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Environmental Pollution and Social Inequality: The Perspective of Environmental Justice

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Abstract:

Environmental pollution is now a global problem that directly affects ecosystems and the health of people who live, but disproportionately affects low-income communities. The paper discusses four types of environmental pollution namely air, water, soil, and noise in connection to social inequality within the framework of environmental justice. The study underscores that pollution is not an equal opportunity killer; it disproportionately affects the poor, aggravating disease and poverty. Worse, when environmental policies are crafted without acknowledging these injustices, they will inevitably perpetuate existing inequalities. The research results indicated the importance of increased policy equity, stakeholder engagement, and technological innovation in reducing environmental risk and enhancing sustainability. To solve these problems, modern people need a holistic solution that involves policy change; local action, and technology developed for cleaner capabilities. Together, these findings highlight the necessity of embedding environmental justice concerns into policy to build an equitable and healthier future for everyone.

Keywords: Environmental justice, social inequality, pollution, policy reform, community action

1. Introduction

Pollution of the environment has become a worldwide problem that has huge effects on ecosystems and people's health all over the world. The main types of pollution—noise, water, land, and industrialization—have all gotten worse over the past 100 years as farming, cities, and factories have grown. There are many bad effects of polluting the environment, including many biological problems and very high health risks for people.[1] For example, In 2021, air pollution was the second largest cause of mortality worldwide, affecting 8.1 million people, including 1.4 million children younger than five.[2] Similarly, water pollution from farming runoff, factory waste, and bad waste management taints drinking water sources, causing diseases that spread through water and other health problems.[3] Toxic trash and too

much use of pesticides and fertilizers can pollute the soil, which lowers crop yields and can lead to health problems throughout the food chain. Noise pollution is less talked about, but it makes stress-related diseases and a lower quality of life much worse, especially in cities.[4]

A growing knowledge of social inequality, especially when it comes to how different groups experience environmental damage, has gone hand in hand with the growing understanding of pollution as a major world problem. Inequality in social position, salary, and access to resources makes the effects of pollution in poor areas worse. Studies have repeatedly shown that natural dangers affect low-income and disadvantaged groups more than others. A lot of the time, these communities do not have the money or political power to stop harmful businesses from putting up shop in their areas. As a result, more people get diseases linked to pollution and the quality of life is lower overall.[5] This intersection of environmental pollution and social inequality begot the emergence of what people now call economic justice (EJ) movements. The case of EJ is a movement that emerged in the 1980s from within the US that has targeted environmental burdens and services as being unequally distributed, especially with respect to racial minorities and low-income communities. [6] Regardless of one's race, color, country of origin, or socioeconomic status, the movement demanded equal treatment and meaningful participation of all individuals in the administration and execution of development projects and environmental policies, rules, and regulations. The work of Carrillo and Pellow shows that environmental inequities do not arise by chance but rather come from well-instained political, economic, and social systems.[7]

A large and growing body of literature focuses on environmental justice, encompassing a wide array of both environmental problems and partly solutions from across the globe. Wind tunnel studies have shown that overtaking also results in two drivers tussling to see who can stick closest behind the lead car at nose-bleed speeds. [8] A UK study also demonstrated the confluence of industrial pollution and social deprivation, with industrial pollution sites significantly more likely to be located in deprived areas—making two-fold worse health problems for these people. [9]

Exploring these relationships systematically from an environmental justice standpoint will help to disentangle the complex linkages between environmental exposure and social status. This knowledge of the double impact that environmental pollution has on social inequities, and in turn vice versa, is crucial for developing environmentally just and sustainable policies. The objective of this research is to investigate the status quo in terms of environmental contamination and socio-economic disparities, disentangle explaining linkages between both issues and devise explicit tangible measures volitional for reaching out disparity characterized by fume power. This research framework will only be limited to four areas: air pollution, water pollution, soil contamination, and noise pollution. The project will also investigate the potential impacts of types of pollution on different socio-economic groups and consider how these are shaped by economic, social, and policy factors. The research will also explore whether environmental policies have dampened or exacerbated these injustices and suggest policy responses that could yield more equitable patterns of exposure.

