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The Impact of Environmental Pollution Caused by Human Activities and Overcome

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Abstract
This study analyzes the impact of environmental pollution caused by human activities and how to mitigate it. The study used qualitative methods. The results revealed four types of human activities that cause pollution: industry, transportation, agriculture, and households. The findings, industrial sector pollution includes exhaust emissions, liquid waste, and solid waste. Transportation includes air pollution from vehicle emissions, water pollution from fuel spills, and soil pollution from vehicle waste. Agriculture includes excessive use of chemicals and livestock waste. Households include domestic waste, wastewater, and emissions from fuel or garbage combustion. Mitigation measures are reviewed through three aspects: air, water, and land. Several researchers' findings indicate that appropriate mitigation measures include the application of environmentally friendly technologies, proper waste management, strengthening regulations, and increasing public awareness through education and active participation.

Abstrak

Penelitian ini menganalisa tentang dampak pencemaran lingkungan disebabkan aktivitas manusia beserta cara penanggulangan. Penelitian menggunakan metode kualitatif. Hasil penelitian, terdapat empat jenis aktivitas manusia penyebab pencemaran yaitu industri, transportasi, pertanian dan rumah tangga. Temuannya, pencemaran sektor industri yaitu emisi gas buang, limbah cair, dan limbah padat. Transportasi yaitu polusi udara dari emisi kendaraan, pencemaran air dari tumpahan bahan bakar, serta pencemaran tanah akibat limbah kendaraan. Pertanian yaitu akibat penggunaan bahan kimia berlebih dan limbah peternakan. Rumah tangga yaitu sampah domestik, air limbah, dan emisi dari pembakaran bahan bakar atau sampah. Cara penanggulangan ditinjau melalui tiga aspek yaitu udara, perairan, dan tanah. Hasil beberapa peneliti menunjukkan bahwa cara penanggulangan tepat adalah penerapan teknologi ramah lingkungan, pengelolaan limbah yang tepat, penguatan regulasi, serta peningkatan kesadaran masyarakat melalui edukasi dan partisipasi aktif.

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Introduction

The environment is a complex and interconnected system, encompassing all biotic and abiotic components that support the sustainability of life on Earth. Phenomenon of

environmental pollution has increased significantly along with the intensification of environmentally unfriendly human activities. Massive industrialization, uncontrolled urbanization, and a lack of awareness of the importance of environmental conservation become the main triggers for environmental pollution in various sectors (Sudiyanto et al., 2025).

Environmental pollution can be defined as the introduction of substances, energy, or other components into the environment that cause changes in the environmental structure and result in a drastic decline in environmental quality. Forms of pollution include air, water, soil, and noise pollution, each of which has serious ecological and social impacts. (Sumampouw & Nelwan, 2024). The following table shows the percentage of the environmental quality index in Indonesia:

Source: BPS. 2024

Figure 1. Percentage of the Environmental Quality Index in Indonesia

Based on the data above, Indonesia's environmental quality index experienced quite dynamic development during the 2015-2023 period. In 2015, the index value high at 68.23. However, in 2016 and 2017, decreased to 65.73 and 66.46, respectively. In 2018 and 2019, the environmental quality index stabilized at around 65-66. However, recovery began to appear in 2020, index value increased to 70.27. The 2021-2023 period showed a positive trend, index values increase to 71.45 and 72.42 in 2021-2022, respectively. In 2023, the index remained relatively stable at 72.54. The following table shows the impacts of environmental pollution caused by human activities, based on the 2022 Indonesian Environmental Statistics (ISLH).

Table 1
Impact of Environmental Pollution Caused by Human Activities

Sector	Main sources of pollution	Types of pollution	Key data (estimates/percentages)

Industry	Industrial liquid waste, factory gas emissions, B3 waste	Water, air, land	59% rivers in Indonesia are severely polluted, largely due to industrial and domestic waste. The volume of industrial wastewater has increased significantly year after year.
Transported	Motor vehicle exhaust gases (CO, Nox, PM2.5)	Land, water, air	Large cities like Jakarta are the largest contributors to air pollution (32%-57%). Indonesia ranked 17th globally for PM2.5 air pollution in 2021.
Household	Solid waste (garbage), domestic liquid waste	Land, water, air	60,44% waste in Indonesia originates from household activities (2023 SIPSN KLHK data). Approximately 0.7-1 kg of waste per person per day.
Agriculture	Use of chemical fertilizers, pesticides, livestock waste	Land, water, air	Chemical residues from fertilizers and pesticides pollute water sources and soil, impacting ecosystems and human health.

