

IFMSA Policy Document

Pollution

Proposed by Team of Officials

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Policy Statement

Introduction:

Pollution, in its various forms, has emerged as an alarming global crisis that poses a significant and pervasive threat to human health, ecological stability, and the overall stability of our planet's ecosystems. From the contamination of air, water, and soil to the accumulation of hazardous waste and the deterioration of biodiversity-rich habitats, pollution inflicts severe consequences on collective health and well-being. Together with climate change and biodiversity loss, it constitutes one of the constituent parts of the *Triple Planetary Crisis*, demanding urgent attention and action. As the world combats the challenges of recovering from the devastating COVID-19 pandemic, the elimination of pollution has emerged as a paramount priority, recognized as a crucial component of the post-pandemic recovery and rebuilding process.

IFMSA position:

The International Federation of Medical Students' Associations (IFMSA) recognizes the profound health impacts of the pollution of air, water and soil. Medical students worldwide call for long-term policy interventions aiming at eliminating environmental contamination in order to tackle the associated disease burden put on individuals and healthcare systems. IFMSA affirms that concerted efforts are needed to mitigate the *Triple Planetary Crisis* so that pollution is eliminated alongside the introduction of global, comprehensive and equitable climate action, and the protection of currently endangered biodiversity. The effects of this multifaceted crisis do not affect all social groups equally, therefore there is a strong need to identify key populations and ensure that their exposure to pollution is reduced. Finally, IFMSA encourages the continuous involvement of medical students and healthcare professionals in research, advocacy, and capacity-building initiatives related to pollution.

Call to Action:

Therefore, the IFMSA calls on:

Governments to:

- Implement and enforce strict regulations and policies to significantly decrease population exposure to pollution
- Actively engage in international regulatory initiatives to influence the establishment of more ambitious global standards in pollution control
- Commit to rapid divestment from fossil fuel use in industry and transport, as well as curb CO₂ emission levels, to minimize the human-induced environmental impact on pollution levels, biodiversity loss and climate change
- Ensure the continuous education of various social and age groups in terms of the causes, preventative measures and health hazards tied to pollution exposure in order to achieve policy understanding and compliance

United Nations Environment Programme and other relevant UN Agencies to:

- Strengthen the efforts in providing tailored advice to Member States, taking into account differing economic systems, GDP levels and most troubling environmental problems to ensure equitable mitigation of pollution
- Follow up on the commitment to eliminate all kinds of pollution by 2030, as outlined in 2019 "*Towards a pollution-free planet*" Implementation Plan
- Foster collaborations between the Member States in order to ensure the creation and subsequent implementation of ambitious international treaties, agreements and frameworks, to ensure that all

countries, irrespective of their economic and developmental status, can equitably progress towards a pollution-free economy

Private Sector to:

- Commit to following standards and guidelines set by local, national and international regulatory institutions to curb the impact of the industries on pollution levels, as well as minimize waste generation
- Ensure transparency to consumers regarding the environmental impact of products and services offered by manufacturers, while providing clear guidance on how to further minimize it on the individual level, e.g., recycle generated waste
- Act in the spirit of social responsibility of business and commit to funding research initiatives aiming at finding novel solutions to pollution challenges caused by the economic activity of the given company

Non-Governmental Organizations to:

- Advocate for strong pollution control on the governmental level, while ensuring that the health impacts of pollution exposure are put at the centre of the political agenda as well as societal discussion
- Collaborate with governments, the private sector, and non-governmental organizations to enhance their efforts in including environmental sustainability practices and pollution prevention measures in their operations
- Educate the public with regards to the health and environmental impacts of pollution through educational campaigns, community engagement, and media outreach

Healthcare facilities to:

- Transition to climate-friendly and carbon-free facilities and equipment, including reducing energy consumption, implementing renewable energy sources, and utilizing energy-efficient equipment to minimize their contribution to air pollution
- Promote environmental awareness and sustainability among staff and patients through awareness campaigns, training programs, and providing information on sustainable practices
- Adopt sustainable materials and waste management practices, with informed waste management systems put in place to ensure proper disposal of medical waste.