2. Analysis of the Current State of Environmental Pollution and Social Inequality

2.1 Air Pollution

Air pollution, including indoor and outdoor air quality issues like CO2 concentration, remains a significant environmental health threat globally, particularly in lower-income and marginalized populations. Research suggests that pollution is typically worse in impoverished areas. This discrepancy not only results from the residential proximity of these communities to industrial sites and large roadways but also because they have reduced access to health services that could help alleviate air pollution-induced health impacts.[10] For example, African American and Hispanic communities in the US have higher exposure to fine particulate matter (PM) of other air pollution, which leads to a significantly higher prevalence rate for respiratory diseases and premature deaths than others. Liu et al. aimed to find out how different groups of people in the entire United States were exposed to six different types of air pollution from 1990 to 2010. [11] The groups were divided into three groups based on race/ethnicity, income, and the pollutants themselves. This study looked at differences in exposure levels for carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), particulate matter with an aerodynamic diameter ≤2.5μ~m (PM2.5; excluding 1990), particulate matter with an aerodynamic diameter ≤10μ~m (PM10), and sulfur dioxide (SO2). The groups they looked at were non-Hispanic White, non-Hispanic Black, Hispanic (any race), and non-Hispanic Asian. A race or ethnic minority group had the highest national average exposure for all years and pollution. In 2010, there was a difference between the race or ethnic group that had the highest and lowest national average exposure to NO2, the smallest for O3, and the middle for the other pollutants, as shown in Figure 1.

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Demographic	Non-Hispanic White	Non-Hispanic Black	Hispanic	Non-Hispanic Asian	Entire population
Proportion of population	64%	12%	16%	4.6%	100%
$PM_{2.5}$ ($\mu g/m^3$)					
10th percentile	6.1	7.9	6.5	6.7	6.3
25th percentile	7.7	9.2	7.7	8.2	7.9
50th percentile	9.3	10	9.6	9.7	9.5
Mean (SD)	9.1 (2.2)	10 (1.8)	9.4 (2.2)	9.4 (1.9)	9.3 (2.2)
75th percentile	11	11	11	11	11
90th percentile	12	13	12	12	12
NO_2 (ppb)					
10th percentile	3.1	3.8	4.6	5.4	3.4
25th percentile	4.3	5.8	6.6	7.5	4.9
50th percentile	6.2	8.7	9.5	10	7.4
Mean (SD)	7.2 (4.1)	9.7 (5.3)	11 (6.1)	12 (5.9)	8.7 (5.1)
75th percentile	8.9	12	15	15	11
90th percentile	12.5	18	21	21	16

Fig. 1 Population distribution and population-weighted exposure distribution for six criteria pollutants for four main racial/ethnic groups and the national average in the year 2010. [11]

2.2 Water Pollution

Water pollution is also a big problem, especially in low-income areas where people often get their water from dirty sources. The main causes of water pollution that mostly affect disadvantaged groups are agricultural waste, industrial release, and not properly treating sewage. People in these areas often cannot get clean drinking water, which makes waterborne diseases and other health problems more common. Water contamination and access is a story of inequality and injustice in Flint, a city where 60% of the population uses food stamps, where 40% of the population lives below the poverty line, and where the median household income is 50% lower than the state-wide figure. No one in the state government would have hesitated to step in and assist a wealthy, mostly white neighborhood in the event of a public health emergency.[12] Additionally, low-income neighborhoods are more likely to be located near polluted water sources like rivers and lakes, further increasing the risk of exposure to harmful chemicals.

2.3 Soil Pollution

A wide variety of soil pollution, especially represented by the industrialization waste discharge with diverse chemical fertilizer and pesticide residues, leads to seriously damaged agricultural productivity and food security, etc., which affects severely poor regions.[13] In 2000, 12.1% of China's prime protected farmland area had heavy metal concentrations above norms, according to a sample study. Surface soil heavy metal pollution has been on the rise, especially when contrasted with the findings of a 1986–1990 national soil background value study. Heavy metals were the most prevalent contaminant in the 19.4% of farming soil that exceeded requirements, according to the most recent official study. The most important heavy metals impacting China's agricultural soils are cadmium (Cd), nickel (Ni), copper (Cu), arsenate (As), mercury (Hg), and lead (Pb)—all of which arise from human activities. A significant portion of the heavy metal contamination in agricultural soils originates from sewage irrigation. Heavy metal concentrations were also much higher in plants grown in wastewater-irrigated soils compared to reference soils. Most of these people are subsistence farmers; soil pollution restricts crop growth, either through lower yields or contamination with toxic materials up to higher levels in food chains. This does more than destabilize the

economy in these communities, it also puts everyone who is consuming contaminated food at a health risk.

