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Addressing the Global Environmental Crisis: The Critical Role of Natural Science in Sustainable Solutions

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ABSTRACT

This research aims to examine the role of natural sciences in overcoming global environmental crises through sustainable science-based solutions. With environmental problems such as climate change, pollution, and ecosystem degradation on the rise, a comprehensive scientific approach is needed to identify effective mitigation and adaptation strategies. The research method used in this article is Systematic Literature Review (SLR). This approach is used to collect and analyze previous research that discusses the contribution of natural sciences in dealing with environmental crises. The literature analyzed includes international journals, academic books, and research reports from trusted institutions. The data are categorized based on relevance, methods, results, and conclusions of the research to gain a deep understanding of the latest developments in sustainable solutions. The results of the study show that natural sciences have a crucial role in overcoming the global environmental crisis through various innovations and science-based approaches. Continuous research has contributed to the development of solutions such as renewable energy, environmental conservation, and environmentally friendly technologies. To increase the effectiveness of the implementation of these solutions, closer collaboration between scientists, governments, industry, and the public is needed in integrating research results into real policies and practices. Thus, increasingly complex environmental challenges can be overcome more effectively, so that the future of the earth can be better preserved for future generations.

Keywords: *Science, Environmental Crisis, Sustainable Solutions, Climate Change, Conservation*

INTRODUCTION

The increasingly worrying global environmental crisis is currently occurring due to various human activities that damage the balance of nature, both directly and indirectly. Directly, excessive exploitation of natural resources, such as massive deforestation, uncontrolled mining, and water and air pollution, have caused serious environmental degradation. Meanwhile, indirectly, a modern lifestyle that relies on fossil fuels, excessive consumption, and high waste production has accelerated climate change and worsened ecosystem conditions. If not addressed immediately, the impact of this crisis will be even wider, including increasing natural disasters, loss of biodiversity, and threats to food security and human health (Humaida, N. 2024). Therefore, more serious global efforts are needed to reduce the ecological footprint and implement more sustainable policies to maintain the balance of nature for future generations. Climate change triggered by greenhouse gas emissions has caused an increase in global temperatures that has had a wide impact on weather systems and ecosystems around the world. Extreme weather phenomena such as increasingly frequent heat waves,

increasingly intense tropical storms, and erratic rainfall have caused major flooding in various regions. These changes not only disrupt human life but also cause species extinction, land degradation, and declining air and water quality (Saidal Siburian, MM, & Mar, M. 2020).

In addition, massive deforestation for industrial purposes and agricultural land expansion has reduced the capacity of forests as natural carbon sinks. Forest loss results in increased concentrations of carbon dioxide in the atmosphere, which worsens the effects of global warming (Poerwantika, TR 2021). Excessive use of fossil fuels in industry, transportation, and power generation also continues to accelerate the rate of climate change by producing large amounts of greenhouse gas emissions. Without changes in policies and human behavior that are more environmentally friendly, the impacts of this crisis will be increasingly difficult to control and could lead to wider ecological disasters, including rising sea levels, extreme droughts, and threats to food security and human health (Mulyani, AS 2021).

In addition to climate change, environmental pollution is a serious threat that disrupts the balance of the ecosystem and endangers the health of living things. Air pollution caused by industrial emissions and motor vehicles has increased levels of pollutants such as carbon monoxide, nitrogen dioxide, and fine particles that contribute to various respiratory diseases, including asthma and lung cancer. In addition, plastic pollution that pollutes the oceans threatens the survival of marine life, such as fish, turtles, and seabirds, which are often trapped or accidentally ingest plastic waste. Microplastics that enter the food chain can also have a negative impact on the health of humans who consume seafood. If not handled immediately, this environmental pollution will get worse and have a broad impact on the balance of the ecosystem and the quality of human life in the future (Trianisa, K., et al. 2020). Therefore, concrete steps are needed such as reducing the use of single-use plastics, increasing environmentally friendly technology, and strict policies to control pollution emissions to protect the environment and the living things in it. This condition shows that the environmental crisis is not only a natural problem, but also a health and social issue that must be addressed immediately with a more systematic and science-based approach.