Universities and Educational institutions to:

- Integrate environmental health in the curriculum, with a focus on pre-medical education, help medical students develop a comprehensive understanding of the impact of pollution on human health and learn effective strategies to address environmental issues in their future medical careers
- Establish a friendly avenue for organizing seminars and workshops specifically dedicated to environmental health, encourage experts, professionals, and researchers in the field to share their knowledge and insights, fostering awareness and promoting discussions on pollution and its health effects
- Facilitate research opportunities for medical students on pollution by offering dedicated research programs, funding opportunities, and collaborations with environmental organizations

IFMSA NMOs and medical students to:

- Commit to following the Recommendations for Sustainable and Climate-friendly Meetings in IFMSA, issued in 2022, in order to minimize the environmental damage caused by the activity around of the General Assemblies, Regional Meetings and other events in terms of the directly and indirectly generated waste
- Increase voices on the campaign for a pollution-free environment through seminars, workshops and outreaches.

Position Paper

Background information:

In 2019, the United Nations Environment Programme received a mandate from its Environment Assembly to coordinate the Implementation Plan “Towards a pollution-free planet”, with the end goal of eradicating all forms of environmental pollution by 2030. [1-2] Pollution, an established threat to human, animal and environmental health, has emerged as a significant object of public policy on the local, national and international levels, pointing to the urgency of developing measures to control population exposure. [3] Growing levels of consumption and a perceived lack of sustainability in the production and disposal of waste from different extractions lead to the continued worsening of the planetary conditions already marred by dangerous levels of pollution. [4] The impact of pollution on health transcends its physical characteristics, as mental well-being tied to pollutant exposure is also significantly threatened. [5] The reduction and subsequent elimination of human-caused pollution are closely aligned with several Sustainable Development Goals (SDGs) of the UN-formulated *Agenda 2030*, including SDG 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 14 (Life below Water) and 15 (Life on Land). [6]

Pollution is a public health threat of global proportions, with severe implications for the safety and well-being of humans and animals. According to the data made available by the World Health Organization, 7 million additional premature deaths are attributed to the effects of air pollution, while over 99% of the global population is exposed to air of subpar quality daily. [7] Over half of these deaths are expressly ascribed to the impact of indoor air pollution. [4] At the same time, the United Nations Environment Programme points out that 80% of wastewater globally does not undergo proper management, which endangers the health of those exposed to freshwater contaminated by pollutants of organic and industrial origins. [8] Importantly, the vulnerability to different kinds of pollution depends upon one’s geographical location, socio-economic status (which determines the ability to avoid exposure), profession, age and gender, among other variables. [9]

In 2020, the United Nations included pollution as one of the components of the *Triple Planetary Crisis*, which also encompasses climate change and biodiversity loss. [10] All three constituent parts of this concept are closely interlinked in their causality and contribute to adverse effects on environmental health. [11] Addressing these crises in a collaborative manner is seen as key to reducing negative health outcomes of individuals exposed to various types of pollution. In order to manage this crisis, a number of concerted solutions are seen as worthy of being introduced on a global scale, including strict legal regulations on industries as well as individual households, technological advancements and the discontinuation of fossil fuel combustion in power generation, transport and other major branches of the economy. [12]

Due to the mobility of many pollutants, the fight for a cleaner world transcends political or geographical borders. International cooperation in research, practical policy implementation and sharing best practices and innovative solutions is crucial in ensuring that common strategies are developed to address pollution on a global scale effectively. As today’s most populous demographic group, the youth is seen as holding the essential keys to mobilizing social and political action on pollution. [4]

Discussion:

1. Definition of Pollution

Pollution can be defined as the introduction or sustained presence of organic or non-organic chemical substances or other physical factors in the components of the natural environment, including air, water and soil, that due to a heightened concentration can give rise to negative effects on the health of living organisms and cause degradation of natural ecosystems, including habitat destruction, disruption of food chains and reduced biodiversity, with all this through its primary and secondary effects. [13] Pollution can take the form of a liquid, gas or solid matter. Pollution can be caused by intentional human activity (for instance, burning of fossil fuels, mining operations, etc.) or natural events (e.g., volcanic eruptions). In other cases, they constitute unintended fallout from human-caused incidents, for instance, leakages, spills or faulty waste disposal. [14] When considering the exposure location, pollutants can be grouped into outdoor pollutants (air pollution due to power generation and transport-induced exhaust) and indoor pollutants (incl. gases and particles produced while using gas stoves, or particles emerging from smoking tobacco). [15] As it contributes to millions of premature deaths each year and is regarded as being a debilitating factor in the onset and progression of a number of chronic diseases, pollution is considered a public health crisis that imposes severe implications on the health systems and the overall state of economies worldwide. [16]

2. Types of Pollution

Pollution can be classified by the sector of the environment affected – water, air, and soil.

