

# Analysis of the Impact of Environmental Criminal Law Enforcement on Environmental Pollution Perpetrators (Case Study of Waste Pollution in the City)

Gustika Sandra<sup>1</sup>, Mukhawas Rasyid<sup>1</sup>, Agustapa<sup>1</sup>, Suriyati<sup>1</sup>

<sup>1</sup>Andi Sudirman University, Indonesia

Email: [gustikasandra84@gmail.com](mailto:gustikasandra84@gmail.com)

**Abstract.** *The main problem of discussion is what factors are the enforcement of environmental criminal law against perpetrators of environmental pollution violations. This type of research is normative research, writing using a legislative approach, namely Law Number 32 of 2009 concerning Environmental Protection and Management. This research uses a data collection method through library studies, data is collected by quoting, analyzing using content analysis of literature that is relevant to the problem discussed, namely the enforcement of environmental criminal law against perpetrators of environmental pollution. The results of the study obtained law enforcement factors seen from pollution actions, environmental damage, non-compliance, significant negative impacts on the environment and health and also environmental criminal sanctions in the form of administrative fines such as warnings to revocation of business permits and severe criminal sanctions against perpetrators. Enforcement of environmental criminal law against perpetrators of pollution has an important influence in efforts to protect the environment and prevent further damage. The deterrent effect provided by criminal sanctions is expected to increase awareness and responsibility of perpetrators towards the environment. In addition, criminal law enforcement also helps ensure that perpetrators are responsible for their actions and recover the losses that have been caused.*

**Keywords:** *Environmental Criminal Law, Pollution, Environment, Administrative Sanctions*

Received: May 15, 2025

Revised: June 23, 2025

Accepted: July 27, 2025

## INTRODUCTION

Indonesia is currently experiencing serious problems related to pollution and environmental damage, which are increasing day by day (Haryanto, 2020; Maruf, 2021). Environmental issues remain a major responsibility because they affect the quality of life in the future. According to Daniele (2011), Exploitation of natural resources and the environment has led to a worsening of environmental quality, especially natural resources. The rampant environmental damage, such as the destruction of marine ecosystems, the destruction of large portions of forests that serve as the world's lungs, continues to occur everywhere, floods, landslides, and of course much more.

One of the most frequently felt impacts in Indonesia is the very complex waste problem due to a lack of public awareness of the consequences of waste, and a lack of government attention in finding waste disposal facilities provided by the government. Natural waste can be in the form of solid, liquid, or gas. Waste is the unwanted waste left after the end of a process. Indonesia ranks

second among countries contributing to waste, both household and plastic waste (Zahrah et al., 2024; Kamaruddin et al., 2022).

In fact, approximately 4.8 to 12.7 million tons of plastic waste entered the ocean in 2010. This is equivalent to approximately 4,762,000,000 - 12,700,000,000 kg. For comparison, its weight reaches 1.3 times the weight of the Great Pyramid of Giza, Egypt. In Bone Regency, the problem is more complex, this is due to the lack of intervention from current policymakers. If left unchecked, there may still be mountains of garbage in various places. This can certainly worsen environmental conditions, especially the aesthetics of the city, besides becoming a source of breeding grounds for germs and disease-causing bacteria. In addition, unpleasant odors disrupt healthy respiratory circulation.

The public's perception of waste is still considered normal, with littering. It is estimated that with a population of 6,680 people, there is the potential to produce waste and dispose of it carelessly. Therefore, law enforcement is needed regarding the protection and prevention of environmental pollution. Based on Law Number 32 of 2009 concerning Environmental Protection and Management (PPLH) is the main legal umbrella in Indonesia that regulates all matters concerning environmental preservation (Pardede et al., 2023; Susanto & Susilo, 2017; Ramada et al., 2025). The main objectives of the Law are to protect the environment so that it remains sustainable and continuous, prevent environmental pollution and damage, guarantee the right of the community to live in a healthy and good environment, regulate community participation and environmental law enforcement (Sulistyaningsih, 2022; du, 2008).