Various human activities produce waste in pollute the air, water, and soil. Industrial activity, contributor greenhouse gas emissions and hazardous liquid waste that pollutes the air and water. Agricultural, the excessive pesticides and chemical fertilizers causes soil pollution and eutrophication. Household activities contribute significantly to environmental pollution through the disposal of plastic waste, domestic waste, and untreated wastewater. Transportation sector, motor vehicle use produces exhaust emissions. (Daud & Agustini, 2024).

Understanding the impacts of environmental pollution caused by human activities and the solutions, hopely that a new paradigm will emerge that places environmental sustainability as a key pillar in every development process. (Iqbal et al., 2024). Effective mitigation measures are needed, whether through technological approaches, policy, or public education. Strategy reduce pollution burdens and encourage sustainable and environmentally conscious development (Supriatna, 2021).

This condition raises the main questions regarding "What types of human activities can cause environmental pollution?", and "What are the effective strategies or methods for overcoming the negative impacts that arise?" This problem formulation is the basis for compiling a study to find applicable solutions in efforts to maintain environmental sustainability and encourage sustainable development.

Methods

This research is a literature review, searching for theoretical references relevant to the case or problem identified. A literature review is a written summary of articles from journals,

books, and other documents that describe theories and information, both past and present, and organizes the literature into topics and documents as needed. The type of data used by the author in this research is data obtained from a literature study. A literature study is a method used to collect data or sources related to the topic addressed in a study.

Result and Discussion

Human activities pollution

The impacts of industrial activities on air, water, and soil (Sasputri et al., n.d.). Industrial activity producing harmful gas emissions such carbon monoxide, sulfur dioxide, nitrogen oxides, and fine particles. These gases can form acid rain, which damages the environment and plants, and fine particles that endanger human respiratory health. Industrial activity has impact on water bodies, as industrial wastewater often contains hazardous chemicals such as heavy metals and toxic compounds that contaminate rivers, lakes, and seas. This pollution degrades water quality, damages ecosystems, kills aquatic organisms, and disrupts the food chain. Organic waste cause a decrease in oxygen in the water, triggering mass mortality of aquatic life (eutrophication). The impact of industrial activities is particularly due to the disposal of toxic waste such as heavy metals, which damage soil structure and fertility and kill vital microorganisms. In addition to chemical pollution, physical damage to the soil also occurs due to compaction and excavation, which reduce the soil's ability to absorb water and air. Toxic substances that seep into groundwater also contaminate clean water sources. These impacts threaten agriculture, habitats, and human health.

The impact of transportation, activities (Wardoyo, 2016) is carbon monoxide, carbon dioxide, nitrogen oxides, sulfur dioxide, and fine particles. The impact of transportation activities on water is oil, fuel, and hazardous chemical waste from land, sea, and air vehicles. Oil and fuel leaks from vehicles and oil spills from ships pollute rivers, lakes, and seas, damaging ecosystems and threatening aquatic life. The impacts of transportation activities on land is oil, and heavy metals from vehicles, which damage soil structure and fertility. These activities also cause soil erosion due to the loss of vegetation.

The impact of agricultural activities on the air (Yusuf et al., 2023) is greenhouse gas emissions such as methane from livestock and rice fields, and nitrous oxide from the excessive use of nitrogen fertilizers. All of this not only pollutes the local air but also contributes to global warming. The impact of agricultural activities on water comes primarily from the excessive

use of fertilizers and pesticides carried by water flow into rivers and lakes, causing eutrophication and the death of aquatic organisms due to lack of oxygen.The impact of agricultural activities, excessive use of fertilizers and pesticides can reduce soil fertility by killing vital microorganisms, leaving the soil hard and nutrient-poor.

The impact of household activities (Utami et al., 2023), is combustion of fossil fuels is wood, kerosene, and cooking gas, which produce pollutants is carbon monoxide, carbon dioxide, nitrogen oxides, and fine particles. The impact of household activities on water comes from soap, detergent, used oil, and garbage. Plastic and organic waste clog waterways and pollute the water. The impact of household activities soil comes from the disposal of inorganic waste is plastic and electronic waste that difficult decompose.