1. Water pollution

Toxic chemicals, sewage, pesticides and fertilizers from agricultural runoff, as well as metals like lead or mercury, are just a few examples of the chemicals or potentially harmful foreign substances that can contaminate water. [17] Surface water like rivers and lakes, soil moisture, groundwater in aquifers, and the oceans can all be impacted by water pollution. Nearly sixty per cent of the species are aquatic, and when the water is contaminated, it has a severely detrimental effect on their life quality and overall health. [18] 80% of the pollution in the marine environment, according to the National Oceanic and Atmospheric Administration (NOAA), originates from the land through runoff. [19] Water pollution, however, has an impact on human health as well as marine life. The United Nations estimates that over 2.5 billion people lack access to appropriate sanitation, and 783 million people lack access to clean water. [20]

2. Air pollution

The presence of unusually high levels of chemical components that can harm living things in the environment is known as air pollution. [7] Particulate materials (like black soot) and a variety of gaseous compounds, including carbon monoxide, carbon dioxide, nitrogen oxides, sulfur oxides, ozone, nitrates, sulfates, organic hydrocarbons, and many others, may be present in contaminated air. [21] Many of these are also present as trace gasses in clean air, but if they are present in excessive amounts, they become pollutants. The common sources are volcanic eruptions, burning fossil fuels, releasing chlorofluorocarbons (CFCs), and emissions from industry and automobiles. This has caused the worst incidences of smog and acid rain worldwide over time. [22] According to a research paper published in the Environmental Research Letters journal, more than 2 million people die from air pollution each year. [23]

3. Soil pollution

Also known as land pollution, soil pollution can directly result from water contamination. On the land's surface, liquid waste containing harmful substances or pathogenic microorganisms may

slowly seep into the soil and then migrate down to contaminate groundwater, which impacts nearby spring users and well drillers. [24] Open defecation, pit latrines, leaky waste and chemical storage containers are a few potential causes. Industrial trash and residential litter can both harm the land. Forty per cent of the world's population, or at least 3.2 billion people, are impacted by soil and land degradation. [25]

3. Global Statistics on Pollution

Pollution is a primary environmental factor causing illness and premature mortality. Each year, more than 9 million premature deaths are attributed to the impact of pollution, most of which specifically to air pollution. [26] This figure translates to far more annual fatalities than are recorded as having been caused by AIDS, TB, and malaria combined. A timely reminder of the vital connections between the environment and health as well as the requirement for methodically addressing these connections is provided by global health emergencies like the COVID-19 pandemic. [27] Air pollution poses the greatest threat to environmental health and is responsible for 7 million avoidable deaths annually. In 2019, the cost of air pollution to the earth was projected to reach \$8.1 trillion, or 6.1 per cent of global GDP, according to a recent World Bank estimate. Low- and middle-income countries (LMICs) see more than 95% of all pollution-induced deaths. [27]

The World Health Organisation (WHO) estimates that 2 billion people globally consume polluted water. Water tainted with harmful bacteria can facilitate the spread of water-borne diseases like diarrhea and cholera if consumed. [28] Each year, polluted drinking water contributes to 485,000 deaths from causes associated with diarrhea. Water sources that are polluted are used by 368 million people. In addition, eighty percent of the trash in the river comes from the land area. Ocean trash causes the death of about 1 million seabirds and other marine creatures every year. [29]

At least 3.2 billion people, or forty per cent of the world's population, are being harmed by the degradation of land and soils. [30] Thus, premature mortality and morbidity caused by pollution have a considerable financial impact on each country, with costs ranging from 5 to 14 percent of GDP. [27]

4. Interlinkage with the *Triple Planetary Crisis*

4.1 *What is the Triple Planetary Crisis?*

Climate change, pollution, and biodiversity loss are the three key interconnected issues that humanity is currently confronting. The triple planetary crisis is a common name for these three issues, coined to stress the interconnection between the causes of these crises and the solutions available to solve them. Each of these issues - each with its unique causes and effects - must be resolved if humanity is to have a viable future on the planet Earth [12]

Climate change is considered to be by far the single most pressing issue confronting humanity right now. Simply said, the term *climate change* refers to long-term variations in temperature and weather that will ultimately profoundly alter the ecosystems that support life on Earth. Human activities are the primary source of climate change. [31] Although almost all human activities produce emissions, energy consumption, industry, transportation, buildings, and agriculture are the largest sources of atmospheric greenhouse gas emissions. Today, more frequent and severe droughts, water shortages, wildfires, rising sea levels, flooding, melting of the polar ice, catastrophic storms, and a reduction in biodiversity are all signs of climate change's consequences. [12]

