Page 1063 - 1092 **DOI:** *https://doij.org/10.10000/IJLMH.119711*

INTERNATIONAL JOURNAL OF LAW MANAGEMENT & HUMANITIES

[ISSN 2581-5369]

Volume 8 | Issue 3

2025

From Dumping Grounds to Justice: A Multidisciplinary Legal Approach to Combating Global Toxic Waste through Environmental, Criminal, Health, and Human Rights Law

PERIYANAYAGI BIBIANA L[1]

ABSTRACT

Toxic waste dumping, which contains toxic chemicals, poses grave risks to human health, environmental sustainability, and socio-economic stability. The global problem in such scenarios involves toxic chemicals, heavy metals, and by-products from heavy industries injected into the atmosphere, hydrosphere, or lithosphere. As is often the case in underdeveloped states, impoverished communities are exposed more intensely due to a lack of viable environmental regulations or even due to proper governmental enforcement. The transboundary nature of waste dumping enables industrialized countries to export toxic materials to poorer regions, not only worsening environmental inequalities but also perpetuating environmental racism. This paper analyzes gaps in criminal law, health law, environmental law, and human rights law through which corporations and organized crime groups, such as Italy's Eco-Mafia, exploit loopholes in the regulation to make money from illegal waste disposal. Case studies such as the Trafigura incident that marred Côte d'Ivoire in 2006 and the Warren County PCB landfill protests in the United States demonstrate how non-enforced laws continue to result in environmental degradation and attendant public health crises as social injustices. Occupational health risks resulting from workers in the formal and informal sectors of recycling, whereby several of them are children, also point to compelling reasons for all-inclusive interventive legal measures. This research adopts a multidisciplinary approach, proposing reforms across criminal, health, environmental, and human rights laws to address the complexities of toxic waste dumping. The paper explores the intersection of environmental and social justice and advocates for stronger legal frameworks and enforcement mechanisms to combat waste dumping effectively. It emphasizes the importance of integrated legal responses to protect vulnerable populations, promote sustainable practices, and ensure environmental and social justice.

Keywords: *Eco-Mafia, Sand-Mafia, Unsafe Shipbreaking, Waste Laundering, Transboundary Dumping, Ecological Crime, Environmental Racism, Environmental Degradation, Dirty Dozen*

[1] Author is a Student at CHRIST (Deemed to be University), Delhi NCR, India.

 [ISSN 2581-5369]

I. INTRODUCTION

India, Toxic waste dumping refers to the illegal or improper disposal of hazardous materials that pose significant risks to human health and the environment. These wastes include chemicals, heavy metals, and industrial by-products, which cause air, water, and soil contamination. The impact of this is both global and local, affecting regions across the world, from industrialized nations to developing countries. On a global scale, toxic waste is often exported from wealthy countries to poorer ones, taking advantage of weak environmental regulations. Locally, waste dumping disproportionately impacts marginalized communities, particularly those in developing nations, where government oversight is limited, and resources to combat environmental violations are scarce. This practice has devastating consequences, including long-term health issues, the destruction of ecosystems, and economic burdens on already vulnerable populations.

Stronger legal mechanisms across multiple domains are essential to combat toxic waste dumping effectively which is exacerbated by the significant gaps in criminal law, health, environmental, and human rights law, where the global community needs to enhance regulation and enforcement, protecting vulnerable populations and ecosystems. Case studies demonstrate how these legal failures contribute to widespread harm, but they also reveal pathways for reform. In the context of criminal law where it fails to penalize the perpetrators effectively as in the 2006 Trafigura case in Côte d'Ivoire[2], where toxic waste dumped in Abidjan led to thousands of illnesses and deaths, illustrates the devastating impact of weak environmental and health laws. In that case, the corporation responsible faced minimal penalties, highlighting the need for stricter criminal and environmental laws. Also, there are insufficient legal frameworks for prosecuting corporations and organized crime involved in waste dumping where they get profit by illegally disposing of hazardous waste in violation of environmental regulations. These groups exploit the regulatory loopholes and weak law enforcement in developing nations where they dispose of the waste at a fraction of the cost of legal disposal. For instance, the Eco-Mafias[3] the Italian mafia carry out illegal waste disposal operations which has a devastating impact on the communities, and harm the environment and wildlife not only this but pose a serious risk to human health along with a severe impact on the economy as well. The 'Ndrangheta mafia[4] in Italy has been linked to sinking ships that

[2] *Trafigura: A Toxic Journey*, AMNESTY INTERNATIONAL, https://www.amnesty.org/en/latest/news/2016/04/trafigura-a-toxic-journey/ (last visited Feb. 20, 2025).

[3] *Eco-Mafia: Environmental Crimes and Toxicity in Italy - NCT CBNW*, NCT CBNW - Powered by NCT, https://nct-cbnw.com/eco-mafia-environmental-crimes-and-toxicity-in-italy/ (last visited Feb. 20, 2025).

[4] Aunshul Rege & Anita Lavorgna, *Organization, Operations, and Success of Environmental Organized Crime*

contained radioactive and hazardous garbage, damaging maritime environments and endangering the health of coastal residents. Numerous investigations into this illegal enterprise have shown the mafia's involvement in environmental damage. Similar to this, organised crime gangs in India, commonly known as the "sand mafia,"[5] mine sand and dispose of garbage illegally. These operations seriously harm the environment by contaminating water supplies, eroding riverbanks, and destroying aquatic ecosystems. These organisations' unrestrained use of natural resources puts public health and local economy at risk in addition to endangering biodiversity. Adding on to it, it also raises the disproportionate impact of environmental hazards imposed on marginalized communities, where communities with less political power are more likely to be exposed to environmental toxic waste, pollution emitting from that and other environmental harms which is otherwise known as Environmental Racism.[6] This is often seen in the context of shipbreaking where the old ships are dismantled which are identified as poor working Being an impactful event on environmental racism this case Warren County PCB Landfill in the United States is an environmental justice movement which emerged in response to this disproportionate burden imposed by the environmental hazards placed on the marginalized communities, specially those with less political and economic power. which became a national social and racial protest that galvanised communities across the country seeking social justice and environmental protection where the number of potential sites to host landfills where ultimately settled on the small African- American Communities. Considering all the impact and consequences the population who suffer due to this toxic waste dumping are not able to revive from this due to gaps and loopholes in the legal implementation and their health and rights are put at stake especially the occupational health hazards of waste handlers in formal and informal recycling sectors where they are exposed to dangerous chemicals or wastes while segregating them and on the process of recycling it, including the children's health who work as child labourers.

II. TOXIC WASTE DUMPING AND ITS EFFECT

Toxic waste dumping[7] is a chemical waste material that is capable of causing death and injury to life. They are often known as B3, which are categorized as dangerous and toxic substances.

in Italy and India: A Comparative Analysis, 14(2) EUR. J. CRIMINOLOGY 160, XXXX (2016), http://dx.doi.org/10.1177/1477370816649627 (last visited Feb. 20, 2025).

[5] Ibid 5

[6] *What Is Environmental Racism?*, BE A FORCE FOR THE FUTURE | NRDC, https://www.nrdc.org/stories/what-environmental-racism (last visited Feb. 20, 2025).

[7] Levi Anatolia SM Exposto & I Nengah Sujaya, *The Impacts of Hazardous and Toxic Waste Management: A Systematic Review*, 1(2) INTERDISCIPLINARY SOC. STUD. 103,http://dx.doi.org/10.55324/iss.v1i2.20 (last visited Feb. 26, 2025)

Such waste is considered toxic if it is poisonous, radioactive, explosive, carcinogenic (causing cancer), mutagenic (causing damage to chromosomes), teratogenic (causing birth defects), or bioaccumulative (increasing in concentration at the higher levels of food chains). These wastes listed above contain harmful and dangerous pathogens, such as syringes, which are sometimes considered toxic waste. It is also known as the illegal or improper disposal of toxic waste at a site, often on a piece of land, which contains unwanted, used, and poisonous chemicals resulting from manufacturing industries. These can cause poisoning if inhaled[8], swallowed, or absorbed through the skin. These toxic wastes result mostly from industrial, biological, and chemical processes and are found in household, office, and commercial wastes. Some familiar products that we use daily and are a part of our routine include batteries used in electronic devices, pesticides, cell phones, and computers.