The basic principles of environmental management use the principles of sustainability (sustainable development), the principle of prudence, the principle of justice, the principle of participation (involving the community), this Law guarantees the community's right to receive environmental information, provide input in decision-making and file environmental lawsuits (including class actions). Law enforcement is carried out through 3 enforcement channels, namely: 1) administratively with sanctions from the government (permits are revoked, projects are stopped, etc.), 2) civilly, through compensation for environmental damage, 3) criminally in the form of threats of imprisonment and fines for perpetrators of pollution/violations.

## **METHODS**

The method used in writing this article is the normative juridical approach method. The data collection method prioritizes legal research with various legal materials through the results of a review of library sources in the form of documents, books, journals, magazines, newspapers related to legal materials, because it departs from the ambiguity of law enforcement in environmental issues, environmental pollution cases are studied using a descriptive approach through legislation, legal concepts, and comparative law. The study material in this article is in the form of secondary data, namely data originating from laws, legal research results, law enforcement in environmental issues.

## **RESULTS AND DISCUSSION**

### **Environmental Criminal Law Acts Based on Pollution Acts**

As previously mentioned, what is considered an environmental crime is (1) environmental pollution, (2) environmental destruction, and (3) other actions that violate applicable laws and regulations. The following are several important things related to perpetrators of environmental pollution based on Law Number 32 of 2009: (1) Responsibility: The law stipulates that every person, both individuals and legal entities, is obliged to protect and preserve the environment and avoid actions that can pollute it; (2) Monitoring Obligation: Perpetrators of environmental pollution are required to monitor and evaluate the environmental impact of their activities. This aims to prevent and reduce the risk of environmental pollution; (3) Prohibition of Pollution: This law regulates certain prohibitions related to environmental pollution, such as prohibitions on carrying out activities that can damage the quality of air, water, and land, as well as prohibitions on dumping waste carelessly; (4) Sanctions: To ensure

compliance with these provisions, Law Number 32 of 2009 provides strict sanctions for violators. These sanctions can include fines, permit revocation, temporary or permanent closure, and other administrative and civil sanctions; (5) Restoration Obligation: In addition, perpetrators of environmental pollution may also be subject to an obligation to carry out environmental restoration. This restoration includes efforts to restore the polluted environment to its original condition, or at least close to its original condition. Thus, Law Number 32 of 2009 concerning Environmental Management and Protection provides a clear and firm legal framework related to environmental protection, including in terms of handling perpetrators of environmental pollution.

In this case, perpetrators of environmental pollution crimes can be divided into four categories based on their role and involvement in an environmental pollution crime based on the legislation, namely: (1) Main Perpetrators, who are individuals or groups who directly commit the crime. They are directly responsible for the actions they commit and can be subject to criminal sanctions in accordance with applicable law; (2) Secondary Perpetrators, who are individuals or groups who provide assistance or support to the main perpetrator in committing the crime, either before, during, or after the crime is committed. They may not be directly involved in the commission of the crime, but make a significant contribution in enabling or facilitating the commission of the crime; (3) Subordinate Perpetrators, who are individuals or groups actively involved in the commission of the crime, but do not have a primary role. They usually cooperate with the principal perpetrator in carrying out the crime and can be held accountable for the specific role they play in the act; (4) Assisting Perpetrators, who are individuals or groups who provide assistance or support to the principal perpetrator after the crime has been committed, with the aim of helping the principal perpetrator avoid arrest, prosecution, or punishment. Their actions may include concealing evidence, providing shelter, or providing other logistical assistance to the principal perpetrator. These classifications may vary depending on the applicable legal jurisdiction, and the definitions and legal consequences for each category of perpetrator may differ.