The greatest global cause of disease and early death, air pollution, claims more than seven million premature deaths each year. [7] Crucially, 99% of the global population breathes air that is more polluted

than WHO standards. Pollution is a result of several factors, including industry, transportation, wildfires and volcanism. [32] Another source of pollution is interior household air pollution, which is brought on by cooking using harmful materials and methods. According to projections, 3.8 million individuals will have passed away from this cause in 2016 alone. [12]

Biodiversity loss is a term used to indicate the decline or extinction of biological diversity, which includes ecosystems, plants, animals, and other forms of life. There are a number of factors contributing to biodiversity loss, including overfishing, habitat loss (from things like deforestation for development), and desertification from climate change. The cornerstone of everything on Earth is biodiversity since we are all ultimately interrelated. Our capacity to feed ourselves and get clean water is impacted by biodiversity loss; without it, the world cannot live. [12]

4.2 Interlinkage with Climate Change

Both air pollution and greenhouse gasses are commonly produced by the same sources, such as diesel-powered vehicles and coal-fired power plants. Some air pollutants, including black carbon, which is a portion of fine particulate matter (PM_{2.5}), do not linger in the environment for very long. [33] Another group of Short-Lived Climate Pollutants (SLCPs) includes methane, hydrofluorocarbons, and tropospheric or ground-level ozone. When compared to carbon dioxide, SLCPs have a far larger capacity to warm the atmosphere. [34] Methane is a precursor to ground-level ozone, which kills over 1 million people yearly and has an 80 times larger potential for global warming than carbon dioxide over a 20-year period, according to the Climate and Clean Air Coalition and Stockholm Environment Institute. [35] Interventions to reduce SLCP emissions can have a rapid positive impact on the climate because of their significant warming potential and short lifespans. When we address short-lived climate pollutants, we receive two advantages: local improvements in air quality and health as well as the worldwide advantage of reducing climate change. [36]

Global warming is causing changes in water quality, amount, distribution, and timing. Flooding and runoff can cause water contamination and pollution. Drought may have an influence on human health, food, and water supplies. [37] Pollution of water bodies can have an impact on the ecosystem and hinder the growth of plants and algae. Climate change and carbon absorption are both impacted by water pollution. The second-largest carbon storage after the ocean is found in soil, which helps to mitigate the effects of climate change. [38] Because soil manages the water cycle, stores carbon, and provides water and nutrients for plant growth, it is vital to biological and human systems. Soil pollution, which modifies the soil's capacity to absorb carbon and changes the temperature and precipitation patterns, among other factors, contributes to climate change. Environmental deterioration and climate change interact with one another in many different ways on Earth. [39]

4.3 Interlinkage with Biodiversity Loss

Biodiversity loss, one of the issues included in the Triple Planetary Crisis, is caused by a multitude of factors, including the expansion of agriculture, pollution, desertification, the presence of invasive species, and the impact of climate change. [40] In recent decades, biodiversity has been negatively impacted by a rapid decline in the number of species and by numerous species facing the risk of extinction. Since 1990, most major land-based habitats have fallen by at least twenty per cent, natural ecosystems have declined by an average of forty-seven per cent, and, according to the International Union for Conservation of Nature Red List of Threatened Species, more than 41,000 animals worldwide are threatened with extinction. [41]

Pollution stands out as a primary catalyst for the decline in biodiversity, affecting ecosystems, human health, and the overall well-being of our planet. Different forms of pollution, such as air, water, soil and

noise, are continuously increasing worldwide. Industrialization, urbanization, and unsustainable agricultural practices impact directly and indirectly on biodiversity with chemical pollutants, plastic and untreated urban and rural waste, greenhouse gasses, and noise. [42] Since 1980, marine plastic pollution has increased tenfold, affecting at least 267 species. [43]

Air pollution englobes pollutants such as sulfur dioxide, nitrogen oxides and particulate matter, and volatile organic compounds that harm not only human health but also plants and animals' health. These compounds come mostly from transport and agriculture and cause not only direct impacts on biodiversity, such as leading to leaf damage, hindering photosynthesis, reduction in plant productivity and shrinking habitats, but also indirect impacts, by contributing to climate change and exacerbating its consequences. [44]

Water pollution is critically linked to biodiversity loss, especially in freshwater biodiversity, where biodiversity is declining faster than biodiversity in terrestrial and marine environments. The pollutants discharged in the water poison aquatic organisms, deteriorate habitats and disrupt food chains. Also, it is significantly correlated to eutrophication in water bodies, by excessive nutrient runoff, which leads to oxygen depletion and loss of vital habitats and living populations. [45]