A. Categories of Toxic Waste Dumping

In general, these toxic waste products generate either toxic materials[9], reactive, ignitable, corrosive, infectious or radioactive and are divided into three categories first is the chemical wastes which are considered to be corrosive, flammable, and reactive which are those chemicals that interact with other substances and tend to create explosive or toxic by-products, they are also acutely poisonous, carcinogenic, mutagenic which affects the major biological changes in the offspring of exposed humans and wildlife and teratogenic also known as heavy metals such as mercury and lead. Secondly, radioactive materials include compounds and elements that produce or absorb ionizing radiation and any such material that interacts with such compounds and elements, such as rods and waste used in power plants, which moderate nuclear reactions. Thirdly medical wastes involve a broad range of wastes from simple tissues and fluids which are capable of possessing and spreading contaminating infectious lethal disease-causing bacteria and other such organisms which emerge from the dumped toxic materials and containers that hold and transfer them mostly in hospital wards even in trace amounts these have cause death or violent illness, chronic effects which causes irreparable harm. Other reactive wastes possess chemical instability and react violently with air or water, which causes explosions or forms other toxic vapours. Wastes that burn at relatively low temperatures can cause an immediate fire hazard and are known as ignitable wastes, these include strong acidic or alkaline substances and corrosive wastes that destroy

[8] Vishnukant Tiwari, *Bhopal Gas Tragedy: Toxic Waste from Deadly Leak Fuels Protests in India*, BBC HOME, https://bbc.com/news/articles/c863jy00430o (last visited Feb. 26, 2025)

[9] *Defining Hazardous Waste: Listed, Characteristic and Mixed Radiological Wastes*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/hw/defining-hazardous-waste-listed-characteristic-and-mixed-radiological-wastes (last visited Feb. 26, 2025).

 [ISSN 2581-5369]

solid material and living tissue upon contact through chemical reaction. Other such wastes, which include used bandages, hypodermic needles, and other materials from hospitals or biological research facilities, are known as infectious wastes.

Famous chemists and environmentalists around the globe commonly group a collection of the world's most dangerous chemical toxins, which are known as the Dirty Dozen and are categorized as persistent organic pollutants (POPs)[10]. Where most POPs consist of pesticides and contain dieldrin, aldrin, endrin, chlordane, hexachlorobenzene, DDT, mirex, heptachlor, and toxaphene, others are emitted or produced through the process of the combustion process. For instance, the by-products of chemical productions such as furans and dioxins, along with the burning of chlorinated substances along polychlorinated biphenyls (PCBs) in paints, plastics, and electrical transformers, which are manufactured using these chemicals and, if burned, are released into the air. Other such toxins belong to a wide range of groups of chemicals called persistent bioaccumulative toxins (PBTs), namely Arsenic, beryllium, cadmium, copper, lead, nickel, and zinc, inclusive of the dirty dozen and can be sustained in the soil, affecting the environment for a longer period.

B. Hazards of this Toxic Waste Dumping

The ecological and health hazards caused due to the release of hazardous substances release where in some cases these hazardous substances irritate the eyes, and skin and make it difficult to breathe affecting the respiratory tract, causing migraine and nausea, or even resulting in other types of illness which severe health effects like behavioural abnormalities, genetic mutations, cancer, physiological malfunctions, physical deformations and birth defects. Other impacts on the environment cause destruction of the organisms in a lake or river, destroys animals and plants in a polluted and contaminated area, which further causes major reproductive complications in animals, or otherwise limits the ability of an ecosystem to survive which affects the chain of life cycle. These have the potential to explode or cause fire, which poses a threat on both animals and human populations. These substances, which consist of toxic waste, have a dual impact on both humans and the environment just after a single episodic release, also known as acute toxicity whereas other substances cause effects after prolonged exposure, also known as chronic toxicity. Using this classification the Environmental Protection Agency (EPA)[11] guides the different aspects of the emergency

[10] *The 12 Initial POPs*, STOCKHOLM CONVENTION, https://chm.pops.int/TheConvention/ThePOPs/The12InitialPOPs/tabid/296/Default.aspx?utm_ (last visited Feb. 26, 2025).

[11] *Health and Ecological Hazards Caused by Hazardous Substances*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/emergency-response/health-and-ecological-hazards-caused-hazardous-substances (last visited Feb. 26, 2025).

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response. These are also used to establish the Superfund reportable quantities. For instance, if a toxic substance is released into the environment with an equal amount to or greater than the RQ, such emission must be reported to the federal government, which simultaneously helps the EPA respond to such release to protect human and wildlife health also the environment from adverse effects of that hazardous substance.

III. CRIMINAL LAW – TRANSBOUNDARY DUMPING

Criminal law serves as a fundamental mechanism to address toxic waste dumping by defining the boundaries of illegal disposal activities, and holding perpetrators accountable for their actions for example under section 280 of the Bharatiya Nyaya Sanhita, 2023[12] and under statutes like the Environmental Protection Act and through the National Green Tribunal. Despite the existing legal frameworks, substantial gaps and loopholes persist[13], which allows offenders to evade liabilities and continue harmful practices. Ambiguity is a significant challenge to establish in cases of corporate criminal liability, especially when waste dumping involves multinational corporations operating across jurisdictions. In most cases, regulatory oversight is either inadequate or enforcement is undermined by systemic corruption, creating a favourable environment for illegal activities. These corporate entities often exploit the complexity of ownership structures, contractual arrangements, and supply chains to avoid direct liability, effectively distancing themselves from the criminal actions of subsidiaries or third-party contractors involved in waste dumping.

Another critical shortcoming in criminal law lies in the insufficient severity of penalties imposed on offenders. Many jurisdictions impose inconsequential fines compared to the financial gains derived from illegal dumping, thus failing to deter future violations. Instead, such penalties are viewed merely as a cost of doing business, rendering the criminal justice system ineffective in preventing recurrence. This lack of deterrence is compounded by the limited capacity of law enforcement agencies to investigate and prosecute environmental crimes effectively. These agencies often face resource constraints, technical challenges in evidence collection, and a lack of specialized knowledge in dealing with toxic waste, which hinders the pursuit of justice.

Furthermore, discrepancies between national regulations and the lack of cohesive international cooperation create significant legal loopholes for offenders. Differing definitions of hazardous

[12] *Bharatiya Nyaya Sanhita*, 2023, s 280.

[13] *India News: Today's Breaking News & Latest Updates From India*, BUSINESS STANDARD, https://www.business-standard.com/india-news/bhopal-toxic-waste-5-cases-filed-against-protesters-opposing-disposal-plan-125010400116 (last visited Feb. 26, 2025).

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waste, as well as varying standards for classification and disposal, allow perpetrators to exploit inconsistencies between legal regimes. This is particularly evident in transboundary movements of waste, where waste is frequently reclassified or disguised to bypass stricter regulations. The infamous "Probo Koala" incident exemplifies these issues; in 2006, toxic waste was dumped in Abidjan, Côte d'Ivoire, by a ship chartered by a multinational company. The legal proceedings were protracted, and accountability was limited, with various parties deflecting responsibility through jurisdictional challenges and claims of regulatory compliance in different countries.

A. The Probo Koala Incident

The Probo Koala incident is a stark example of how these multinational corporations exploit regulatory and legal gaps to evade their accountability for toxic waste dumping. It is also known as the ***"Trafigura toxic waste dumping scandal"*** The incident occurred in August 2006 when the cargo ship named Probo Koala, chartered by the multinational commodities trading company called TRAFIGURA, transported a toxic mixture of oil refining byproducts which included toxic waste which is a mix of petroleum residues like hydrogen sulfide, mercaptans and caustic soda. In its initial attempt, Trafigura sought to dispose of hazardous waste in Europe but opted for Côte d'Ivoire, exploiting weak environmental regulations. A local contractor without proper facilities illegally dumped the waste in urban areas, causing widespread contamination. Over 100,000 people suffered from respiratory issues, skin burns, and gastrointestinal problems, with several deaths linked to exposure. This incident exposed significant gaps in accountability and regulatory oversight, highlighting the failures in both international and domestic criminal law enforcement regarding the illegal transboundary movement and disposal of toxic waste, leading to a public health and environmental disaster.

B. The Main Cause of the Incident

The preliminary cause of this incident is during the process of caustic washing where it was improperly handled and the illegal disposal of toxic waste was generated, it is noted that the company Trafigura had purchased low-grade gasoline which contained high sulfur and attempted to refine this at the sea by using this process and in result it produced a byproduct called slops which is highly toxic and contained hazardous toxic chemicals like hydrogen sulfide and mercaptans which makes it both harmful for both human health and the environment.