### **Criminal Law Actions Based on Environmental Damage**

Criminal law based on environmental damage refers to actions taken against individuals or entities that damage the environment, in violation of existing legal provisions in a country. In the Indonesian context, for example, environmental damage can give rise to criminal liability if there is a violation of environmental laws, such as Law No. 32 of 2009 concerning Environmental Protection and Management. The following are several main aspects related to criminal law based on environmental damage: (1) Types of Environmental Crimes Environmental Pollution, namely crimes involving pollution of water, air, land, or other things that endanger the health of humans and other living creatures. Destruction of Natural Resources Such as illegal logging, mining exploitation that does not comply with regulations, or destruction of marine ecosystems. Violation of Environmental Permits. If a company or individual operates without the appropriate permit or violates the provisions of an existing permit; (2) Violations Subject to Criminal Sanctions, namely Imprisonment Sanctions, Perpetrators of environmental crimes can be sentenced to imprisonment if proven to have committed acts that seriously damage the environment. In addition to imprisonment, perpetrators can also be subject to substantial fines, depending on the extent of the damage caused to the environment. Environmental restoration is crucial. Criminals are also required to undertake restoration or rehabilitation efforts for the environment damaged by their actions. (3) The Role of Environmental Law in Indonesia, namely Law No. 32 of 2009, which regulates environmental protection and management, contains criminal provisions governing violations committed by parties who damage the environment. Articles 104-115 of Law No. 32/2009 regulate criminal sanctions for perpetrators of environmental pollution and destruction caused by activities that do not comply with established standards.

Example of Forest Burning Cases In Indonesia, forest fires carried out by companies or individuals with the aim of clearing land illegally often cause major environmental damage. This

is a criminal offense that can be subject to criminal sanctions. Waste Pollution: A company that discharges hazardous waste into rivers or the sea, resulting in damage to ecosystems and human health, can be prosecuted under the articles of the Environmental Protection Law. Law enforcement against perpetrators of environmental damage depends not only on criminal law action, but also on oversight by institutions such as the Ministry of Environment and Forestry (KLHK), as well as civil society organizations that have a role in monitoring and reporting violations. Law Enforcement Challenges Corruption and Political Influence in some cases, law enforcement against environmental damage can be hampered by political interests or corruption. Lack of Evidence and Technology is a gathering sufficient evidence to prove environmental damage can be a challenge, especially when the damage is hidden or occurs gradually. Lack of Public Awareness this is because the community or business actors who are not aware of the importance of environmental conservation can also cause uncontrolled environmental damage.

### **Environmental Criminal Law Actions Based on Non-Compliance**

Environmental crimes based on non-compliance refer to violations of the law committed by individuals, companies, or organizations that fail to comply with established regulations and standards for environmental sustainability. This non-compliance with legal provisions can relate to various actions, such as failing to follow licensing procedures, failing to comply with emission or waste standards, or failing to maintain the sustainability of natural resources.

#### ***Types of Non-Compliance That Lead to Environmental Crimes***

Failure to Obtain an Environmental Permit: Any activity that has the potential to cause environmental impacts (such as factory construction, mining, or land clearing) must have a valid environmental permit. Non-compliance in this case can result in criminal sanctions. Failure to Comply with Emission and Waste Standards: Companies or individuals that fail to comply with exhaust emission standards or dispose of hazardous waste without proper treatment can be subject to criminal penalties. Violation of Natural Resource Management Procedures: Failure to comply with sustainable natural resource management, such as illegal logging or ecosystem destruction, can result in criminal sanctions. Failure to Implement Environmental Damage Remediation Efforts. If a particular activity causes environmental damage and the perpetrator fails to undertake the required remediation efforts, this may also constitute non-compliance, subject to criminal sanctions.