Untreated waste and plastic pollution are considered physical, chemical, and biological stressors to ecosystems and biodiversity. This form of pollution contributes to ecosystem degradation, animal injury, starvation and death, by entanglement, suffocation and contamination. [46-47]

5. Determinants and Causes of Pollution

Pollution is caused by various factors and can have multiple determinants. Here are the key determinants and causes of pollution:

1. **Industrial Activities:** Industrial emissions from sectors such as manufacturing, factories, power plants, industrial processes and energy production contribute significantly to air pollution. These include emissions that release pollutants such as particulate matter, greenhouse gasses, and toxic chemicals into the air, water, and soil. [48]
2. **Eutrophication:** Excessive use of fertilizers in agriculture can result in runoff of nutrients into nearby water bodies. This prevents sunlight from penetrating the water body, lowering oxygen levels and further making the area uninhabitable. In 2019, the Gulf of Mexico experienced a significant "dead zone" caused by nutrient runoff from agricultural lands along the Mississippi River. [49] The excess nutrients fueled algal blooms, leading to oxygen depletion and negatively impacting marine life. [50]
3. **Oil spillage:** The spilt oil can coat the surface of water bodies, suffocate marine plants and animals, and contaminate habitats such as coral reefs, mangroves, and wetlands. It can affect water quality, reduce oxygen levels, and harm aquatic organisms. Oil spills can also contaminate drinking water sources, affecting human health and local communities. According to a study, an average of 240,000 barrels of crude oil are spilled in the Niger Delta every year, mainly due to unknown causes (31.85%), third-party activity (20.74%), and mechanical failure (17.04%). [51]
4. **Transportation:** Vehicle emissions remain a major source of air pollution globally. The burning of fossil fuels in vehicles, including cars, trucks, and planes, leads to air pollution through the emission of carbon monoxide, nitrogen oxides, and volatile organic compounds. [52] In 2021, the city of Delhi, India, faced hazardous levels of air pollution largely attributed to vehicular emissions, resulting in health issues and the implementation of emergency measures. [53]

5. **Agricultural Practices:** Intensive agriculture involves the use of chemical fertilizers, pesticides, and herbicides, which can contaminate water sources and lead to soil degradation, while livestock farming generates methane emissions. [54-55] In 2020, excessive use of fertilizers caused a massive algal bloom in Florida's Lake Okeechobee, leading to water contamination and harmful effects on aquatic life. [56]
6. **Waste Disposal:** Improper management of solid waste, including landfill sites, incineration, and improper disposal of hazardous waste, can release toxins into the environment, polluting air, soil, and water. [57] For instance, the improper disposal of plastic waste in rivers and oceans contributes to marine pollution. The Great Pacific Garbage Patch, a massive accumulation of plastic debris, is an ongoing example of this issue. [58]
7. **Deforestation and Land Use Changes:** The clearing of forests for agriculture, mining, urbanization, or logging disrupts ecosystems, reduces carbon absorption, and leads to soil erosion, contributing to air and water pollution. [59] Deforestation in the Amazon rainforest has been a persistent concern. [60]
8. **Natural Events:** Natural phenomena like volcanic eruptions, dust storms, and wildfires can release large amounts of particulate matter, smoke, and greenhouse gasses into the atmosphere which have led to a significant rise in air pollution. In 2020, Australia experienced devastating bushfires, emitting vast amounts of smoke and pollutants, impacting air quality across the continent. [61]
9. **Household Activities:** Burning solid fuels, such as wood or coal, for cooking and heating in developing countries leads to indoor air pollution. They can release indoor air pollutants like carbon monoxide, volatile organic compounds, and particulate matter which can have detrimental effects. [62] This issue affects the health of millions of people, particularly women and children. [63]
10. **Climate Change:** Environmental changes, including rising temperatures and altered precipitation patterns, can exacerbate pollution levels and lead to the formation of smog, increased wildfires, and changes in water quality. [64] In the past few years, rising temperatures and altered weather patterns have contributed to more frequent and intense heat waves, exacerbating air pollution, as seen in the 2021 heatwave in the western United States, where high temperatures worsened smog formation. [65]
11. **Population Growth and Urbanization:** Rapid urbanization and population growth put pressure on resources and infrastructure, leading to increased waste generation, energy consumption, and pollution. As cities expand, the demand for energy, transportation, and waste management rises, resulting in higher pollution levels. [66] Examples include the pollution challenges faced by megacities like Beijing and Mumbai. [67]
12. **Lack of Environmental Regulations and Enforcement:** Insufficient or ineffective regulations, weak enforcement, and inadequate monitoring contribute to pollution problems by allowing polluting activities to continue unchecked. [68]

