste:** Overburden is the initial rock or material that is typically discarded to access valuable mineral deposits. This type of waste usually hasn't undergone any chemical processes. Overburden waste can be repurposed as construction material for building roads, houses, or buildings due to its solid nature and the absence of hazardous chemicals.
3. **Recycling Solid Tailings Waste:** Solid tailings waste can be recycled as raw material for producing items like clay, concrete, tiles, and glass, thus reducing the environmental impact of mining waste. To reduce the potential environmental impacts, governments are obligated to require that every mining operation obtain environmental permits or conduct Environmental Impact Assessments (AMDAL) from authorized local officials before commencing their activities.

## **2.1 Impacts of Hazardous Mining Waste (B3) on Health and the Environment**

The issue of environmental pollution caused by hazardous waste (B3) has gained global attention, including in Indonesia.[17] This concern was initially triggered by the Minamata disease, which resulted from mercury waste poisoning in Japan. Indonesia's participation in the Basel Convention of 1989 on the control of transboundary movements of hazardous waste and its involvement in the Earth Summit in Rio de Janeiro reflects the country's commitment to environmental issues.[18] To implement the provisions of the Basel Convention and the Earth Summit, Indonesia has established specific legal frameworks to address waste-related matters. These include Presidential Regulation No. 27 of 2020 on the Management of Specific Waste and Government Regulation of the Republic of Indonesia No. 22 of 2021 concerning the Implementation of Environmental Protection and Management.

Waste is closely associated with pollution as it contains substances that can disrupt the environmental ecosystem.[19] When waste producers or communities that generate waste fail to manage it properly, environmental pollution becomes a significant concern. Environmental pollution resulting from industrial waste or waste disposal requires attention from various stakeholders, including the government, business entities, communities, and law enforcement authorities. The Indonesian government has made efforts to protect, preserve, and manage the environment, exemplified by the enactment of Law No. 32 of 2009 on Environmental Protection and Management. This law aims to safeguard the environment from criminal activities carried out by individuals or groups intentionally causing environmental damage. Such damage can affect the ecosystem and climate, as well as impact human life and community sustainability.[20]

As per Gramedia, mining waste comprises residual materials from mining activities. If these toxic substances within mining waste are not properly processed and remain unmanaged, they can contaminate and harm the environment. According to the Environmental Protection and Management Law No. 32 of 2009, environmental pollution occurs when living organisms, substances, energy, and/or other components enter the environment due to human activities, exceeding established environmental quality standards. Environmental damage refers to direct or indirect alterations in the physical, chemical, and/or biological characteristics of the environment that surpass the criteria for environmental damage.

- a. The impacts of mining activities on the environment stem not only from waste disposal but also from changes to environmental components and the disruption of environmental functions. The scale of mining activities directly correlates with the magnitude of the impacts. Environmental alterations arising from mining activities may be permanent and irreversible, such as changes in land topography, including river courses, lake and hill formations during the mining period.[21] Here are some examples of the impacts of hazardous mining waste (B3) on the environment:  
Disruption of Aquatic Biota Balance: Contamination of water bodies can disturb the equilibrium of aquatic life.
- b. Increased Toxicity on Specific Organisms: Certain organisms' life stages may be more vulnerable to toxins.
- c. Biodiversity Impact: Mining waste can affect the diversity of species in an area.
- d. Generation of Less Tolerant Species: The presence of mining waste may result in the emergence of species that are less tolerant to their environment.
- e. Decline in Water Quality: Water bodies can suffer reduced quality due to mining waste contamination.
- f. Local Ecosystem Damage: Mining waste can harm the local ecosystem.
- g. Health and Safety Hazards: Hazardous mining waste can pose health and safety risks to the community through water, soil, and air contamination.
- h. Hazardous waste also negatively impacts human health through exposure via water, soil, and air. Specific parts of the human body that are vulnerable to the effects of B3 residues include:
  - i. Kidneys and Heart: Generally affected by toxic substances like cadmium.
  - j. Bones: Typically influenced by toxic substances like benzene.
  - k. Brain and Nervous System: Often impacted by toxic substances like methyl mercury and lead.
  - l. Liver: Susceptible to toxic substances like carbon tetrachloride.
  - m. Lungs: Affected by toxic substances like paraquat.

- n. Eyes: Influenced by toxic materials like chloroquine, leading to significant effects on growth.



Figure 3. Hazardous and Toxic waste emblem from ITS General and Bureaucratic Reform Bureau

Environmental health is a fundamental human right and a key component of the well-being that Indonesia aspires to achieve, in accordance with its national principles encapsulated in Pancasila and the 1945 Constitution.[22] The declining quality of the environment poses a threat to human and other forms of life, necessitating the dedicated and consistent protection and management of the environment by all stakeholders (Law No. 32 of 2009).