### ***Legal Basis in Indonesia***

Prasetyaningsih et al. (2022) and Maskun et al. (2024) said that, In Indonesia, non-compliance with environmental regulations is regulated by several legal provisions, primarily Law No. 32 of 2009 concerning Environmental Protection and Management (Law No. 32/2009), and its derivative regulations. Several articles related to non-compliance that have the potential to result in criminal sanctions include: (1) Articles 104-115 of Law No. 32/2009, which regulate environmental crimes arising from non-compliance with obligations stipulated in laws and regulations concerning environmental protection and management; (2) Articles 36-42 of Law No. 32/2009, which outline the obligations that must be complied with by every individual or business entity, such as the obligation to possess an environmental permit and follow applicable procedures; (3) Criminal Sanctions for Environmental Non-Compliance. Non-compliance with environmental regulations can be subject to various types of criminal sanctions, including: Imprisonment. For individuals or companies found guilty of serious environmental violations, criminal sanctions can be imposed. The length of the prison sentence varies depending on the type and impact of the violation. In addition to imprisonment, perpetrators can also be subject to substantial fines. These fines aim to provide a deterrent effect and force perpetrators to comply with applicable environmental regulations. Environmental Restoration: In some cases, in addition to criminal sanctions, perpetrators are also required to restore the environment damaged by their actions.

Examples of cases of environmental non-compliance include: Water Pollution by Industry. If a company discharges industrial waste into a river without a permit or without proper processing, this action constitutes non-compliance and can be subject to criminal penalties, as regulated in Law No. 32/2009. Illegal Logging: If an individual or company carries out logging without a permit or violates existing permit provisions, this is a form of non-compliance with forest management regulations that can be subject to criminal sanctions. Violations of B3 Waste Management (Hazardous and Toxic Materials) this is related to non-compliance in B3 waste management, for example, disposing of hazardous chemicals carelessly or without permits, can cause serious environmental and human health damage. Challenges in Law Enforcement Corruption and Non-Transparent Practices Non-compliance with environmental regulations is often influenced by corrupt practices, where environmental permits are issued without following proper procedures or adequate oversight. In addition, Difficulties in Supervision and Law Enforcement of environmental violations are often hampered by a lack of adequate human resources and facilities to carry out supervision effectively. Many violations occur undetected, or are difficult to prove legally. Political and Economic Influences such as environmentally damaging projects receive protection because they involve large political or economic interests. This can hinder fair law enforcement.

### **Environmental Criminal Law Actions Based on Significant Negative Impacts on the Environment and Health**

Environmental criminal law based on significant negative impacts on the environment and health is a form of law enforcement aimed at addressing actions or activities that cause significant damage to the environment and/or public health. When a human act or omission impacts the quality of the environment and seriously threatens the health of individuals or communities, such actions can be prosecuted under criminal law. In Indonesia, Law No. 32 of 2009 concerning Environmental Protection and Management (Law No. 32/2009) serves as the primary legal basis for handling cases that threaten the environment and health by imposing criminal sanctions on perpetrators.

Types of Significant Negative Impacts on the Environment and Health: Some significant negative impacts on the environment and health that can be subject to criminal sanctions include: (1) Air Pollution, namely exhaust emissions from motor vehicles, factories, and forest or land burning (especially illegal forest fires), which increase air pollution. Air pollution can cause various respiratory diseases, cancer, and long-term health problems in humans; (2) Water Pollution, namely the discharge of industrial liquid waste, domestic waste, or other hazardous waste into rivers, lakes, or seas that contaminate water sources. Water pollution causes damage to aquatic ecosystems and can cause diseases such as diarrhea, cholera, and poisoning due to consuming contaminated water; (3) Land Pollution, namely the indiscriminate discharge of hazardous waste or chemicals into the soil that leads to soil contamination. This not only damages the quality of the soil and ecosystem, but can also affect agricultural yields and natural resources that depend on healthy soil; (4) Ecosystem Destruction and Loss of Biodiversity, namely Illegal logging, poaching, and destruction of natural habitats that lead to the extinction of species or disruption of ecosystems can damage the balance of nature and increase its vulnerability to climate change and natural disasters; (5) Disposal of Hazardous Waste (B3), such as hazardous and toxic waste (B3) that is not managed properly can pollute the soil, water, and air. This B3 waste can be very dangerous for human health, causing cancer, organ disorders, or genetic disorders; (6) Climate Change and Global Warming: Environmentally unfriendly industrial activities, including fossil fuel combustion and deforestation, contribute to greenhouse gas emissions that cause global climate change and natural disasters such as floods, droughts, and heat waves.