On the other hand, excessive exploitation of natural resources is a major factor that worsens environmental conditions. Activities such as massive deforestation, uncontrolled mining, and large-scale oil and gas exploration have caused significant ecosystem degradation. Deforestation, for example, not only reduces the forest's ability to absorb carbon dioxide, but also threatens biodiversity and accelerates soil erosion (Hasid, HZ, SE, S. et al. 2022). Meanwhile, environmentally unfriendly mining activities often pollute water sources and cause the loss of natural habitats for many species. Excessive exploitation of marine resources, such as illegal and destructive fishing, also disrupts the balance of marine ecosystems and threatens global food security. If this practice continues without strict regulations and the application of sustainability principles, environmental damage will become increasingly uncontrolled, resulting in a broader ecological crisis, and threatening the lives of humans and other living things. Therefore, collective awareness and wiser policies are needed in managing natural resources in order to maintain ecosystem balance and sustainability in the future (Bakhtiar, HS (2024, July).

Previous research has shown that science can play an important role in conservation efforts, local decision-making, environmental monitoring, law enforcement, and achieving environmental justice. In the context of conservation, science helps understand and mitigate negative impacts on ecosystems and species, so that more effective protection strategies can be implemented. Science also contributes to local

decision-making by providing accurate data, which allows for better policy-making regarding natural resource management and environmental protection. In addition, environmental monitoring through technology and scientific methods allows for early identification of environmental problems, such as pollution or habitat destruction. In terms of law enforcement, science provides evidence that can be used to address environmental violations and ensure that perpetrators of environmental damage can be held accountable. Finally, science plays a role in realizing environmental justice, by ensuring that the policies taken are not only environmentally friendly but also socially just, so that they benefit all levels of society, especially those most affected by environmental damage. (Aminudin, C. 2020). Large-scale deforestation for industrial purposes has reduced the area of forest cover which plays an important role in absorbing carbon dioxide (CO_2) from the atmosphere. Trees and vegetation in forests function as natural carbon sinks through the process of photosynthesis, where they capture CO_2 and store it in the form of biomass. When forests are cut down in large numbers without adequate reforestation, the carbon storage capacity is significantly reduced, so that more CO_2 remains in the atmosphere. This accelerates the greenhouse gas effect and causes an increase in global temperatures or global warming (Wawan, W. 2020). In addition, the deforestation process often involves land burning, which releases more carbon emissions into the air and further worsens climate conditions. If this unsustainable deforestation practice continues, the impact will not only accelerate climate change but also cause loss of biodiversity, soil degradation, and disruption to the water cycle that plays a role in the balance of the ecosystem. Therefore, stricter forest conservation efforts are needed as well as the implementation of sustainability policies to reduce the negative impacts of deforestation (Wibisono, RB 2024).

The use of hazardous chemicals in agriculture and industry has become one of the main causes of environmental pollution, especially to land and water. In the agricultural sector, pesticides, herbicides, and chemical fertilizers are often used to increase crop yields and control pests. However, these chemicals can seep into the soil and contaminate water resources such as rivers, lakes, or aquifers. When these chemicals are contaminated into the soil, they can disrupt soil structure, reduce fertility, and damage microorganisms that are important for the balance of the ecosystem (Zuhra, A. 2021). On the other hand, water pollution due to industrial waste or hazardous chemicals also threatens aquatic life and ecosystems that depend on clean water. Toxic substances that are contaminated into water bodies can kill aquatic organisms, damage habitats, and reduce the quality of water used for human purposes, such as drinking water and irrigation. In addition, these chemicals can enter the food chain, affecting the health of humans and animals that consume contaminated water or agricultural products (Darza, SE 2020).