6. Impact of Pollution

6.1 Impact on Human Health, including Physical, Mental and Social Well-being

6.1.1 Physical Well-being

Particulate Matter (PM) in polluted air can penetrate the respiratory system, leading to respiratory problems, asthma, bronchitis, and an increased risk of lung cancer. [69] In addition to this, high ozone levels cause breathing difficulties, lung inflammation, worsen asthma symptoms, and increase the risk of cardiovascular diseases. [70] According to the WHO, outdoor air pollution is estimated to cause 4.2 million

premature deaths worldwide each year. [71] Likewise, contaminants in water bodies can cause waterborne diseases like diarrhea, cholera, hepatitis A, and typhoid. [72] Chemical pollutants, such as heavy metals, pesticides, and industrial waste, can accumulate in the food chain, leading to long-term health risks. [73] The WHO reports that polluted water and poor sanitation are responsible for 0.7 million deaths annually due to diarrheal diseases. [74] Soil contaminated with hazardous substances can affect agricultural crops, leading to food contamination and potential health risks from consuming contaminated produce. [24]

6.1.2 Mental Well-being

Studies show that pollution can lead to stress, sleep disturbances, anxiety, depression, and impaired cognitive function. Exposure to certain chemicals found in polluted environments, such as lead, mercury, and certain pesticides, has been linked to neurodevelopmental disorders, cognitive impairments, and mental health disorders. The Global Burden of Disease study estimated that environmental factors, including chemical exposures, contributed to 16% of all neuropsychiatric disorders globally. [75]

6.1.3 Social Well-being

Pollution can lead to the displacement of communities due to contaminated land, water, or air, resulting in social disruption, loss of livelihoods, and increased poverty. [76] Displacement and loss of homes due to pollution are widespread globally, impacting millions of people, particularly in developing countries. Vulnerable populations, such as children, the elderly, low-income communities, and marginalized groups, often bear a disproportionate burden of pollution-related health impacts, exacerbating existing health disparities. [77]

6.2 Impact on Animal Health

Animals, as living beings on Earth, are also affected by various types of pollution. Pollution can have a direct effect by contributing to the development of health conditions or an indirect effect by altering their ecosystem and living patterns. [78] Aquatic animals are highly affected by water pollution, both by land-based and water-based sources. Plastic waste and toxic plastic pollutants derived from the degradation of macroplastics are important actors in the demeaning of animal health. [79] Larger pieces of plastics (including damaged, discarded or lost fishing nets) can cause direct death of aquatic animals and marine birds through entanglement or suffocation. Sub-lethal lesions can impair their food capturing, reproductive ability, mobility and their capacity to escape from predators. [80] Microplastics are ingested by different kinds of marine organisms, causing organ toxicity as they are deposited on the gastrointestinal tissue. Some of their hazardous components have bio-accumulating potential and can alter endocrine functions. This is more frequent in marine environments, as the salinity facilitates plastic degradation. As seabirds feed on fish, they are notably exposed to microplastics. In fact, it is estimated that up to 78% of identified species of seabirds have deposited MPs in their digestive tracts since the 1960s. [81]

More endocrine disruptors have been found in pesticides, being responsible for mutations and fertility problems, and affecting both terrestrial and aquatic species [82]. Nonetheless, although chemical pollutants can elicit a range of sublethal effects on individual organisms, research on how they affect animal groups is severely lacking. [82] Other important pollutants that negatively impact animal health are heavy metals. These include, for example, lead, to which avian species are especially sensitive. Lead can be ingested by birds through ammunition, fishing tackle and consumption of contaminated food sources. Lead interacts with the immune system, causing immunosuppression, and hinders growth and reproductive ability. [83] Birds are again notable victims of pollution when it comes to light pollution. As human communities and lighting technologies develop, artificial light increasingly modifies natural light regimes [84]. The UN states that more than eighty percent of the world's population lives under a "lit sky", and in Europe and North America, the figure is closer to ninety-nine per cent. Migratory birds are

particularly exposed to artificial light, which alters their timing of migration and seasonal patterns. These unnatural light-induced behaviors are responsible for the death of millions of birds every year. [85]

6.3 Impact on Environmental Health

The marine environment is the vast body of water that covers seventy-one percent of the Earth's coverage. It holds thousands of different species, and its health is crucial for the planet's health. Dismally, marine ecosystems are subject to diverse types of pollution that jeopardize their harmony and existence. The same toxic substances are found in freshwater bodies.