Environmental Crimes Based on Negative Impacts Law No. 32 of 2009 regulates environmental crimes based on significant negative impacts on the environment and health, and provides severe criminal sanctions for those found guilty. Several relevant articles include: 1) Articles 104-115, which regulate criminal sanctions for individuals or business entities that



pollute or damage the environment that results in ecosystem damage or a threat to human health. Pollution carried out illegally, without a permit, or exceeding permitted limits will be subject to criminal penalties. 2) Articles 116-117 stipulate criminal penalties for perpetrators who cause or contribute to significant environmental damage that impacts human health. This applies to activities that damage or pollute directly and clearly harm the environment or society.

Types of Environmental Criminal Sanctions Based on Significant Impacts, namely based on significant negative impacts on the environment and health, perpetrators of environmental crimes can be subject to several types of criminal sanctions including: 1) Imprisonment, Imprisonment sanctions are given to perpetrators who intentionally or due to negligence cause serious damage to the environment that threatens public health. The duration of the prison sentence can vary, depending on the severity of the damage. Very large fines can be imposed on perpetrators who violate environmental provisions. The amount of the fine is determined based on the damage caused and the type of violation committed. Environmental Recovery or Rehabilitation, In addition to imprisonment and fines, perpetrators may also be required to restore or rehabilitate the damaged environment, such as planting trees for forest rehabilitation, cleaning polluted rivers, or treating hazardous waste that is disposed of carelessly. Shutdown or Cease Operations in some cases, companies or entities proven to have caused major environmental damage may be ordered to cease operations or close facilities that continuously pollute the environment.

Example of a Case of Significant Negative Impact on the Environment and Health, namely the Case of Air Pollution by Industry, A large factory that discharges hazardous gas waste into the atmosphere without going through a filtration process can cause severe air pollution. This air pollution can lead to an increase in respiratory diseases and other health problems in the surrounding community. If found to have violated regulations, the factory can be subject to criminal sanctions. Case of River Pollution by Industrial Waste, A company discharges hazardous chemical waste into a river that flows through a residential area. This waste pollutes the water and threatens the health of residents who depend on the river as a source of clean water. This action can be subject to criminal penalties with large fines and imprisonment. Forest fires are commonplace, often carried out by companies illegally clearing plantations, often resulting in large-scale air pollution that harms public health. These actions can be subject to criminal penalties, including substantial fines and land rehabilitation obligations. In the case of hazardous waste disposal (B3), a company that processes B3 waste and disposes of it carelessly in open areas can cause soil and water contamination that threatens public health. Perpetrators can face criminal penalties, including fines, imprisonment, and the obligation to clean up the contaminated area.

Environmental law is a branch of science that regulates the relationship between humans and the environment and establishes rules and regulations for protecting and sustainably managing the environment (Biber, 2012). The primary objective of environmental law is to prevent pollution and environmental damage, and to ensure the equitable and sustainable use of natural resources for present and future generations. Environmental law in Indonesia is based on Law No. 32 of 2009 concerning Environmental Protection and Management. Environmental crimes related to pollution are regulated by Law No. 32 of 2009 concerning Environmental Protection and Management (UU PPLH). Relevant articles cover water, air, and land pollution, as well as the criminal sanctions that can be imposed on perpetrators, both individuals and corporations (Greife & Maume, 2020; Ogus & Abbot, 2002). Today, human activities are increasingly globalized, industrialized, and interconnected. This impacts air quality and climate change at local, regional, and even global scales. Rapid population growth and increasing energy demand are the primary causes of the release of hazardous pollutants, including greenhouse gases, into the atmosphere, posing a serious threat to human health and the environment, known as air pollution.