Overall, the use of hazardous chemicals in agriculture and industry not only pollutes the soil and water, but also threatens the balance of the ecosystem and the survival of living things, including humans. Therefore, it is important to implement environmentally friendly technologies and stricter policies to reduce the negative impacts of these chemicals on nature. Therefore, a more sustainable strategy is needed in managing natural resources so that the ecological balance is maintained and human needs can still be met without damaging the environment.

METHOD

The research method used in this article is a Systematic Literature Review (SLR). The aim is to collect and analyze previous research related to the role of natural sciences in overcoming the global environmental crisis. SLR was chosen because this approach

provides a comprehensive overview of the latest developments in sustainable solutions. In SLR, scientific literature such as international journals, academic books, and research reports from trusted institutions are analyzed in depth and categorized based on relevance, methods, results, and conclusions of the research (Febrianti, S. 2024).

The SLR process involves selecting peer-reviewed literature to ensure the quality of valid and reliable data. The literature is categorized to identify research trends, such as renewable energy technologies, conservation innovations, and science-based climate change mitigation strategies. In addition, the SLR also reveals research gaps that still need attention, such as technology efficiency, implementation challenges, and socio-economic impacts of science-based solutions. With this approach, this study provides a mapping of the contribution of natural sciences to environmental solutions, as well as compiling recommendations for scientists, policy makers, and practitioners to effectively address the global environmental crisis.

RESULTS AND DISCUSSION

The global environmental crisis is a serious problem faced by humans due to various activities that damage the balance of nature. One of the main causes is climate change triggered by increased greenhouse gas emissions, such as carbon dioxide and methane, which causes global warming, melting polar ice, and extreme weather. In addition, deforestation is also a major threat because the loss of forests reduces the earth's ability to absorb carbon and causes the extinction of various species. Environmental pollution, both air, water, and soil, further worsens the condition of the ecosystem and has a negative impact on human health. This crisis also leads to a shortage of natural resources, such as clean water and energy, which has the potential to cause social and economic conflicts (Anwar, M. 2022). Therefore, various efforts are needed to overcome this crisis, such as the use of renewable energy, reforestation, better waste management, and government policies that support sustainable development. With awareness and cooperation from various parties, it is hoped that the global environmental crisis can be overcome for the sake of human survival and the earth's ecosystem.

Environmental pollution is worsening the condition of the ecosystem, including air pollution due to industrial and motor vehicle pollution that can cause respiratory problems, water pollution due to industrial waste and plastic that pollutes rivers and oceans, and soil pollution caused by the use of pesticides and hazardous chemicals in agriculture. This crisis has also led to a scarcity of natural resources, such as clean water and energy, which are increasingly difficult for people in various parts of the world to access. The scarcity of these resources has the potential to cause social and economic conflict, because people have tocompete to get their basic needs (Eva, Y. 2022)