Due to this result which was highly toxic, the company sought to dispose of this byproduct at the lowest possible cost, which led to their attempt disposal in several countries. At first

instance, Trafigura tried to offload the waste in European ports like Amsterdam. But after knowing the high costs associated with properly treating the waste, the company arranged to dump the waste in Côte d'Ivoire where the regulations and enforcement were weaker and the disposal costs were lower.

C. Consequences of the Incident

This Probo Koala had caused severe consequences for the people of Abidjan. During the days of dumping the residents began reporting their symptoms such as respiratory problems, nausea, headaches, skin rashes and eye irritation. Hospitals and clinics became overwhelmed as thousands sought medical attention. Sooner it was reported that over 100,000 people were affected with at least 15 deaths directly linked to this toxic exposure.

This also severely caused environmental impact which contaminated the soil and water sources resulting in long-term damage to local ecosystems. The cleanup effort required significant resources and international assistance, but the health and environmental impacts continued to linger for years after the incident.

D. Legal and Regulatory Gaps

The Probo Koala incident exposed significant gaps in the enforcement of international and domestic laws governing hazardous waste disposal. The incident highlighted the limitations of international treaties like the Basel Convention[14], which were designed to regulate the global trade of toxic waste. The main objective of this convention is to reduce the generation of hazardous waste and especially to control transboundary movements.

The Trafigura toxic waste dumping incident in Côte d'Ivoire exemplifies how multinational corporations exploit regulatory loopholes to offload hazardous waste in countries with weak governance. Despite the Basel Convention requiring prior informed consent before transboundary waste transfer, poor enforcement allowed Trafigura to dump toxic sludge through a local contractor at minimal cost, bypassing stricter European disposal regulations. This incident exposed the concept of "toxic colonialism," where developing nations bear the brunt of environmental harm caused by wealthier countries. Though Trafigura paid compensation and funded cleanup efforts, it evaded significant criminal penalties and denied responsibility, highlighting a broader failure in enforcing corporate accountability. The case reveals the shortcomings of domestic and international criminal law in addressing cross-border environmental crimes, particularly due to the absence of a unified prosecutorial

[14] *Basel Convention > The Convention > Overview*, BASEL CONVENTION, https://www.basel.int/theconvention/overview/tabid/1271/default.aspx (last visited Feb. 26, 2025).

framework and weak corporate criminal liability standards. Strengthening legal frameworks and enforcement mechanisms is essential to prevent such incidents and protect vulnerable populations from environmental exploitation.

IV. ENVIRONMENTAL LAW – ECO MAFIA, ECOLOGICAL CRIME

Environmental law aims to protect the environment, but gaps and loopholes enable exploitation by criminal networks, such as eco-mafias, who exploit weak enforcement, jurisdictional ambiguities, and insufficient international cooperation. The disparity in environmental regulations between developed and developing nations allows eco-mafias to target regions with lax laws, often in Asia and Africa, where vulnerable communities are exposed to hazardous waste disguised as legal shipments. These regions lack the resources and infrastructure to manage waste properly, and environmental racism intensifies the issue, with marginalized communities bearing the brunt of toxic waste exposure.

Furthermore, the transboundary movement of waste is another significant gap within environmental law. Treaties like the Basel Convention attempt to regulate the international trade of hazardous waste, but enforcement remains weak, and many loopholes persist. For instance, perpetrators may falsely label hazardous waste as recyclable materials or industrial goods to circumvent regulations. Additionally, the rise of electronic waste (e-waste) has presented new challenges for environmental law. Developed countries often ship e-waste under the guise of donations or second-hand electronics to developing countries, where toxic components like mercury, lead, and cadmium are improperly handled, leading to severe environmental and health consequences. The lack of adequate legal frameworks and infrastructure in these receiving countries further compounds the issue, leaving them vulnerable to environmental degradation.

Another problem is the inadequate punishment for environmental crimes. In many jurisdictions, penalties for illegal waste dumping are not severe enough to deter offenders, particularly organized crime groups that factor these risks into their business models. When penalties do exist, they are often monetary fines that pale in comparison to the profits generated from illegal waste dumping. Furthermore, environmental crimes are frequently treated as civil rather than criminal offences, reducing the likelihood of jail time or significant penalties for those responsible. This creates a culture of impunity, where perpetrators feel that the risks of engaging in illegal dumping are minimal. Moreover, a lack of coordination between environmental law and other legal frameworks, such as criminal law and health

law[15], contributes to the problem. Environmental law often operates in isolation from other regulatory regimes, preventing a comprehensive approach to combating toxic waste dumping. For example, waste dumping can have significant health implications, particularly in communities near illegal dumpsites[16]. Yet health law rarely intersects with environmental law in a meaningful way. This lack of integration leaves gaps in accountability, where the long-term health impacts of exposure to hazardous waste are not adequately addressed. Additionally, the involvement of organized crime in waste trafficking means that criminal law needs to be better integrated into environmental enforcement mechanisms. The illicit waste trade is often linked to other illegal activities, such as drug trafficking and money laundering, and addressing waste crimes requires a multidisciplinary approach that involves law enforcement, environmental agencies, and international cooperation.

Shipbreaking[17], a practice primarily occurring in countries like India, Bangladesh, and Pakistan, is another area where environmental law has struggled to keep pace. Old ships, laden with hazardous materials such as asbestos, heavy metals, and oil sludge, are often dismantled in these countries under dangerous and environmentally damaging conditions. International regulations, such as the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, have attempted to address the issue, but enforcement remains a significant challenge. Ship owners frequently circumvent these regulations by flagging vessels under "flags of convenience" registered in countries with weak environmental protections. This allows shipbreaking to continue with minimal oversight, leaving workers exposed to toxic substances and polluted coastal environments.

To conclude, the environmental law provides a framework for regulating waste disposal, its effectiveness is undermined by several critical gaps and loopholes. Perpetrators such as eco-mafias exploit weak enforcement, jurisdictional inconsistencies, and the lack of international cooperation to continue their illegal activities. Vulnerable communities, particularly in developing nations, disproportionately suffer the consequences of these crimes, facing long-term environmental and health impacts. To address these issues, environmental law must be more effectively integrated with criminal law, health law, and international regulatory

[15] Lucia Fazzo et al., *The Health Impact of Hazardous Waste Landfills and Illegal Dumps Contaminated Sites: An Epidemiological Study at Ecological Level in Italian Region*, 11 FRONTIERS IN PUB. HEALTH, http://dx.doi.org/10.3389/fpubh.2023.996960 (last visited Feb. 26, 2025).

[16] Prince O. Njoku, Joshua N. Edokpayi & John O. Odiyo, *Health and Environmental Risks of Residents Living Close to a Landfill: A Case Study of Thohoyandou Landfill, Limpopo Province, South Africa*, 16(12) INT'L J. ENV'T RES. & PUB. HEALTH 2125 (2019), http://dx.doi.org/10.3390/ijerph16122125 (last visited Feb. 26, 2025).

[17] *The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships*, INT'L MARITIME ORG., https://www.imo.org/en/about/Conventions/pages/the-hong-kong-international-convention-for-the-safe-and-environmentally-sound-recycling-of-ships.aspx (last visited Feb. 26, 2025).

frameworks. Enhanced cooperation between countries, stricter enforcement mechanisms, and harsher penalties for environmental crimes are essential for closing the gaps that currently allow for the continued exploitation of toxic waste disposal.

A. Eco Mafias

Eco-mafias[18] are organized criminal groups that engage in illegal environmental activities, particularly the illicit disposal and trafficking of toxic waste. These groups operate in regions where environmental regulations are weak or poorly enforced, taking advantage of legal loopholes and corrupt officials to profit from hazardous waste disposal, often at the expense of vulnerable communities and ecosystems. Eco-mafias, which initially emerged in Italy, particularly in regions controlled by the Camorra and 'Ndrangheta, have since expanded their operations globally, contributing significantly to environmental degradation and public health crises.

Eco-mafias play a central role in the illegal dumping of hazardous industrial waste, offering businesses a cheaper alternative to proper waste disposal. Industries, such as chemical, pharmaceutical, and construction companies, often turn to these criminal networks to avoid costly regulations. Eco-mafias dispose of the waste illegally in unregulated landfills, rivers, forests, or near populated areas, causing severe environmental damage. This contamination of soil, water, and air leads to long-term health risks for humans and ecosystems, exacerbating the environmental crisis.