Air pollution is defined as a condition in which air quality declines and is contaminated by substances that are harmful or harmless to humans, making it unusable (Manisalidis et al.,

2020; Saxena, 2025; Bikis, 2023). Air pollution generally occurs in large cities and industrial areas that produce gases containing substances above acceptable limits. Sources of air pollution can originate from various activities, both mobile and stationary. These sources include industry, transportation, offices, and household activities (housing). Furthermore, air pollution can also be caused by various natural activities, such as forest fires, volcanic eruptions, toxic natural gas emissions, and others. In addition to the mobile and stationary sources mentioned above, there are specific emissions for which there are no established control measures at either the national or international level (Wang, 2004; Dallmann & Harley, 2010). These sources include aircraft, ships, trains, and other specific heavy vehicles. Therefore, the use of these specific emission sources must adhere to environmental management principles. To achieve the desired air quality, air pollution control is crucial. Air pollution control must be based on government-established quality standards (Fujikura, 2007; Xu et al., 2020). This includes pollution prevention and mitigation efforts, as well as air quality restoration through ambient air quality inventories, pollution source prevention, both mobile and stationary, including nuisance sources, and emergency response. Air pollution can impact humans and the environment, such as impacting agricultural productivity, negatively impacting ecosystems, and causing aesthetic disturbances (Plutino et al., 2022; Izah et al., 2023). Of these impacts, the impact on human health and well-being is the most significant of the total damage caused by air pollution.

**Impact on the Environment** The influence of air pollution on environmental degradation or damage that can occur is as follows: (1) Inhibiting plant photosynthesis, In areas with high levels of pollution, plants will experience growth disorders and are susceptible to disease. The presence of particulates stored on the surface of leaves can inhibit the process of photosynthesis; (2) Causing acid rain, Acidic rain can dissolve heavy metals found in the soil so that it affects the quality of groundwater and surface water, damages plants, and is corrosive so that it damages materials and buildings; (3) Increasing the greenhouse effect, The greenhouse effect is caused by the presence of CO<sub>2</sub>, CFC, methane, ozone, and N<sub>2</sub>O in the troposphere layer which absorbs solar heat radiation reflected by the earth's surface. As a result, heat is trapped in the troposphere layer and causes the phenomenon of greenhouse gases (global warming) which will result in regional and global climate change, Changes in the life cycle of flora and fauna; (4) Damage to the ozone layer, The ozone layer (O<sub>3</sub>) is the earth's natural protector which functions to filter ultraviolet radiation from the sun. Damage to the ozone layer due to CFC emissions results in unfiltered UV-B rays from the sun, potentially causing skin cancer and plant diseases. Air pollution affects human health both directly and indirectly. Direct impacts occur when there is direct contact with pollutants. The following are some of the impacts of air pollution on health:

Table 1. Impacts of Air Pollution on Health

No	Impact	Description
1	Skin cancer (melanoma)	The depletion of the ozone layer in the atmosphere will lead to increased ultraviolet radiation, which can trigger skin cancer.
2	Lung cancer	Compounds such as benzopyrene, asbestos, and nitrosoamine are highly potent carcinogenic agents.
3	Baldness (alopecia), anemia, and gastroenteritis	Baldness (alopecia), anemia, and gastroenteritis.
4	Bronchitis and emphysema	SO <sub>2</sub> gas and benzopyrene can weaken the movement of cilia in the throat. These gases also stimulate mucus secretion in the bronchi of the lungs.
5	Asphyxia (suffocation)	CO gas is highly reactive with hemoglobin (Hb) in the blood, with an affinity 240 times greater than oxygen. CO binds with Hb to form COHb, which is very stable, preventing oxygen absorption and transport.
6	Respiratory tract irritation	This can slow or even stop the movement of cilia, making it unable to clean the respiratory tract.