According to the World Health Organization (WHO), environmental health involves establishing an ecological balance between humans and their environment to ensure human well-being. This encompasses various aspects, including:

1. Provision of Safe Drinking Water
2. Management of Wastewater and Pollution Control
3. Solid Waste Disposal
4. Vector Control
5. Prevention/Control of Soil Contamination by Human Excreta
6. Food Hygiene, including Dairy Hygiene
7. Air Pollution Control
8. Radiation Control
9. Occupational Health
10. Noise Control
11. Housing and Settlements
12. Environmental and Air Transportation Aspects
13. Regional and Urban Planning
14. Accident Prevention
15. Public Recreation and Tourism
16. Sanitation Measures related to Epidemiological Conditions, Natural Disasters, and Population Movements. Preventive measures are required to ensure a safe environment.

A healthy environment, as defined by Health Law No. 17 of 2023, Article 105, Paragraph (1), is one that is free from adverse health risks, including those resulting from extreme conditions and global threats of climate change. An environment free from health risks is



one that is devoid of elements that can jeopardize health, such as:

1. Untreated liquid waste, solid waste, and unprocessed gas emissions.\*\*
2. Unprocessed waste materials, not meeting the requirements set by central and local governments.
3. Vectors and disease-carrying animals.
4. Hazardous chemicals.
5. Excessive noise levels.
6. Ionizing and non-ionizing radiation.
7. Contaminated water sources.
8. Polluted air.
9. Contaminated food.

This approach to environmental health underscores the importance of safeguarding human health through the preservation and maintenance of a clean and safe environment.

#### **4 Conclusion**

The protection and management of the environment from hazardous waste generated by mining activities represent a systematic and integrated effort aimed at preserving the functions of the natural environment. This initiative's primary objective is to prevent environmental pollution and damage, encompassing planning, utilization, control, maintenance, monitoring, and legal enforcement (Law No. 32 of 2009). In its implementation, it is advisable to approach mining industry stakeholders through communication and guidance without emphasizing criminal sanctions. Dr. Faisal, in his book "Criminal Law Politics" (2020), posits that criminal law serves as a form of social control. This means that criminal law should only be employed when alternative measures prove inadequate. Therefore, criminal law should be a last resort when other options have been exhausted.

Responsibility and awareness are the key prerequisites for achieving a healthy environment. This implies that all activities must be driven by environmental considerations. The application of suitable sanctions should ideally be in the form of civil liability, such as the reimbursement of damages, which can later serve as a means of rehabilitating the environment to its original state. The local communities living in proximity to mining operations typically bear the greatest brunt of environmental contamination and should be the primary focus when addressing these issues.

#### **References**

- [1] S. Akhmaddhian, 'Penegakan Hukum Lingkungan Dan Pengaruhnya Terhadap Pertumbuhan Ekonomi Di Indonesia (Studi Kebakaran Hutan Tahun 2015)', *UNIFIKASI*, vol. 3, no. 1, Feb. 2016, doi: 10.25134/unifikasi.v3i1.404.
- [2] L. Fitri, J. D. N. Manik, and I. Rosiana, 'Upaya Administratif Sengketa Antara Pegawai Negeri Sipil dengan Pemerintahan Provinsi Kepulauan Bangka Belitung', *PROGRESIF: Jurnal Hukum*, vol. 17, no. 1, 2023.
- [3] A. Yanto, N. Azzahra, A. Gladisy, M. M. Zakirin, and M. S. Anwar, 'Revitalisasi Kewenangan