2.4 Noise Pollution

Noise pollution is less talked about than other types of pollution, but it has big effects on health and society, especially in cities. Research has shown that noise pollution is more common in minority and low-income areas because homes there are often close to airports, busy roads, and factories. Noise levels that are too high for long periods of time can cause many health issues, such as worry, trouble sleeping, and heart problems.[14] Noise has extra-auditory impacts, one of which is disrupting sleep, as shown in Figure 2. Interference from both the cerebral cortex and the descending pathways of the autonomic processes delays the arrival of auditory information to the brain's auditory region. So, even when a person's level of sensitivity to noise while sleeping varies depending on a number of circumstances, their bodies are still responsive to environmental stimuli while they are asleep. These factors can vary depending on the type of noise, its intensity, frequency, spectrum, interval (duration, regularity, expected), significance, and the difference between the background noise level and the maximum amplitude of the occurring noise stimulus. The most disproportionately affected by noise pollution are often the lowest-income communities. Furthermore, annoying background noise is often only the tip of the iceberg when it comes to the real issue. Protecting these communities from this massive environmental attack should, therefore, be a daily concern. These communities are also more unequal because they do not have the means to lessen these effects, like insulation or access to quieter places to live.

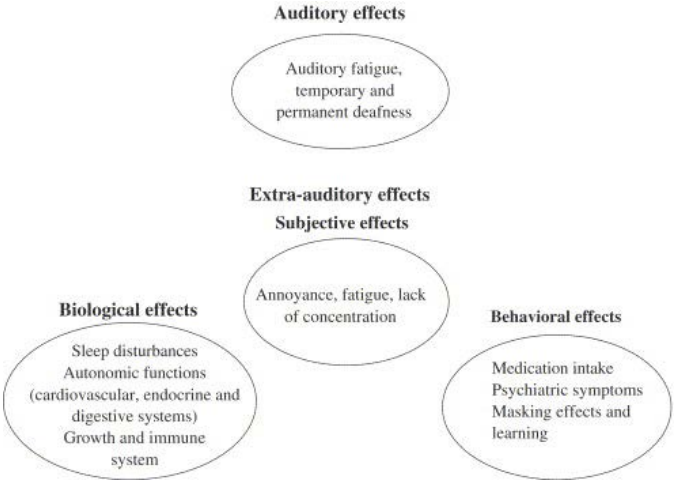

Fig. 2 Auditory and extra-auditory effects of noise.[14]

3. Mechanisms of Environmental Pollution and Social Inequality

3.1 Economic Factors

The connection between social inequality and environmental pollution is heavily influenced by economic factors. Because marginalized communities often have limited income options, they live in affordable housing (cheaper rent), which supports higher pollution levels. Such exposure makes poverty worse by reinforcing poor health and low life expectancy, reducing economic mobility.[15] As all other components of vulnerability—institutional, economic, and social—increase, so does physical vulnerability, which pertains to material structures, namely buildings and technological infrastructure. There has been a gradual loosening of safety and maintenance standards to entice investments and create jobs, as well as cancellation or avoidance of maintenance works in the building, transport, and manufacturing sectors due to budget shortfalls and the adoption of environmentally hazardous and technologically unsafe practices by households, firms, and organizations to cut costs and save money. Using polluting wood, refusing to use fuel for heating to save high energy bills, and moving to cheaper but hazardous housing complexes are all examples of such risky activities that enhance physical and health vulnerability in an attempt to lessen economic vulnerability. Moreover, this is often accompanied by economic policies promoting industrial growth at the expense of environmental safety, which in turn raises pollution in economically disadvantaged areas, exacerbating social inequalities.