The impacts that can occur on humans and the environment depend greatly on the pollutant components present in the air. The impacts of pollutants commonly found in the air are as follows

## CONCLUSION

Criminal law enforcement based on environmental non-compliance is an effort to ensure that every individual, company, or entity operating in a country complies with existing regulations to maintain environmental sustainability. Non-compliance with applicable environmental regulations can cause extensive damage to both nature and humans. Therefore, strict law enforcement, accompanied by good oversight, is crucial to ensure that environmental regulations are enforced and complied with by all parties. Environmental criminal law enforcement based on significant negative impacts on the environment and health aims to provide a deterrent effect and ensure that perpetrators of environmental damage, which can endanger ecosystems and human health, are punished in accordance with applicable laws. Effective and firm law enforcement is crucial to prevent further damage and to encourage the public and business actors to pay greater attention to environmental sustainability and protection. Criminal law enforcement related to environmental damage aims to maintain the balance of the ecosystem and protect the rights of other living creatures. Therefore, it is crucial to have firm, effective policies and well-implemented law enforcement to minimize the impact of environmental damage. Furthermore, public awareness of the importance of protecting the environment is also a key factor in preventing further damage.

## SUGGESTION

Criminal Law Enforcement Efforts against environmental pollution, it is recommended to do. Counseling and Education are one of the preventive measures that can be done by increasing public and industrial awareness about the importance of complying with environmental regulations and the long-term impacts of non-compliance. Stricter Supervision, authorized government institutions, such as the Ministry of Environment and Forestry (KLHK), need to be more active in conducting supervision and law enforcement. The use of technology such as satellite or drone monitoring can also help detect violations that are more difficult to see. Improving Inter-Agency Cooperation in this case Cooperation between law enforcement agencies, civil society organizations, and the private sector is very important to ensure that non-compliance with environmental regulations can be addressed more effectively. Lack of Public Awareness\*\*: Communities and business actors are often less aware of the consequences of environmental damage. Without a good understanding of the importance of environmental protection, they may not be too concerned about the damage caused.

## REFERENCES

- Biber, E. (2012). Which Science-Whose Science-How Scientific Disciplines Can Shape Environmental Law. *U. Chi. L. Rev.*, 79, 471.
- Bikis, A. (2023). Urban air pollution and greenness in relation to public health. *Journal of environmental and public health*, 2023(1), 8516622. <https://doi.org/10.1155/2023/8516622>
- Dallmann, T. R., & Harley, R. A. (2010). Evaluation of mobile source emission trends in the United States. *Journal of Geophysical Research: Atmospheres*, 115(D14). <https://doi.org/10.1029/2010JD013862>
- Daniele, V. (2011). Natural resources and the 'quality' of economic development. *the Journal of Development studies*, 47(4), 545-573. <https://doi.org/10.1080/00220388.2010.506915>
- du Plessis, A. (2008). Public participation, good environmental governance and fulfilment of environmental rights. *Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad*, 11(2), 1-34. <https://doi.org/10.4314/pej.v11i2.42232>