B. Waste Laundering

Eco-mafias have also been known to engage in waste laundering, which involves disguising hazardous waste as less dangerous or recyclable materials. This allows them to transport and dispose of toxic waste under false pretences, avoiding the scrutiny of regulatory authorities. For instance, in some cases, hazardous industrial waste is labelled as construction debris or recyclable material and shipped to countries with weak environmental laws. In regions where waste management systems are underdeveloped or poorly regulated, eco-mafias dump this toxic waste, often with little to no oversight, resulting in widespread contamination.

The global nature of waste trafficking allows eco-mafias to exploit differences in environmental regulations between countries. Developed countries, where environmental laws are typically stricter, generate large quantities of hazardous waste but find it difficult and expensive to manage. By contrast, developing nations often lack the legal frameworks and

[18] *Eco-Mafia: Environmental Crimes and Toxicity in Italy*, NCT CBNW, https://nct-cbnw.com/eco-mafia-environmental-crimes-and-toxicity-in-italy/ (last visited Feb. 26, 2025).

infrastructure to adequately control waste imports. As a result, eco-mafias act as intermediaries, moving waste from countries with stringent regulations to those with lax enforcement. Countries in Africa, Southeast Asia, and Eastern Europe are frequently targeted for this kind of activity, making them hotspots for illegal waste dumping.

In Italy, eco-mafias have become particularly notorious for their involvement in the illegal waste trade. The Camorra, an organized crime syndicate based in the Campania region, is known for its control over illicit waste disposal. The "*Triangle of Death*[19]," a region between Naples and Caserta, has seen widespread dumping of toxic waste by the Camorra, leading to an increase in cancer rates and other health problems among residents. This region has become infamous for environmental crimes, and it illustrates the devastating impact of eco-mafia operations on public health and the environment. The Italian government has struggled to combat this issue due to the entrenchment of these criminal groups within the waste disposal industry, combined with corruption and insufficient law enforcement resources.

C. Corruption

Corruption plays a crucial role in enabling eco-mafia operations. In many cases, eco-mafias bribe local officials, law enforcement, and regulatory agencies to look the other way or to actively facilitate illegal waste dumping. This corruption creates a cycle in which environmental crimes go unpunished, and criminal networks continue to profit at the expense of communities and the environment. The involvement of government officials also makes it difficult to crack down on eco-mafia activities, as local authorities may be complicit or unwilling to take action against these powerful criminal groups.

Eco-mafia activities pose a serious threat to both the environment and public health, especially in marginalized communities. Illegal dumping leads to long-term health issues such as cancer, respiratory ailments, and developmental disorders in children due to exposure to hazardous chemicals. These activities exemplify environmental racism, as impoverished communities lacking political influence are disproportionately burdened. International efforts to combat eco-mafias remain inadequate due to the complexity and transnational nature of waste trafficking. While treaties like the Basel Convention aim to regulate hazardous waste movement, weak enforcement allows eco-mafias to exploit legal gaps. The growing issue of electronic waste trafficking often disguised as second-hand goods, further complicates enforcement and poses severe risks from toxic substances like lead, mercury, and cadmium.

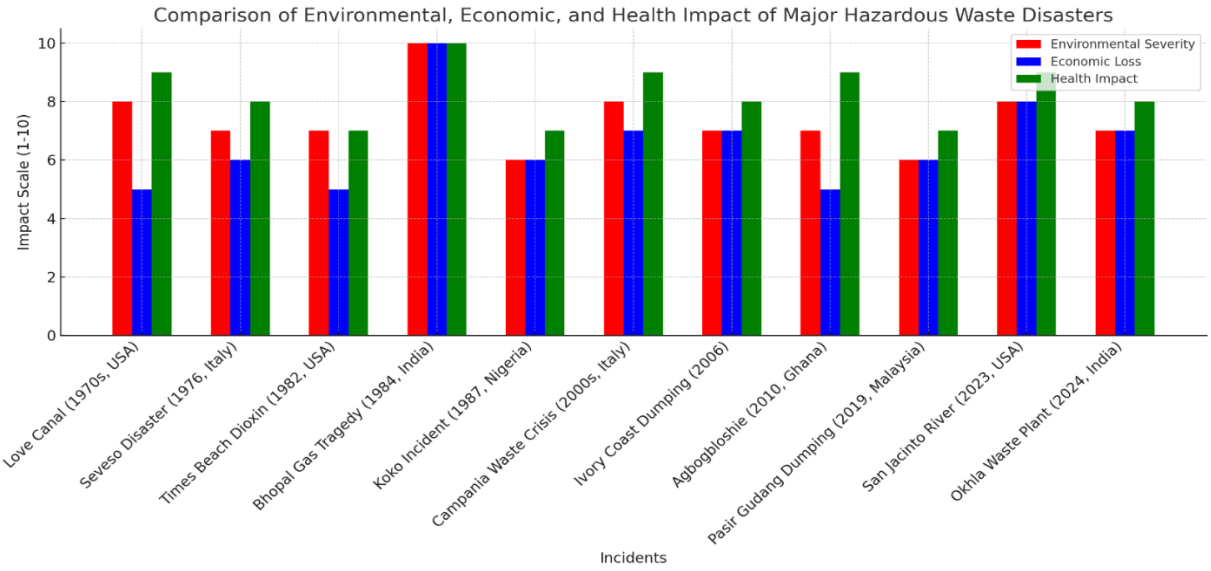
[19] Angela Giuffrida, *'Triangle of Death': Will Italy Finally Tackle Mafia's Toxic Waste Dumping?*, THE GUARDIAN (Feb. 18, 2025), https://www.theguardian.com/world/2025/feb/18/triangle-of-death-will-italy-finally-tackle-mafias-toxic-waste-dumping (last visited Feb. 26, 2025).

 [ISSN 2581-5369]

Combating eco-mafias demands robust international cooperation, stringent enforcement of environmental laws, and efforts to eliminate corruption in the waste sector. A coordinated global response is essential to hold perpetrators accountable and protect vulnerable communities from ongoing harm.

V. HEALTH LAW – BODILY IMPACTS

Health law[20] plays a critical role in addressing the harmful effects of toxic waste dumping and establishing legal frameworks to protect public health, especially in communities affected by hazardous waste. Toxic waste dumping presents severe bodily impacts and occupational health hazards for waste handlers[21], leading to various acute and chronic health conditions. These workers frequently encounter exposure to hazardous materials such as heavy metals, organic solvents, and biological agents, resulting in respiratory disorders, skin diseases, musculoskeletal injuries, and neurological impairments. For instance, the infamous Love Canal incident in the late 1970s involved the disposal of industrial waste, leading to alarming rates of birth defects and health issues among residents and worke



1. Love Canal - New York, USA, 1970s[22]

The Love Canal disaster involved a neighbourhood in Niagara Falls, New York, where toxic waste was buried by a chemical company (Hooker Chemical) in the 1940s and 1950s. Decades later, the buried chemicals began seeping into homes and schools, causing an

[20] *Health-Care Waste*, WORLD HEALTH ORG., https://www.who.int/news-room/fact-sheets/detail/health-care-waste (last visited Feb. 26, 2025).
[21] *Health Care Waste Management – Public Health Benefits, and the Need for Effective Environmental Regulatory Surveillance in Federal Republic of Nigeria*, INTECHOPEN, https://www.intechopen.com/chapters/44569 (last visited Feb. 26, 2025).
[22] Lenore J. Gensburg et al., *Mortality Among Former Love Canal Residents*, 117 ENV'T HEALTH PERSP. 209 (2009), http://dx.doi.org/10.1289/ehp.11350 (last visited Feb. 26, 2025).

alarming rise in health issues, such as miscarriages, birth defects, and cancers.

This disaster led to the enactment of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or "Superfund" law in 1980. It also introduced the concept of holding polluters financially responsible for health damages and environmental cleanup.

2. Seveso Disaster – Italy, 1976[23]

This explosion on July 10, 1976, at a chemical plant in seveso released a cloud of dioxin into the atmosphere, as it led to skin lesions, such as chloracne and other long-term health issues among the nearby population

3. Times Beach Dioxin Contamination - USA, 1982[24]

The Town of Times Beach, Missouri was found to be contaminated with high levels of dioxin which resulted from spraying of waste oil mixed with dioxin-contaminated waste on unpaved roads to control dust, forcing the residents of this town to evacuate and relocate permanently.