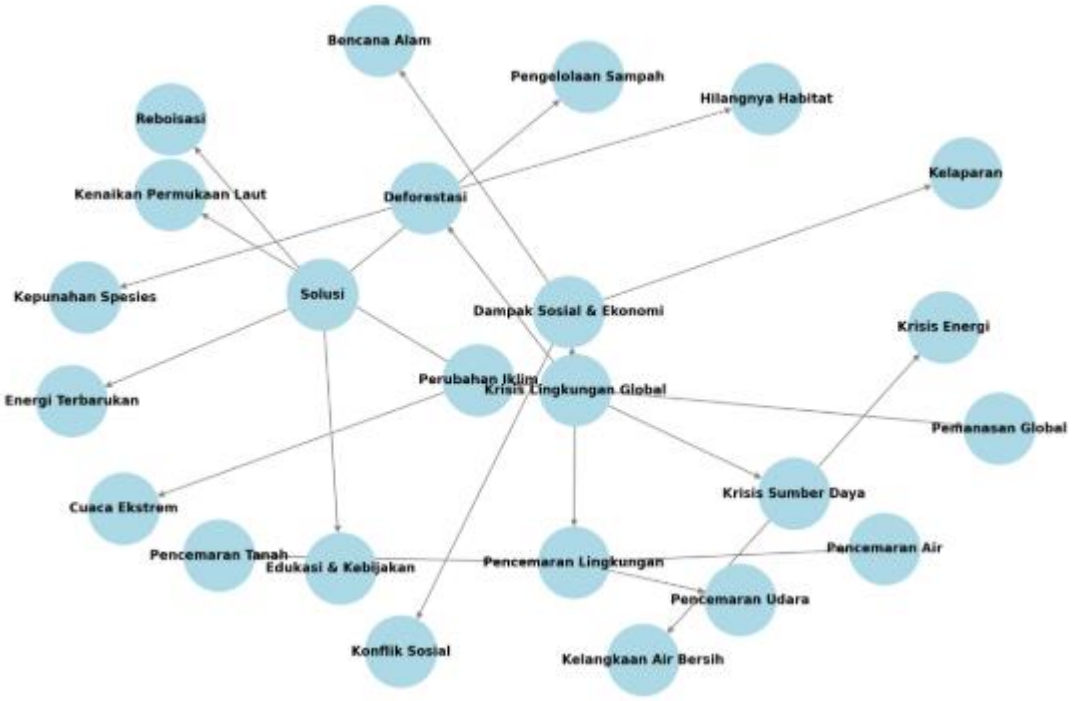

Figure 1. Global Environmental Crisis Diagram
Source: Data Research flowchart

To overcome the global environmental crisis, various efforts are needed involving all parties, including individuals, governments, and international organizations. One of the main solutions is the transition to renewable energy, such as solar, wind, and hydro, which are more environmentally friendly than fossil fuels. In addition, reforestation and reforestation need to be encouraged to restore ecosystem balance and increase carbon absorption by forests (Nasution, UJ 2024). Better waste management, such as reducing plastic use, recycling, and more environmentally friendly waste disposal systems, are also important steps in reducing pollution. Furthermore, the government needs to implement policies that support sustainable development and educate the public about the importance of protecting the environment. With awareness and cooperation from various parties, it is hoped that the global environmental crisis can be overcome for the sake of human survival and the sustainability of the earth's ecosystem (Lasaiba, MA 2024).

The Role of Natural Sciences

Natural Sciences (IPA) have a very important role in overcoming the environmental crisis by providing a deep understanding of various natural processes and the impacts of human activities on the environment. Through the study of biology and ecology, IPA helps us understand how ecosystems work and the relationships between species, making it important to maintain the balance of nature and protect biodiversity. In addition, chemistry and physics allow us to identify pollutants that pollute air, water, and soil and their impacts on human health and the environment. With this understanding, we can develop technologies to reduce pollution and reduce its negative impacts (Hayunanda, V., 2025). IPA also plays a role in the development of environmentally friendly technologies, such as renewable energy, electric vehicles, and

more efficient waste management. Meteorology and atmospheric science have a very important role in understanding global climate change. This science helps us monitor atmospheric conditions, weather patterns, and global temperature changes that can affect various aspects of life, including ecosystems, extreme weather patterns, and the availability of natural resources. With data obtained from meteorological research, we can get a clearer picture of climate change trends and predict future impacts. This data is very important for formulating appropriate mitigation policies. Mitigation refers to steps taken to reduce or counteract the causes of climate change, such as reducing greenhouse gas emissions. Accurate information about climate change patterns allows policymakers to develop more effective policies, such as regulating energy use, promoting renewable energy, or setting limits on industrial emissions (Rahmayanti, H., & Feryl Ilyasa, SKM 2022).