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3.2 Social Factors

Race, culture, and social class are also important social factors to consider when trying to figure out how pollution affects different areas. Because they do not have much political or social power, low-income and minority areas are often the first places where polluted businesses and places to dump trash go.[16] This means that some people are more likely to be affected by natural dangers than others, which keeps social inequality going. This kind of systemic inequality is often caused by a mix of past discrimination, a lack of political power, and economic weakness. All of these issues make it harder for marginalized groups to stop harmful industries from moving into their neighborhoods. Also, the environmental justice movement has made it clear that these differences in social status are not just random events; they are part of larger patterns of race and economic injustice that have shaped urban growth and industry policy in many countries for a long time. For instance, studies in Southern California have shown that communities of color are twice as likely as Whites to be harmed by air pollution and toxic waste sites.[17] This is because of intentional siting choices, not random chance or market forces.

3.3 Policy Factors

Environmental policies and regulations lift social inequalities that all too often occur alongside pollution burdens. This simply fuels greater environmental injustice, if not just being ultimately defeated by a power structure in the context of enforcement. For instance, policies permitting industrial encroachment on low-income neighborhoods or failing to fully regulate toxicity in these areas can generate health inequities that perpetuate social disparities.[18] As shown in Figure 3, the Jim Crow laws of the early twentieth century forcefully divided the JFK Neighborhood, a traditionally Black residential neighborhood in Northeast Oklahoma City, from Black inhabitants residing north of NE 8th St. In 1951, city planner Donald White officially designated the region as an industrial zone, stating that the land was “ideally suited” for that purpose without taking into account the potential adverse effects on Black people. In addition, the efficacy of environmental regulations frequently differs depending on social and political power in relevant communities. Richer, politically connected communities can often fight for stricter environmental protections and police enforcement though some poor nations get their own back by spending less on pollution controls, while poorer communities may be unable to afford the effort.[19] This non-uniform approach, he says, reinforces environmental injustice, whereby the traditionally disadvantaged populations carry a higher burden of negative externalities.

Fig .3 JFK Neighborhood, Oklahoma City, Oklahoma, nearby heavy industries framed in red (April 2023).[18]

4. Strategies for Addressing Environmental Justice

4.1 Policy Recommendations

To really work for environmental justice, many different types of policies need to be put in place that deal with both the underlying causes of environmental inequality and the direct needs of communities that are harmed. There are three main types of interventions: law structures, economic rewards, and social safety measures. Creating and enforcing strong law systems that directly deal with environmental inequalities is one of the most important areas of supporting environmental justice. These guidelines

should have strict rules about where harmful businesses can be located, especially in areas where people are weak. Also, all environmental impact assessments should include required environmental justice assessments (EJAs) to make sure that the effects on disadvantaged groups are fully thought through before a project is allowed. [20] Affected communities should also be able to use the law to protect their surroundings and hold pollution responsible. When it comes to environmental justice, economic measures can be very useful. One way is to give businesses cash benefits to use better technologies and leave less of an impact on the earth. Tax breaks, rebates, and funds for green projects can motivate businesses to reduce pollution and put money into long-term methods. [21] At the very least, putting a price on carbon that makes businesses pay to pollute can have huge impacts and provide funding for programs dedicated to environmental justice. Modern society needs fair social policies that protect and help those who are most in need of fixing the unfair contexts leading to environmental injustice. It can ensure a larger number of people in the poorest regions have access to schools and medical care too, thereby reducing how much natural hazards affect population health (as well as improving quality of life overall). Under any social security plan, the individuals harmed by a move in response to environmental risk should be able to do so free from pecuniary concern.[22]