Mitigation methods

Mitigating environmental industrial activities (Muadifah, 2019), is air, use of clean technology and filters, reducing greenhouse gas emissions. Replacing fossil fuels with renewable energy, strict monitoring and regulation. Government set emission standards and monitoring, and production process management. Water, liquid waste treatment: building effective wastewater treatment plants (WWTPs), reducing the use of hazardous chemicals, regular water quality monitoring, conducting routine laboratory tests., and roper solid waste management, avoiding water pollution from solid waste. Land, solid and toxic waste management, use implement safe waste management systems, land reclamation, restore contaminated land using bioremediation techniques, control of physical activity, reduce excessive soil compaction and excavation, and education and training: increase awareness workers and industry managers.

Mitigating environmental pollution from transportation activities (Lambonan, 2024), is air, use environmentally friendly vehicles, such as electric, hybrid, or alternative-fuel vehicles (e.g., biodiesel or CNG) to reduce exhaust emissions, develop and improve public transportation systems (electric buses, MRT, LRT), conduct regular vehicle maintenance and emissions testing to prevent excessive emissions, and improve traffic efficiency use intelligent traffic management. Water, prevent the discharge of waste oil and fuel into waterways by providing safe, install oil separators in garages or vehicle wash areas to filter waste oil, closely monitor activities at ports and shipping lines do not pollute the sea or rivers, and conduct regular maintenance and inspections on ships and heavy vehicles. Land, use environmentally friendly materials when constructing roads and transportation, conduct reclamation and

revegetation areas affected by transportation route construction, and improve the road drainage system.

Mitigating environmental impacts of agricultural activities (Jemly Lengkong, 2024), is air, livestock manure management, convert livestock waste into biogas, land management without burning, use no-burn farming methods or conservation tillage, appropriate fertilization, use organic fertilizers to reduce nitrous oxide emissions, and integrated pest management (IPM), reduce use of chemical pesticides and biopesticides. Water, create a buffer zone, plant vegetation along the banks of rivers/lakes, efficient irrigation, use drip or sprinkler irrigation systems, build a waste retention pond (lagoon), this pond can be used to store livestock waste, and implement IPM and organic fertilizers, reduce the potential pollution by reducing chemical. Soil, use organic fertilizers and compost, increase soil fertility and reduce chemical fertilizers, soil conservation, apply techniques terracing, mulching, or ridges to reduce erosion, bioremediation of contaminated soil, use microorganisms to break down pollutants soil, and selection of pest-resistant plant varieties, reduce pesticide use.

The mitigation household (Dewi, 2021), is air, using clean and efficient energy, switch to electric stoves or LPG gas, avoiding waste burning, use 3R program (*reduce, reuse, recycle*), choosing environmentally friendly household products, use cleaning products, and planting trees or plants around the house. Water, household wastewater management (greywater), build infiltration use environmentally, do not dispose of used oil in drains, use oil recycling programs, manage household waste properly, participate in waste management programs community, and public education and awareness, promote awareness of the importance of good sanitation. Soil, household waste sorting, separate organic and inorganic waste, household hazardous waste management, used batteries, lamps, electronics, and pesticides, reducing of hazardous chemicals, choose natural or environmentally friendly products, and using composters or biopores, reduces organic waste and produces natural fertilizer that.

Conclusion

Based on the analysis of the impacts of environmental pollution caused by human activities and how to mitigate them, it is hoped that a new paradigm will emerge that places environmental sustainability as a key pillar in every development process. Therefore, this paper

aims to comprehensively examine various forms of environmental pollution caused by human activities, their ecological and social impacts, and formulate effective and applicable mitigation measures to create a healthy and sustainable environment.

However, mitigation is comprehensive approach, including implementation of environmentally friendly technologies, proper waste management, strengthening regulations, and increasing public awareness through education and active participation. Preventive and corrective strategies must be implemented sustainably to reduce pollution and repair existing environmental damage. Mitigation of pollution sources and the implementation of effective and applicable solutions, hopely that will build between human activities and environmental sustainability. In this way, environmentally conscious sustainable development can be realized for a healthier and more livable future for the earth.

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