In addition, natural sciences (IPA) also play a major role in providing sustainable solutions for natural resource management. In agriculture, for example, IPA can develop more environmentally friendly farming methods, such as organic farming or the use of technology to conserve water. In the forestry sector, IPA helps develop conservation techniques that can prevent deforestation and restore damaged land. In fisheries, this science can help manage fish populations sustainably to ensure the survival of species and aquatic ecosystems (Putri, VN, 2025). The scientific approach applied by IPA in natural resource management aims to maintain a balance between resource utilization and environmental protection. This is important to ensure that future generations can enjoy the same, or even better, benefits from the natural resources that exist today. Thus, natural science not only helps us understand the causes and impacts of environmental problems, but also provides effective and implementable science-based solutions to improve the state of the environment and reduce the damage that has occurred. This provides a solid foundation for global efforts to address and overcome the environmental crisis. As in the following figure:

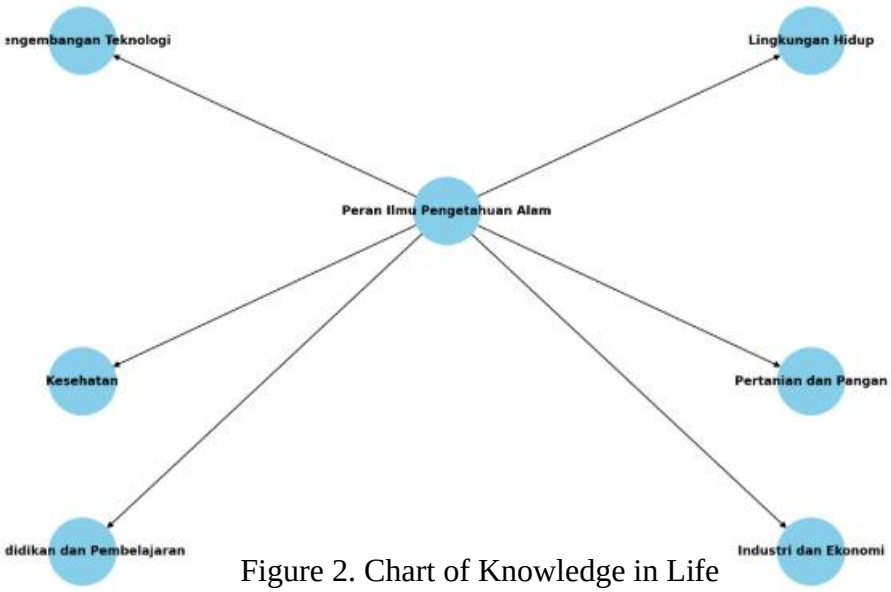

Figure 2. Chart of Knowledge in Life
Source: Data Research

Natural Sciences (IPA) plays a very important role in human life. Through an understanding of natural phenomena, IPA helps us understand various events that occur around us, such as the process of rain, the formation of rainbows, and the water cycle. In

the health sector, IPA contributes to the discovery of medicines, vaccines, and medical technologies that improve the quality of human life (Rahmatunnisa, S2022, October). In addition, in the agricultural sector, the application of IPA allows the development of superior plant varieties and efficient cultivation techniques, thereby increasing food production. In the industrial sector, IPA supports innovation and efficiency through the development of new technologies. Overall, IPA not only helps us understand the world but also provides practical solutions to the various challenges faced by humans (Moenawar, MG 2019).

In addition, science plays an important role in more environmentally friendly technological innovations. For example, the discovery of renewable energy such as solar, wind, and biomass is the result of scientific research aimed at reducing dependence on environmentally damaging fossil fuels. In addition, in the field of transportation, research on electric vehicles and fuel efficiency technology helps reduce harmful carbon emissions. Science also provides insight into more efficient and environmentally friendly waste management methods, such as recycling and waste processing that does not pollute soil and water (Darmawan, S., & Wibowo, P. 2024). No less importantly, science helps us understand the increasingly worrying climate change, by providing accurate data on weather patterns, global temperatures, and the environmental impacts they cause. This scientific research forms the basis for making global policies aimed at reducing the negative impacts of climate change, such as increasing global temperatures, rising sea levels, and increasingly frequent natural disasters. With this knowledge, countries around the world can work together to reduce greenhouse gas emissions, develop mitigation policies, and adapt to unavoidable climate change.