4. Bhopal Gas Tragedy – India, 1984[25]

A catastrophic gas leak occurred at the Union Carbide pesticide plant in Bhopal, which released approximately 40 tonnes of methyl isocyanate and this incident resulted in thousands of immediate deaths and long-term health complications for over half a million people. Decades later, in January 2025, recently efforts began to remove the remaining toxic waste from the site, though concerns persist about the ongoing contamination and health risks.

5. Koko Incident - Nigeria, 1987[26]

This incident brought international attention to the transboundary movement of hazardous waste, resulting in the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1989).

[23] Brenda Eskenazi et al., *The Seveso Accident: A Look at 40 Years of Health Research and Beyond*, 121 ENV'T INT'L 71 (2018), http://dx.doi.org/10.1016/j.envint.2018.08.051 (last visited Feb. 26, 2025).
[24] Kevin S. Held, *St. Louis County Town Goes from Resort to Environmental Disaster*, FOX 2 (June 18, 2022), https://fox2now.com/news/missouri/st-louis-county-town-goes-from-resort-to-environmental-disaster/ (last visited Feb. 26, 2025).
[25] Nikita Yadav, *Bhopal Gas Tragedy: Toxic Waste Removed from Union Carbide Factory After 40 Years*, BBC NEWS (Jan. 2, 2025), https://www.bbc.com/news/articles/cgj6e1e2688o (last visited Feb. 26, 2025).
[26] David Murfin, *Koko Toxic Waste Incident and the Bamako Convention: A Tale of Environmental Vigilance*, RUBO - HAZARDOUS WASTE MGMT. LTD (June 12, 2024), https://www.rubowaste.co.uk/hazardous-waste-news/koko-toxic-waste-bamako-convention (last visited Feb. 26, 2025).

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6. Campania Waste Crisis - Italy, 2000s[27]

In the Campania region of Italy, organized crime (the Camorra) dumping illegal waste led to a large-scale public health crisis. Hazardous industrial waste, including toxic chemicals, was improperly disposed of in landfills or burned, contaminating the air, water, and soil.

7. Ivory Coast Toxic Waste Dumping - Abidjan, 2006[28]

The cargo ship Probo Koala, chartered by the company Trafigura, discharged toxic waste in and around the ivory coast which released harmful chemicals leading to widespread heath issues among the local population, including respiratory problems, skin irritations and gastrointestinal ailments.

8. Agbogbloshie - Ghana, 2010[29]

Agbogbloshie, a large informal e-waste recycling site in Ghana, became a dumping ground for electronic waste from developed countries. Informal workers, including children, dismantle toxic electronic components, releasing dangerous chemicals like lead, mercury, and dioxins into the environment.

9. Pasir Gudang Chemical Dumping - Malaysia, 2019[30]

The Illegal dumping of chemical waste into the Kim Kim River led to fumes affecting nearby schools and residential areas, and the residents, including their children, experienced symptoms like breathing difficulties, nausea and dizziness.

10. San Jacinto River Waste Pits – USA, 2023[31]

A study was conducted which revealed unusually high rates of cancers, including cervical, leukemia, lung, bronchus, and lymphoma, in communities near the San Jacinto River in Texas and it is aslo noted that this area is known for its Superfund site which contains toxic waste pits and contamination from these pits is the cause of health issues of the residents.

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[27] *Waste Crisis in Campania, Italy*, CEECEC, https://ceecec.net/case-studies/waste-crisis-in-campania-italy/ (last visited Feb. 26, 2025).

[28] *Côte d'Ivoire: 10 Years On, Survivors of Toxic Waste Dumping 'Remain in the Dark,' Say UN Rights Experts*, UN NEWS (Aug. 17, 2016), https://news.un.org/en/story/2016/08/536822.

[29] Anuli Njoku et al., *Environmental Injustice and Electronic Waste in Ghana: Challenges and Recommendations*, 21 *Int'l J. Envtl. Res. & Pub. Health* (forthcoming), https://www.ncbi.nlm.nih.gov/pmc/articles/PMCXXXXXXX (add full citation details when available).

[30] Mohd Faiz Ibrahim et al., *The Impacts of Illegal Toxic Waste Dumping on Children's Health: A Review and Case Study from Pasir Gudang, Malaysia*, 18 *Int'l J. Envtl. Res. & Pub. Health* (forthcoming), https://www.ncbi.nlm.nih.gov/pmc/articles/PMCXXXXXXX (add full citation details when available).

[31] *Unusually High Cancer Rates Found from Atascocita to La Porte Along San Jacinto River, State Agency Finds*, HOUSTON CHRONICLE (Feb. 25, 2025), https://www.houstonchronicle.com/news/houston-texas/environment/article/texas-cancer-cluster-superfund-san-jacinto-20184859.php (last visited Apr. 7, 2025).

11. Okhla Waste-to-Energy Plant - Delhi, 2024[32]

The Timarpur-Okhla Waste Management plant in Delhi emitted high levels of toxic substances, inclusive of cadmium, lead and arsenic which exposed over a million residents to significant health risks, especially the hazardous ash from the plant was also found to be illegally dumped in residential areas, which lead to exacerbation of environmental and health crisis.

To conclude health law plays a crucial role in mitigating the harmful effects of toxic waste dumping by establishing regulations for safe waste disposal, monitoring environmental contamination, and protecting affected communities. Incidents such as Love Canal, Bhopal, and Agbogbloshie demonstrate that the failure to enforce health laws and environmental regulations can lead to devastating health consequences. Strengthening health laws, both nationally and internationally, remains essential to safeguard public health from the dangers of hazardous waste. These incidents highlight the urgent need for rigorous enforcement of occupational health standards and the establishment of legal frameworks that prioritize the health and safety of workers in waste management, ultimately reinforcing their rights against the risks posed by toxic waste dumping. Furthermore, the implementation of health surveillance programs and preventive measures can mitigate long-term health effects, contributing to a safer working environment for waste handlers.

VI. HUMAN RIGHTS LAW AND THE INJUSTICE CAUSED TO POPULATION INVOLVED

Human rights law serves as a pivotal framework in the fight against toxic waste dumping, addressing the myriad of human rights violations that arise when hazardous materials are improperly disposed of. The detrimental effects of toxic waste on human health and the environment often disproportionately impact marginalized and vulnerable communities, who may lack the resources or political power to defend their rights effectively. As such, the relationship between human rights and environmental protection has garnered increasing attention in recent years, recognizing that a healthy environment is essential for the realization of fundamental human rights.

At the core of this issue is the recognition of the right to a healthy environment, which numerous international treaties and declarations. For instance, the 1972 Stockholm Declaration states that *"man has the fundamental right to freedom, equality, and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being."*

[32] *Toxic Emissions from Okhla Waste Plant Put Millions at Health Risk: Report*, BUSINESS STANDARD, https://www.business-standard.com/india-news/toxic-emissions-from-okhla-waste-plant-put-millions-at-health-risk-report.

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This principle emphasizes that individuals should not be subjected to hazardous waste that compromises their health, safety, and overall quality of life. Toxic waste dumping can lead to various adverse health outcomes, including respiratory diseases, cancers, and reproductive health issues, thus violating Article 7[33] which provides the right to just conditions of work, and equal pay including the right to health enshrined in instruments like the International Covenant on Economic, Social and Cultural Rights (ICESCR).

Toxic waste dumping disproportionately impacts marginalized communities already facing socioeconomic challenges, such as poverty and limited access to education. These groups often lack the power to challenge harmful practices by corporations or governments. The principle of non-discrimination is vital, ensuring that all individuals have equal rights to protection from environmental harm. Dumping in these communities deepens inequalities, perpetuating cycles of poverty and marginalization while violating fundamental rights to life, health, and an adequate standard of living.

International human rights mechanisms also play a significant role in addressing toxic waste dumping. The United Nations Special Rapporteur on Human Rights and the Environment[34] has highlighted the importance of protecting individuals from environmental harm, stating that governments must take preventive measures to avoid environmental degradation that could infringe upon human rights. This includes creating and enforcing regulations that govern waste management practices, conducting environmental impact assessments, and ensuring that communities have access to information regarding hazardous waste disposal activities.

In any legal dispute, identifying the probable legal issues is the first step, which may span areas like contract breach, criminal offences, family disputes, or torts. Relevant statutes include the Bharatiya Nagarik Suraksha Sanhita, Bharatiya Nyaya Sanhita, Civil Procedure Code, Indian Contract Act, and personal laws depending on the nature of the case. Jurisdiction is determined by subject matter and territorial relevance. civil matters go to civil courts, criminal matters to magistrates or sessions courts. The right to sue depends on whether the person is directly affected or has legal standing. Disputes can be resolved via litigation or Alternative Dispute Resolution (ADR) mechanisms such as mediation, arbitration, or conciliation. ADR offers a time- and cost-effective approach, while litigation may be

[33] *International Covenant on Economic, Social and Cultural Rights*, OFFICE OF THE HIGH COMMISSIONER FOR HUMAN RIGHTS, https://www.ohchr.org/en/instruments-mechanisms/instruments/international-covenant-economic-social-and-cultural-rights (last visited Feb. 27, 2025).