- Cigarette butts: yearly, 4.5 trillion cigarettes are littered in the environment. They are considered the most common of individual litter in the world. They are often found in coastal environments, damaging them and flowing into the sea. [86]
- Heavy metals: mercury is considered “one of the top ten chemicals of major public health concern” by the WHO. Mercury has been found in jeopardizing quantities along the Amazon River, endangering wildlife across the river system and posing a threat to human health (especially indigenous communities). As it bioaccumulates across the food chain, freshwater predators and their marine counterparts are at higher risk of their lethal and sublethal consequences. [87]
- Plastic debris: plastic debris accumulation modifies the habitats in the marine environment. Submerged ecosystems such as seagrass and coral reefs in the marine environment degrade macro and mega plastic debris on the seafloor. As a result, degraded benthic ecosystems reduce the species richness and composition. A study in Oman threw light on this issue, concluding that sixty-nine per cent of Oman's coral sites were negatively affected by plastic pollution and more than 20 genera of corals was adversely affected by decreasing coral biodiversity. [81]
- Floating plastic debris: these pieces of plastic act as floating objects and provide a stable substrate for the rafting and transportation of mobile and sessile organisms. This effect acts as a mode of introducing invasive species into a new ecosystem. The buoys are capable of traveling long distances and non-endemic species have been found on plastic samples collected along the Pacific Ocean. [81]
- Fertilizers and pesticides: they bring elevated concentrations of nutrients (especially nitrogen) to stimulate the blooming of aquatic algae, reducing oxygen levels and impeding fish from breathing. [88]

Land environments are equally disrupted by pollutants.

- Air pollution: industrial gas emissions generate nitric and sulfuric acids in the atmosphere which, when precipitated, are the main toxic substances found in acid rain. Acid rain acidifies the water and soil environments and damages trees and plantations. Another air pollutant that alters plants' life cycles is ozone. Although it is a natural component of the atmosphere, higher proportions translate into an impairment in photosynthetic rhythm and metabolism. [88]
- Microplastics: seabirds spread particulate plastics through regurgitation and thus function as vectors for marine-derived microplastics and other contaminants in aquatic and terrestrial environments. [89]
- Heavy metals: heavy metals found in soil and underground bodies of water are absorbed by plants through their roots and interfere with ionic homeostasis and the activity of enzymes. This effect results in diminished nutrition, multiplication and, lastly, putrefaction. [90]

The global crisis that developed after the start of the war in Ukraine goes beyond the death casualties and shortage of resources, as the environment continues to be a silent victim of armed conflicts worldwide. Some of the factors contributing to environmental damage include the release of pollutants after the bombing of chemical sites, fuel leaks due to the destruction of petrol-storing infrastructure,

overwhelming waste management systems including nuclear waste, military vehicles' emissions and dumping, among many others. [91]

7. Relevance to Public Health

According to the UNEP, "All people have the right to a clean, healthy and sustainable environment. As human rights and the environment are interdependent, a clean, healthy and sustainable environment is necessary for the full enjoyment of a wide range of human rights" [92]

As seen in previous paragraphs of this document, pollution has a multiaxial negative impact on human health. All different kinds of pollution are responsible for millions of premature deaths, reduced DALYs and contribute to the development of chronic and acute illnesses. [27] Pollution has typically been viewed as a local issue to be addressed through subnational governments. Now, however, it is increasingly clear that contamination transcends local boundaries and represents a planetary threat, thus demanding a global response. [26]

The 2017 Lancet Commission on Pollution estimated health economic losses secondary to premature deaths to have summed up to US\$ 4.6 trillion in 2015. The greatest burden of these losses occurs in LMIC. [26] Local economies are also affected by pollution. For example, Tourism-oriented islands and coastal areas such as Hawaii and Maldives are economically threatened by declining annual income through tourism due to the pollution of their landscapes. [81] The cleaning of these ecosystems burdens communities with the need to allocate an extra budget for waste removal. Countries that depend on fishery resources, both economically and nutritionally, are struggling because of marine plastic pollution. In states like Bangladesh, Cambodia or Indonesia, fifty per cent of total animal protein intake comes from seafood sources. [81]