- Pengelolaan Pertambangan Oleh Pemerintah Daerah Dalam Mengoptimalkan Pelaksanaan Otonomi Daerah Di Bangka Belitung’, *Innovative: Journal of Social Science Research*, vol. 3, no. 2, pp. 8321–8330, 2023, doi: <https://doi.org/10.31004/innovative.v3i2.1386>.
- [4] A. Yanto, ‘Resolusi Konflik Zona Ekonomi Eksklusif Indonesia Dan Vietnam Dalam Pengamanan Sumber Daya Maritim Natuna Utara’, *Recht Studiosium Law Review*, vol. 2, no. 1, pp. 9–18, 2023.
- [5] A. Yanto, F. Salbilla, R. C. Sitakar, and Yokotani, ‘Implikasi Resentralisasi Kewenangan Pertambangan Timah Terhadap Potensi Pendapatan Daerah Di Bangka Belitung’, *Jurnal Interpretasi Hukum*, vol. 4, no. 2, pp. 344–357, 2023, doi: <https://doi.org/10.55637/juinhum.4.2.7756.344-357>.
- [6] A. Yanto, *Kamus Ilmiah Populer*. CV Bukupedia Indonesia, 2020.
- [7] H. Fitriansyah, ‘Pengaruh Reduksi Sampah Rumah Tangga Berbasis Program 3R di Kota Pangkalpinang Menggunakan Pemodelan Sistem Dinamik’. UNDIP, 2021.
- [8] A. Yanto, *Hukum dan Manusia: Riwayat Peralihan Homo Sapiens Hingga Homo Legalis*. Yogyakarta: Segap Pustaka, 2022.
- [9] A. D. I. Rahmah, ‘Studi Pengelolaan Limbah Bahan Berbahaya dan Beracun (B3) di Kawasan Pelabuhan Batu Bara (Studi Kasus: PT X di Sumatera Selatan)’, *Journal of Science, Technology, and Virtual Culture*, vol. 2, no. 2, 2022.
- [10] A. Yanto and F. Hikmah, ‘Akomodasi Hukum Yang Hidup Dalam Kitab Undang-Undang Hukum Pidana Nasional Menurut Perspektif Asas Legalitas’, *Recht Studiosium Law Review*, vol. 2, no. 2, pp. 81–91, 2023, [Online]. Available: <https://talenta.usu.ac.id/rslr>
- [11] F. Hikmah, A. Yanto, and K. Ariski, ‘Perlindungan Hak Ekonomi Bagi Pemilik Hak Cipta Dalam Perspektif Hukum Kekayaan Intelektual di Indonesia’, *Jurnal Pendidikan dan Konseling*, vol. 5, no. 2, 2023, doi: <https://doi.org/10.31004/jpdk.v5i2.13503>.
- [12] K. Benuf and M. Azhar, ‘Metodologi Penelitian Hukum sebagai Instrumen Mengurai Permasalahan Hukum Kontemporer’, *Gema Keadilan*, vol. 7, no. 1, pp. 20–33, 2020, doi: <https://doi.org/10.14710/gk.2020.7504>.
- [13] D. P. Rahayu and Sulaiman, *Metode Penelitian Hukum*. Thafamedia, 2020.
- [14] M. W. Firdaus, A. Yanto, F. Hikmah, and S. Nugroho, ‘Urgensi Resolusi Konflik Klaim Nine Dash Line Tiongkok Di Perairan Natuna Utara’, *JIC*, vol. 8, no. 2, p. 277, Jun. 2023, doi: [10.26623/jic.v8i2.6972](https://doi.org/10.26623/jic.v8i2.6972).
- [15] D. Haryadi, Darwance, and R. D. Salfutra, ‘Integrative Law Enforcement about Tin Mining Reclamation Responsibility at Bangka Belitung Island.’, *E3S Web Conf.*, vol. 68, p. 03017, 2018, doi: [10.1051/e3sconf/20186803017](https://doi.org/10.1051/e3sconf/20186803017).
- [16] A. Sumantri, B. Harmani, and Wibisono, ‘Studi Pengelolaan Lingkungan Berkelanjutan di Wilayah Pengendapan Pasir Sisa Tambang’, *Jurnal Ekologi Kesehatan*, vol. 7, no. 1, 2022.
- [17] A. Yanto, *Hukum dan Ketertiban: Fragmen Pemikiran Tentang Paradigma Hukum dan Perkembangannya*. Yogyakarta: Megalitera, 2022.
- [18] A. Yanto, ‘Sosialisasi Transisi Energi dan Pemanfaatan Nuklir Dalam Bauran Energi Indonesia di Politeknik Manufaktur Bangka Belitung’, *Jurnal Besaoh*, vol. 2, no. 01, pp. 20–38, 2022.
- [19] A. Yanto, F. Hikmah, S. Nugroho, and D. Firmansyah, ‘Tinjauan Yuridis Penegakan Hukum Illegal Fishing di Natuna Utara’, *Lex Jurnalica*, vol. 20, no. 2, 2023, doi: <https://doi.org/10.47007/lj.v20i2.6749>.
- [20] K. K. P. Fatma, ‘Pertanggungjawaban Pihak Ketiga Jasa Pengolah Limbah B3 Dalam Mengolah Limbah B3’, *Tanjungpura Law Journal*, vol. 6, no. 1, 2022.
- [21] Z. Zam and I. M. Putrawan, ‘Evaluasi Kebijakan Pengelolaan Lingkungan Pertambangan di Pulau Obi Provinsi Maluku Utara’, *Jurnal Pendidikan Lingkungan dan Pembangunan Berkelanjutan*, vol. 21, no. 2, 2020.
- [22] A. Yanto and F. Hikmah, *Sapiens 3.0: Riwayat Evolusi, Revolusi, Hingga Replikasi Realitas*. Penerbit Megalitera, 2023.