[34] *Special Rapporteur on the Human Right to a Healthy Environment*, OFFICE OF THE HIGH COMMISSIONER FOR HUMAN RIGHTS, https://www.ohchr.org/en/special-procedures/sr-environment (last visited Mar. 1, 2025).

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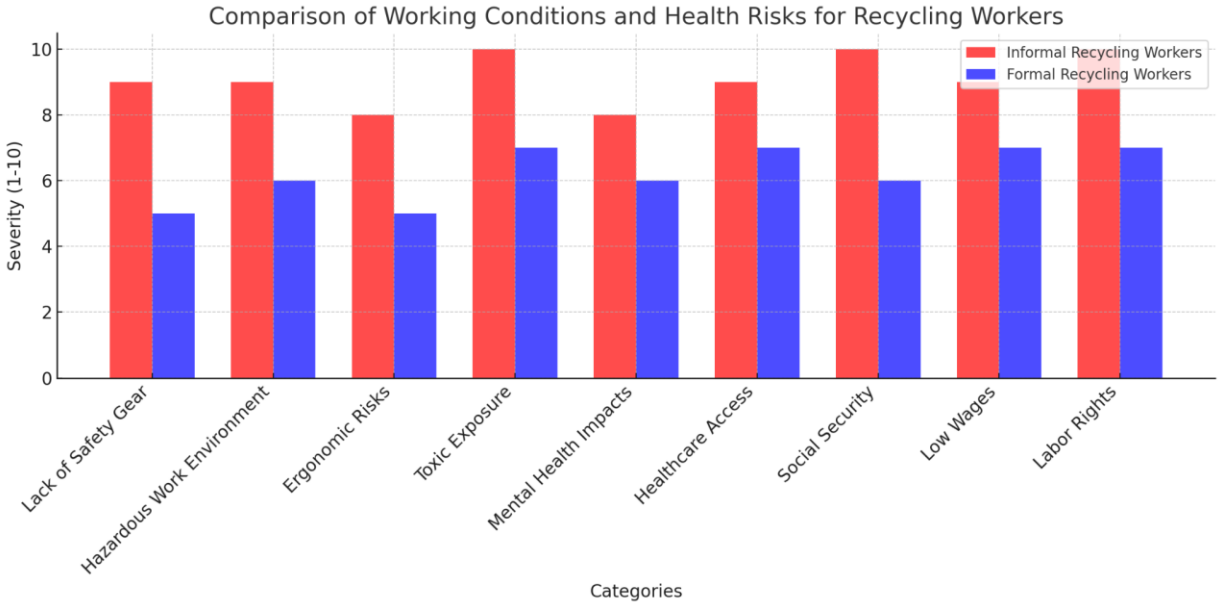
necessary for enforceable or precedent-setting outcomes. Solutions must be tailored to both parties, ensuring equitable remedies like compensation, restitution, custody arrangements, or compliance with contractual or statutory obligations.

A. Comparison of Informal and Formal Recycling Workers

CATEGORY	INFORMAL RECYCLING WORKERS	FORMAL RECYCLING WORKERS
WORKING CONDITIONS		
Lack of Safety Gear	No access to PPE (gloves, masks, goggles)	PPE may be provided, but enforcement is inconsistent
Hazardous Work Environment	Work in unsafe dumpsites or makeshift centers	Work in regulated facilities, but safety compliance varies
Ergonomic Risks	High risk of musculoskeletal disorders due to manual labour	Some automation may reduce risk, but repetitive tasks persist
HEALTH RISKS		
Toxic Exposure	High exposure to heavy metals, chemicals, and e-waste	Exposure to hazardous waste, but with some safety measures
Mental Health Impacts	Anxiety and depression due to job insecurity and exposure risks	Work pressure and job insecurity leading to stress
ACCESS TO SERVICES		
Healthcare	Limited or no access to healthcare and inability to	Access to healthcare may be available but not

	afford treatment	comprehensive
Social Security & Rights	No labor protections, no unemployment benefits	Some protections, but there are also rights violations (wage theft, long hours)
COMPENSATION & RIGHTS		
Wages	Low or inconsistent income	Low wages despite formal employment
Legal Protection	No labor rights, lack of legal recourse	More legal rights, but limited enforcement



A. Informal Recycling Workers

Informal recyclers face significant occupational hazards due to their lack of access to personal protective equipment (PPE) like gloves, masks, and goggles, leaving them vulnerable to injuries and toxic exposure. Their work environments often dumpsites or makeshift recycling centres lack basic infrastructure such as sanitation, lighting, and waste management, compounding the risks. Manual handling of waste leads to musculoskeletal issues from

repetitive strain and poor ergonomics. These workers are routinely exposed to hazardous substances, including heavy metals and electronic waste, resulting in respiratory problems, skin conditions, and chronic illnesses like cancer. The psychological burden of economic insecurity and hazardous work contributes to mental health challenges, such as anxiety and depression. Additionally, their informal status deprives them of access to healthcare, labour protections, and social security benefits. The absence of legal recognition restricts their ability to demand safer conditions or seek redress for injuries, leaving them highly vulnerable and marginalized within the waste management ecosystem.

B. Formal Recycling Workers

Formal recycling facilities are generally subject to safety and health regulations, but enforcement is often inconsistent. To cut costs, some facilities neglect proper training and safety protocols, exposing workers to toxic e-waste substances like lead, mercury, and cadmium. This can result in serious health consequences. Additionally, workers face high stress due to low wages, job insecurity, and fast-paced environments. Despite having more protections than informal workers, formal recycling employees may still encounter labour rights violations such as wage theft, long working hours, and restricted access to collective bargaining, contributing to economic instability and inadequate workplace safety.

C. Challenges Faced by the Recycling Workers:

The challenges faced by both informal and formal recycling workers include stigmatization in society, which can lead to social isolation and further marginalization. This stigma can discourage community support and political advocacy for better working conditions. The dumping of toxic waste often occurs in economically disadvantaged areas, disproportionately affecting low-income communities and leading to environmental injustice, and this systemic inequality exacerbates health risks and economic instability for both informal and formal workers. Effective regulations regarding waste management and worker protections are often lacking or poorly enforced. Advocating for stronger policies is essential to protect the rights and health of recycling labourers.

The impact of toxic waste dumping on both informal and formal recycling labourers is profound, encompassing health risks, poor working conditions, and lack of access to services. Addressing these issues requires a comprehensive approach that includes stronger regulations, better enforcement of labour rights, and increased awareness of the critical roles these workers play in managing waste. Ensuring that both informal and formal recyclers receive adequate protection and support is vital for promoting health, safety, and justice in waste management

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practices.

VII. LAWS WHICH EXIST AND WHICH FAILED TO PROTECT

Toxic waste dumping remains a serious global concern, challenging the effectiveness of criminal, environmental, health, and human rights laws due to persistent enforcement gaps and regulatory shortcomings. Despite the existence of various legal frameworks at international, regional, and national levels, illicit disposal of hazardous waste continues, especially in vulnerable communities lacking political and economic influence.

In the realm of criminal law, instruments like the Indian Penal Code, 1860 (now replaced by the Bharatiya Nyaya Sanhita, 2023), provide provisions to penalize public harm caused by negligent waste management. However, these laws are rarely enforced against large corporations or eco-mafia networks responsible for systematic toxic dumping. At international level, the United Nations Convention against Transnational Organized Crime targets cross-border environmental crimes, including hazardous waste trafficking. Still, weak enforcement, corruption, and lack of international coordination significantly undermine its effectiveness. Similarly, the OECD Anti-Bribery Convention, intended to address corporate corruption, often fails to deter illegal conduct in the waste management sector due to inadequate monitoring and compliance.