- Fujikura, R. (2007). Administrative guidance of Japanese local government for air pollution control. In *Development of Environmental Policy in Japan and Asian Countries* (pp. 90-116). London: Palgrave Macmillan UK. [https://doi.org/10.1057/9780230624931\\_5](https://doi.org/10.1057/9780230624931_5)
- Greife, M. J., & Maume, M. O. (2020). Do companies pay the price for environmental crimes? Consequences of criminal penalties on corporate offenders. *Crime, Law and Social Change*, 73(3), 337-356. <https://doi.org/10.1007/s10611-019-09863-4>
- Haryanto, B. (2020). Indonesia: country report on children's environmental health. *Reviews on Environmental Health*, 35(1), 41-48. <https://doi.org/10.1515/reveh-2019-0088>
- Izah, S. C., Iyiola, A. O., Yarkwan, B., & Richard, G. (2023). Impact of air quality as a component of climate change on biodiversity-based ecosystem services. In *Visualization techniques for climate change with machine learning and artificial intelligence* (pp. 123-148). Elsevier. <https://doi.org/10.1016/B978-0-323-99714-0.00005-4>
- Kamaruddin, H., Patittingi, F., Assidiq, H., Bachril, S. N., & Al Mukarramah, N. H. (2022). Legal aspect of plastic waste management in Indonesia and Malaysia: Addressing marine plastic debris. *Sustainability*, 14(12), 6985. <https://doi.org/10.3390/su14126985>
- Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: a review. *Frontiers in public health*, 8, 14. <https://doi.org/10.3389/fpubh.2020.00014>
- Maruf, A. (2021). Legal aspects of environment in Indonesia: An efforts to prevent environmental damage and pollution. *Journal of Human Rights, Culture and Legal System*, 1(1). <https://doi.org/10.53955/jhcls.v1i1.4>
- Maskun, M., Kamaruddin, H., Khalid, R. M., Anugerah, M., Wiranti, W., & Bachril, S. N. (2024). Regulatory Challenges in Wastewater Management and its Impacts on Environmental Sustainability. *Hasanuddin Law Review*, 10(3), 322-341. <https://doi.org/10.20956/halrev.v10i3.5560>
- Ogus, A., & Abbot, C. (2002). Sanctions for pollution: do we have the right regime?. *Journal of Environmental Law*, 14(3), 283-298. <https://doi.org/10.1093/jel/14.3.283>
- Pardede, M., Situmorang, M., Aristeus, S., Rumadan, I., Lumban Toruan, H. D., Diogenes, ... & Nugrahani, E. L. P. (2023). Perspectives of sustainable development vs. law enforcement on damage, pollution and environmental conservation management in Indonesia. *Journal of Water and Climate Change*, 14(10), 3770-3790. <https://doi.org/10.2166/wcc.2023.417>
- Plutino, M., Bianchetto, E., Durazzo, A., Lucarini, M., Lucini, L., & Negri, I. (2022). Rethinking the connections between ecosystem services, pollinators, pollution, and health: focus on air pollution and its impacts. *International journal of environmental research and public health*, 19(5), 2997. <https://doi.org/10.3390/ijerph19052997>
- Prasetyaningsih, D. M., Hendarto, E., Anwar, N., & Elfaki, K. E. (2022). Effectiveness of Environmental Law Implementation: Compliance and Enforcement. *Volksgeist: Jurnal Ilmu Hukum Dan Konstitusi*, 215-225. <https://doi.org/10.24090/volksgeist.v5i2.6826>
- Ramada, D. P., Kamal, U., & Utari, I. S. (2025). Environmental criminal law as a tool for ecological protection: Interpreting the constitution in the context of environmental crimes. *Semarang State University Undergraduate Law and Society Review*, 5(2), 1013-1056. <https://doi.org/10.15294/lshr.v5i2.30327>
- Saxena, V. (2025). Water quality, air pollution, and climate change: investigating the environmental impacts of industrialization and urbanization. *Water, Air, & Soil Pollution*, 236(2), 73. <https://doi.org/10.1007/s11270-024-07702-4>

- Sulistyaningsih, E. (2022, June). Community participation in improving environmental protection and effort management. In *IOP conference series: earth and environmental science* (Vol. 1030, No. 1, p. 012021). IOP Publishing. <https://doi.org/10.1088/1755-1315/1030/1/012021>
- Susanto, H. A., & Susilo, D. (2017). Legal Supervision And Enforcement In Environmental Law Under The Law Number 32 Year 2009 On Environmental And Protection Management. *YURISDIKSI: Jurnal Wacana Hukum dan Sains*, 10(1), 1-18.
- Wang, M. Q. (2004). Examining cost effectiveness of mobile source emission control measures. *Transport Policy*, 11(2), 155-169. <https://doi.org/10.1016/j.tranpol.2003.10.003>
- Xu, F., Tian, M., Yang, J., & Xu, G. (2020). Does environmental inspection led by the central government improve the air quality in China? The moderating role of public engagement. *Sustainability*, 12(8), 3316. <https://doi.org/10.3390/su12083316>
- Zahrah, Y., Yu, J., & Liu, X. (2024). How Indonesia's cities are grappling with plastic waste: an integrated approach towards sustainable Plastic Waste Management. *Sustainability*, 16(10), 3921. <https://doi.org/10.3390/su16103921>