Finally, science helps us manage natural resources sustainably. In agriculture, for example, science plays a role in creating environmentally friendly farming techniques, such as organic farming, which reduces dependence on chemical fertilizers and pesticides that damage soil and water. Likewise, in forestry and fisheries, science provides a scientific approach to ensure that these natural resources are managed in a way that maintains the balance of the ecosystem and avoids over-exploitation (Ismail, IA, 2024). With all its contributions, science not only provides theoretical knowledge, but also offers practical solutions that can be implemented to overcome the increasingly deepening environmental crisis (Afandi, T., & Mahmudah, U. 2025).

Sustainable Solutions to environmental problems

Addressing environmental issues sustainably requires a comprehensive and collaborative approach between governments, the private sector, communities, and individuals. One of the main steps is the transition to renewable energy sources such as solar, wind, and hydroelectric power. The use of renewable energy not only reduces dependence on fossil fuels that contribute to greenhouse gas emissions but also helps reduce air and water pollution (Mudhoffar, K., & Magriasti, L. 2024). In addition, the implementation of a circular economy is important in waste management efforts. By recycling and reusing products, we can reduce the volume of waste sent to landfills, reduce pollution, and save natural resources. Communities need to be encouraged to sort waste, reduce the use of single-use plastics, and choose products with environmentally friendly packaging.

Environmental education and awareness also play a crucial role. Through effective education programs, people can understand the impact of their activities on the environment and the importance of conservation actions. The younger generation, in particular, can become agents of change with innovative ideas and active participation in environmental conservation activities. In addition, strengthening regulations and law enforcement related to the environment is very necessary. The government must establish policies that support environmentally friendly practices and provide strict sanctions for violators (Hijran, M., &

Suntara, RA 2025). Collaboration between the government, the private sector, and the community in implementing this policy will ensure its effectiveness. Finally, technological innovation can be a solution to overcome environmental problems. The development of clean and environmentally friendly technologies, such as electric vehicles and efficient waste treatment systems, can reduce negative impacts on the environment. Investment in research and development of green technology must be encouraged to create more effective and efficient solutions. By integrating these various sustainable solutions, we can maintain the balance of the ecosystem and ensure a better quality of life for future generations (Herdianto, D. 2024).
In the field of renewable energy, physics and chemistry have driven rapid advances in the efficiency and effectiveness of alternative energy sources. For example, research in photovoltaics has enabled the development of solar panels with higher efficiency, which can convert solar energy into electricity more optimally. In addition, wind turbine technology continues to improve thanks to a deeper understanding of fluid dynamics and lighter but stronger materials, which allow for more stable and efficient energy production.

In addition, innovations in energy storage are also significant results of the application of natural science. Lithium-ion batteries used in electric vehicles and large-scale energy storage systems are the result of in-depth research in the field of materials chemistry. The development of hydrogen fuel as a clean energy alternative is also growing, with various studies focusing on more efficient and environmentally friendly methods of water electrolysis. All of these innovations show that a science-based approach can provide concrete solutions to reduce dependence on fossil fuels, which are one of the main causes of climate change. With the advancement of science-based technologies, the transition to a low-carbon economy is becoming more realistic and can be realized on a global scale. In addition, research in the fields of ecology and conservation biology has produced various more effective environmental conservation strategies, such as forest rehabilitation, ecosystem-based land management, and biodiversity conservation programs. The application of the concept of industrial ecology is also an important innovation in reducing industrial waste and increasing resource efficiency through the concept of recycling and a circular economy.

CONCLUSION

Based on the research results, it can be concluded that natural science has a very important role in overcoming the global environmental crisis through various innovations and science-based approaches. Through continuous research, various solutions such as renewable energy, environmental conservation, and environmentally friendly technologies can continue to be developed to create a more sustainable system. In the future, closer cooperation is needed between scientists, government, industry, and society in implementing scientific research results into real policies and practices. Thus, increasingly complex environmental challenges can be overcome more effectively and the future of the earth can be better protected for future generations.

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