Environmental law frameworks, such as the Basel Convention (1989) and the Bamako Convention (1991), were established to regulate the transboundary movement of hazardous waste and ban exports to developing countries. Yet, waste brokers routinely exploit regulatory loopholes, leading to continued illicit waste flows. In India, the Environment (Protection) Act, 1986, and the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, provide the domestic regulatory basis. However, weak implementation, non-compliance by industries, and limited oversight from regulatory bodies like the Central Pollution Control Board undermine their efficacy. The Stockholm Convention on Persistent Organic Pollutants (2001) addresses the long-term environmental impacts of hazardous chemicals, but shipbreaking activities in Alang, Gujarat, continue to release pollutants into the environment, reflecting regulatory failure.

In terms of health law, statutes like the Factories Act, 1948, and the Public Liability Insurance Act, 1991, are meant to protect workers from hazardous exposure and ensure compensation in cases of industrial accidents. In practice, industries often underreport accidents and fail to compensate affected workers, leaving communities exposed to significant health risks. These failures contravene the International Covenant on Economic, Social and Cultural Rights ,

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which enshrines the right to health and a safe working environment. The Bhopal disaster is a glaring example decades later, toxic waste remains untreated, affecting generations with chronic health issues.

From a human rights law perspective, the National Green Tribunal Act, 2010, was a significant step in providing access to environmental justice in India. Instances of environmental racism where toxic waste disproportionately affects marginalized and economically disadvantaged communities reveal deep systemic inequalities. The shipbreaking industry in Alang and waste dumping in Gujarat highlight the limitations of judicial and regulatory protections for vulnerable populations.

In conclusion, although comprehensive legal instruments exist to address toxic waste dumping, enforcement remains weak due to corruption, lack of coordination, inadequate monitoring, and institutional inertia. To ensure justice and public welfare, urgent legal reforms are necessary to strengthen accountability, close regulatory loopholes, and empower affected communities through stronger health and human rights protections.

A. Notable Cases related to Toxic Waste Dumping in India:

CASE NAME	**Environmental Law**	**Criminal Law**	**Health Law**	**Human Rights Law**
Vellore Citizens Welfare Forum v. Union of India 1996 SCC 5 647	Inadequate enforcement of regulations, allowing tanneries to pollute water bodies; TNPCB failed to monitor effluent discharge.	Lack of criminal prosecution under IPC for causing public harm.	Pollution-related health issues were not adequately addressed.	Local communities' right to health was compromised.
M.C. Mehta v. Union of India 1988 1 SCC 471	Weak enforcement of the Water (Prevention and Control of Pollution) Act, 1974, allowing industries to pollute.		Insufficient enforcement of health laws to address illnesses from polluted water.	Neglect of marginalized communities relying on the Ganges for drinking water and livelihood.

Sterlite Industries Ltd. v. Union of India 2013 4 SCC 575	Ineffective enforcement of Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2016.	No criminal liability established against the company for environmental harm.	No robust health impact assessment; health issues escalated without intervention.	Authorities ignored local community concerns about environmental health risks.
Indian Council for Enviro-Legal Action v. Union of India and Others 1996 3 SCC 212	Weak enforcement of the Environment (Protection) Act, 1986, allowing illegal operations of a glass factory.	Minimal legal repercussions for the company despite ongoing pollution.	Rising cancer rates and other health impacts inadequately investigated.	Marginalized villagers' rights were overlooked.
Art of Living Foundation Case (2017)	Failure to enforce the Water (Prevention and Control of Pollution) Act, leading to ecological damage.		Potential health risks from pollution and waste mismanagement were not assessed or mitigated.	Rights of local residents and ecological rights of the river were neglected.
Union of India v. Union Carbide Corporation 2023 SCC OnLine SC 264	Non-enforcement of regulations allowed improper storage of hazardous chemicals.	Lack of accountability for corporate negligence; minimal legal consequences for those responsible.	Inadequate medical care and compensation for victims.	Failure to protect the right to health and a safe environment for affected populations.

VIII. SOLUTIONS TO COMBAT TOXIC WASTE DUMPING

S.NO	SOLUTION	IMPLEMENTATION	WHY USE IT	KEY BENEFITS
1.	**Waste Brokers Regulation**[35]	Enforce strict registration and tracking of intermediaries in waste trade	Reduces fraudulent documentation and illegal disposal	Enhances traceability, ensures accountability, and strengthens enforcement
2.	**Whistleblower**[36]	Establish robust legal protections and incentives for whistleblowers	Encourages insider reporting of illegal waste activities	Improves detection, enforces compliance, and protects informants
3.	**Waste-to-Energy Technologies**[37]	Convert hazardous waste to energy via thermal treatment	Minimizes landfill usage and recovers energy	Reduces waste volume, generates power, and cuts greenhouse emissions
4.	**Blockchain for Waste Management**[38]	Track hazardous waste using blockchain from generation to disposal	Ensures data transparency and traceability	Prevents concealment, strengthens accountability, and enhances

[35] *Waste Broker*, CURBWASTE, https://www.curbwaste.com/waste-management-industry-glossary/waste-broker (last visited Mar. 1, 2025).
[36] *Whistleblower Protection*, OFFICE OF INSPECTOR GENERAL, https://www.epaoig.gov/whistleblower-protection (last visited Mar. 1, 2025)
[37] Igor, *Waste to Energy Technologies Overview*, WASTE TO ENERGY INT'L (May 19, 2021), https://wteinternational.com/news/waste-to-energy-technologies-overview/ (last visited Mar. 1, 2025)
[38] Recykal, *Blockchain Transforms Waste Management Through Traceability*, RECYKAL (Aug. 29, 2024), https://recykal.com/blog/blockchain-in-waste-management-revolutionizing-the-path-to-a-sustainable-future/.

				monitoring
5.	**Eco-Labelling & Certification[39]**	Certify companies following sustainable waste practices	Promotes ethical consumer choices	Encourages corporate responsibility and drives market-driven sustainability
6.	**Mobile App Reporting Systems[40]**	Develop citizen-reporting apps with GPS and photo upload capabilities	Empowers communities to report in real-time	Aids enforcement, deters illegal dumping, and increases civic participation
7.	**Environmental Justice Frameworks[41]**	Include marginalized communities in policy-making	Corrects systemic neglect and promotes fairness	Ensures equity, reduces disproportionate exposure, and fosters trust
8.	**Corporate Environmental Responsibility[42]**	Integrate sustainability beyond compliance into business operations	Fosters ethical behavior and long-term planning	Builds public trust, reduces liabilities, and enhances ESG profiles
9.	**Decentralized Waste Systems[43]**	Empower communities to operate local waste	Enhances responsiveness	Reduces illegal dumping, boosts

[39] Eco Label, *How to Get ECO LABEL Certificate?*, https://www.ecolabel.net/en/belgelendirme/eco-label-sertifikasi-nasil-alinir/ (last visited Mar. 1, 2025)

[40] *TrashOut: Locate and Get Rid of Illegal Dumps*, https://www.trashout.ngo/ (last visited Mar. 1, 2025).

[41] Dominic Lenzi et al., *Justice, Sustainability, and the Diverse Values of Nature: Why They Matter for Biodiversity Conservation*, 64 *Curr. Opin. Env'tl. Sustainability* 101353 (2023).

[42] RSB, *Why Is It Important for Companies to Protect the Environment*, RSB ENVIRONMENTAL (June 1, 2023), https://rsbenv.com/why-is-it-important-for-companies-to-protect-the-environment (last visited Mar. 3, 2025).