4.2 Community Action

A large part of environmental justice is just getting people to collaborate. Justice must imply the capacity for humans to ever be masters of their natural destinies. There are a variety of ways in which more people can become involved with their community and government around the environment. Involving them in decisions about their environments is one of the greatest ways to help environmental justice. One way to do this is by setting up local advisory boards, which allow people a vehicle for voicing their concerns and influencing policy decisions. As Williamson et al. said, it is important for these boards to be representative of the community.[23] Public meetings and inclusive planning can also help make sure that the needs and goals of groups that have been left out are understood and met. In addition to taking part in official decision-making processes, communities should be pushed and helped to take direct action to fix environmental problems. As an example, this could mean leading clean-up efforts, keeping an eye on pollution levels in the area, and pushing for better environmental laws at the local, regional, and national levels.[24] Community development depends on giving them the tools and information they need to do their own environmental studies and get involved in environmental problems. Making people aware of environmental issues is also an important part of building the environmental justice movement. Getting more people to understand the connections between social injustice and natural health can help environmental justice efforts get more support. Public awareness efforts, training programs, and community events can all help with environmental justice problems. [25]

4.3 Technological Innovation

Technological innovation can contribute greatly to the reduction of environmental pollution which in turn promotes sustainability, addressing some very fundamental issues related to environmental injustice. Clean technology is important in terms of pollution prevention by design. Together with private sector stakeholders, governments should commit significant funds to develop technologies that waste less, pollute less, and consume energy more efficiently. For instance, the development of renewable energy technologies like solar and wind power can reduce dependence on fossil fuels (a contributor to air pollution which disproportionately impacts low-income areas). [26] Green industries represent an area where equitable growth intersects with the environmental challenges of our time — boosting economic opportunity in marginalized communities and promoting clean technologies. However. as Musvoto et al. noted, green jobs in renewable energy, sustainable agriculture, or restoring the environment have a potential opportunity by combining with poverty reduction programs. [27] Technology can also improve the real-time monitoring of environmental conditions helping threatened communities independently gather data to make informed demands. These include mapping the pollution sources and monitoring changes in environmental quality, e.g., with Geographic Information Systems (GIS) and remote sensing technologies, as exemplified in Figure 4. [28] This information can give communities the power to take polluters into their own hands and demand stricter environmental policies.

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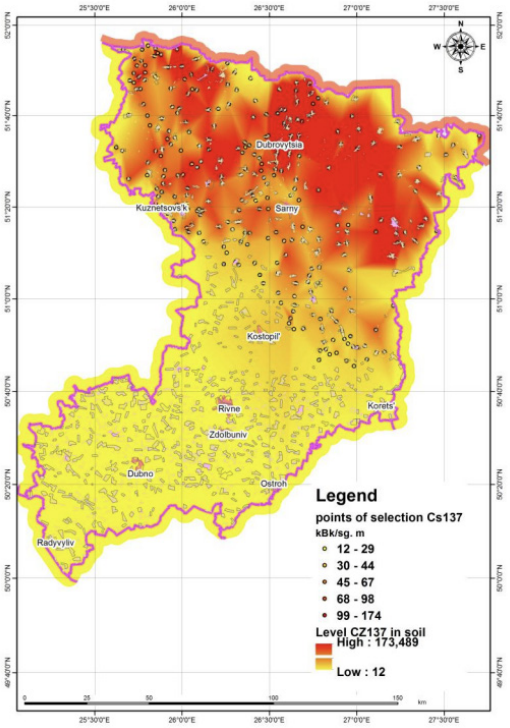

Fig. 4 Information ecological-cartographic models of environmental pollution Cs137 on the Rivne region).[29]

5. Conclusion

Environmental contamination and enhanced levels of social unfairness thus interacted in complex multifarious ways with major implications for human health and justice. Environmental justice provides us with a framework to analyze and address these problems, along with contributing towards environmental governance that is both fairer and more sustainable. It is evidenced that poverty and marginalized communities are exposed to greater environmental risks, which become even worse when there are equalities in the process of decision-making on the environment. Solving these issues will involve policy, community action (policy and beyond), and technological innovation. Therefore, policies need to be shaped that give a higher level of protection for those populations, and participation as well as empowerment in communities are needed along with attention towards the voices from deprived sections. At the same time, innovation in technology provides ways of limiting pollution and monitoring its condition. In the future, modern people can further study social inequality and environmental pollution on interaction process relationship dynamics, and improve relevant policy effects testifying methods or measures targeted solutions. In this way, modern people can help advance a fairer and more sustainable future where the benefits and burdens of the environment are evenly distributed among different groups.

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