[43] OECD, *Extended Producer Responsibility: A Guidance Manual for Governments* (OECD Publishing 2001), https://doi.org/10.1787/9789264189867-en.

		solutions	and reduces reliance on centralized systems	local resilience, and supports circular economy
10.	**Green Supply Chain Management[44]**	Assess and reduce environmental impacts across supply chains	Prevents waste generation at source	Promotes sustainable sourcing and lowers lifecycle emissions
11.	**Green Infrastructure Investments[45]**	Use bioremediation and phytoremediation for natural site restoration	Provides eco-friendly remediation	Revives ecosystems, improves biodiversity, and avoids chemical-intensive cleanup methods
12.	**Behavioural Change Campaigns[46]**	Educate public on responsible disposal through community programs	Encourages mindset change and proactive habits	Minimizes hazardous waste generation and boosts responsible consumption
13.	**Informal Waste Integration[47]**	Formalize waste pickers into cooperatives	Recognizes vital contributions	Increases recycling rates, provides safety,

[44] European Commission, *EU Slashes Sustainability Red Tape – At What Cost?*, *Vogue Business* (Apr. 1, 2025), https://www.voguebusiness.com/story/sustainability/eu-slashes-sustainability-red-tape-andnbspat-what-cost.
[45] *Manchester, Coventry Get Funding from CT Grant Program for Waste Management Projects*, *CT Insider* (Apr. 4, 2025), https://www.ctinsider.com/journalinquirer/article/ct-manchester-coventry-waste-recycling-deep-20250284.php.
[46] *Don't Be a Dumper or You Might Get Snapped in the Act: Government Warns*, *The Courier Mail* (Dec. 4, 2024), https://www.couriermail.com.au/news/northern-territory/nt-gov-launches-dont-be-a-dumper-campaign-to-tackle-territorywide-illegal-dumping/news-story/cc602727cbd1d1f26cb1785549d620f5.
[47] Centre for Science and Environment, *Integration of Informal Sector in Solid Waste Management* (July 12, 2021), https://www.cseindia.org/integration-of-informal-sector-in-solid-waste-management-10886.

			to recycling	and supports livelihoods
14.	**Community-Led Waste Initiatives[48]**	Promote grassroots recycling and composting programs	Empowers locals and leverages indigenous knowledge	Reduces dumping, fosters accountability, and enhances segregation
15.	**Eco-Industrial Parks[49]**	Promote industrial symbiosis among co-located businesses	Encourages resource sharing and efficiency	Cuts industrial waste, drives innovation, and supports green industrialization
16.	**Extended Producer Responsibility[50]**	Mandate producers to manage post-consumer product waste	Shifts burden to producers, encouraging eco-design	Reduces hazardous waste, encourages recycling, and aligns with global best practices (EU, Japan)
17.	**Biochar for Soil Remediation[51]**	Apply biochar to polluted land to neutralize toxins	Prevents contamination spread	Restores soil, improves agricultural output, and sequesters

[48] *Fair Haven, New Haven Leaders Announce New Neighborhood Cleanup Campaign on East Side of City*, *New Haven Register* (Mar. 3, 2025), https://www.nhregister.com/news/article/fair-haven-new-haven-leaders-announce-20204033.php.
[49] *Ireland's Next Top Model Town*, *The Times* (Mar. 30, 2025), https://www.thetimes.co.uk/article/irelands-next-top-model-town-0gq5pr6bq.
[50] TOMRA, *What is Extended Producer Responsibility (EPR)?* (Mar. 30, 2022), https://www.tomra.com/news-and-media/feature-articles/what-is-extended-producer-responsibility
[51] Fotis Bilias et al., *Towards a Soil Remediation Strategy Using Biochar: Effects on Soil Chemical Properties and Bioavailability of Potentially Toxic Elements*, 9 *Toxics* 184 (2021), https://doi.org/10.3390/toxics9080184.

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				carbon
18.	**Mobile Hazardous Waste Units**[52]	Deploy mobile collection for hazardous household and industrial waste	Increases accessibility and proper disposal	Reduces environmental contamination, prevents illegal dumping, and reaches remote areas
19.	**Product-as-a-Service (PaaS) Models**[53]	Lease products instead of selling	Encourages full lifecycle management	Reduces waste, fosters reuse, and ensures safe product return and recycling
20.	**Green Chemistry Alternatives**[54]	Substitute toxic chemicals with eco-friendly solutions	Reduces pollution at the source	Lowers industrial risk, protects health, and promotes sustainable innovation
21.	**Pay-As-You-Throw (PAYT) Schemes**[55]	Charge based on amount of waste generated	Discourages overproduction of waste	Encourages reduction, increases recycling, and aligns incentives with sustainability

[52]*Mobile Hazardous Waste Units – Tackling Dangerous Waste*, https://www.alba.info/en/business-areas/waste-management/local-authorities/mobile-hazardous-waste-units/ (last visited Apr. 7, 2025)

[53] '*How do you transform your company from a linear to a circular business*?' (*Inchainge*) https://inchainge.com/learning-solutions/product-as-a-service(last visited Apr. 7, 2025)

[54] New Mexico State University, *Green Alternatives to Toxic Household Products and Hazardous Waste*, (last visited Apr. 7, 2025), https://pubs.nmsu.edu/_g/G313/index.html.

[55]Tim Radford, *What is Pay-As-You-Throw? A Waste Expert Explains*, WORLD ECONOMIC FORUM (Jan. 2022), https://www.weforum.org/stories/2022/01/pay-as-you-throw-waste-expert-pollution-trash/.

22.	**Phytoremediation Techniques[56]**	Plant pollution-absorbing species for cleanup	Offers low-cost, green remediation	Restores ecosystems, cuts cleanup costs, and supports biodiversity

The gaps in legal frameworks perpetuate impunity, allowing offenders to exploit weaknesses in criminal law with devastating impacts on vulnerable communities. To address this, a multifaceted approach is needed, including strengthening international regulations, enhancing cross-border cooperation, and imposing severe penalties to deter illegal activities. Equipping law enforcement with specialized training and implementing robust whistleblower protections are crucial. These measures will ensure justice, safeguard public health, and protect the environment. Collaborative efforts between governments, communities, and businesses are essential to developing effective strategies and policies that reduce toxic waste dumping and promote sustainability.

IX. CONCLUSION

Toxic waste dumping is a pervasive and deeply concerning global crisis, involving the illegal or improper disposal of hazardous materials such as chemicals, heavy metals, and industrial by-products. This practice leads to extensive environmental degradation, severe public health issues, and significant economic burdens. Marginalized communities and developing nations disproportionately suffer from these impacts, exacerbating existing global inequalities. The routine export of toxic waste by wealthier countries to those with weaker environmental regulations perpetuates environmental injustice and racism. Notable examples like the Warren County PCB landfill protests in the U.S. and unsafe shipbreaking practices in South Asia reveal how vulnerable populations are systematically exposed to environmental harm.

This persistent issue is largely facilitated by the inadequacies within existing legal frameworks across criminal, environmental, health, and human rights law. Criminal law often fails to deter environmental offenders due to insufficient penalties and the difficulty of prosecuting corporate entities. The 2006 Trafigura incident in Côte d'Ivoire, where a multinational corporation dumped hazardous waste causing illness to over 100,000 people with minimal legal repercussions, exemplifies this failure. Additionally, the rise of organized crime groups such as Italy's Eco-Mafia illustrates how weak enforcement and regulatory gaps

[56] Nidhi Sharma et al., *Phytoremediation of Hazardous Radioactive Wastes*, in *Phytoremediation of Hazardous Wastes* (IntechOpen, 2022), https://www.intechopen.com/chapters/68483.

are exploited for illegal profit, to the detriment of public and environmental health.

Environmental laws, both national and international, struggle to address the complexities of transboundary waste movement. The Basel Convention, which regulates the international trade of hazardous waste, suffers from limited enforcement, allowing for mislabeling and the exploitation of weak governance in developing nations. The unsafe dismantling of ships in places like Alang, India, and Chittagong, Bangladesh, despite international conventions, highlights the failure to ensure environmental safety and regulatory compliance.

Health law is crucial in mitigating the bodily impacts of toxic waste exposure. However, cases such as the Bhopal Gas Tragedy, Love Canal in the U.S., and the e-waste dumping site in Agbogbloshie, Ghana, illustrate the severe health consequences that follow regulatory neglect. Workers, including children, in informal recycling sectors are routinely exposed to toxic substances without proper protection, underscoring the urgent need for enforceable occupational health standards and compensation mechanisms.

Human rights law provides a foundational basis for environmental justice by recognizing the right to a clean and healthy environment. Toxic waste disproportionately affects marginalized communities, infringing upon their rights to life, health, and dignity. Environmental racism persists where politically disempowered populations are systematically subjected to environmental hazards, and legal mechanisms often fall short in providing adequate redress.

To effectively combat toxic waste dumping, a comprehensive, multidisciplinary legal approach is essential. This requires harmonizing international regulations, imposing stringent penalties on corporate and criminal offenders, and enhancing cross-border legal cooperation. Law enforcement agencies must be equipped with specialized training and resources, and whistleblower protections must be strengthened to encourage reporting of illegal activities.

Moreover, innovative solutions such as regulating waste brokers, adopting waste-to-energy technologies, using blockchain for transparent waste tracking, and promoting community-led waste management can help mitigate this issue. Integrating environmental justice principles and enforcing corporate environmental responsibility are equally critical.

Ultimately, addressing toxic waste dumping demands a unified global effort. By closing legal loopholes, ensuring accountability, and protecting vulnerable populations, the international community can move towards achieving environmental and social justice, promoting public health, and securing a sustainable future for generations to come.

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 [ISSN 2581-5369]