Food safety is the basic requirement for human health and public safety. According to the Food and Agriculture Organization (FAO), one-third of the plastic produced globally ends up in the soil with plastic particles then entering the food chain. [93-94] The United Nations Economic Commission for Europe (UNECE) estimated that nearly sixty per cent of the top agricultural soil in 11 European countries has been found to contain residues of multiple persistent pesticides. Other dangerous pollutants like cadmium, lead and arsenic have been found in different crops and exceeding their safety limits. [95]

Vulnerability to infectious diseases is another public health concern regarding pollution. Hospital and intensive farming sewage contains antibiotics and antimicrobial-resistant bacteria, fungi and genes, that contribute to the growing threat of antimicrobial resistance. [96] Further to this, some pollutants have been found to be toxic to the immune system. They have been associated with reduced antibody responses to vaccines, increased risk in children for hospitalization with infectious disease, and, recently, increased severity of COVID-19 infections. [26] Another form of pollution that has to be taken into account in public health policies and urban planning is noise pollution. Environmental noise is ranked second in terms of DALYs in Europe. [97]

8. Groups of particular vulnerability to pollution

To fully comprehend and effectively address the environmental hazard of pollution, it is imperative to understand that individuals are not equally vulnerable to pollution, facing an increased risk or severity of health outcomes. Communities can be either more susceptible, more exposed, or otherwise more vulnerable to environmental pollutants, depending on their different characteristics and factors, such as residential segregation, proximity to industrial facilities, and limited access to resources and decision-making processes. [98]

The WHO identifies certain population groups as vulnerable due to a combination of inherent factors, environmental and social factors they have experienced, and unusually high levels of exposure to pollutants. [99] Inherent factors to individuals, in terms of physiology, mostly age and underlying diseases, are often correlated to their susceptibility to pollution. Environmental and social factors take into account factors primarily related to exposure, such as residential location, socio-economic status, education, occupation and access to health services. [98] Exposure to pollution is a personal-related factor to each individual and is influenced by the time spent in different environments, daily movements or activities, lifestyle or behaviors. [98]

Sub-populations considered vulnerable to pollution include young children, the elderly, people with certain underlying diseases and marginalized populations, including low-income communities, socio-economically deprived, ethnic minorities, and indigenous peoples. Even though children are acknowledged as being at increased risk, it is important to note that their vulnerability to pollution may vary depending on their specific stage of childhood. On the other hand, pregnant women, despite mounting evidence pointing to reproductive risks, such as adverse birth outcomes and developmental issues for their children, associated with pollution exposure, are not explicitly identified as a vulnerable group. [98-99]

Therefore, efforts to decrease pollution levels can have a particularly significant positive impact on population groups that are most susceptible to its harmful effects and policies need to specifically aim at these vulnerable individuals. [98] Also, targeting social and economic factors may have indirect benefits in reducing vulnerability to pollution exposure and be more cost-effective than implementing measures to reduce pollution levels. [100]

9. Global efforts on pollution reduction

The action on the critical intersection of pollution and health has been one of the focal objectives of global efforts to combat pollution. In light of a number of critically adverse events that changed the popular perspective on pollution, including the Great Smog in London (1952), major oil spills in the Niger Delta (since the 1960s) and other environmental disasters, many of them located in LMICs, the international drive to recognize and address pollution officially took steam. [101] In 1972, the *Declaration of the United Nations Conference on the Human Environment* (also known as the *Stockholm Declaration*) was signed, with the impact of pollution on the health of living organisms being meaningfully declared for the first time ever, while those suffering from the adverse effects of it were named as deserving of compensation. [102] Immediately after the conference held in Sweden, the United Nations Environment Programme (UNEP) was established in Nairobi, Kenya, with the mission of gathering data on the state of the global natural environment to support signatory member states and international institutions in their policymaking. [102] In the following years, a number of international agreements were signed to protect specific components of the ecosystem or narrow geographical locations of particular importance, for instance, pollution emerging from ships (MARPOL convention of 1982) and the protection of the Mediterranean Sea (Barcelona Convention of 1976). [103]

The Sustainable Development Goals formulated by the UN in its Agenda 2030 devote a lot of attention to the impact of pollution on environmental health. Several SDGs directly relate to pollution reduction, such as SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 14 (Life below Water), and SDG 15 (Life on Land). [6] A specific indicator of the SDG 3 (3.9) calls for a significant reduction in the number of annual deaths and disease incidences that can be attributed to pollution. [104]

10. Role of Youth and medical students in Pollution Reduction

A survey conducted ahead of the United Nations Framework Convention on Climate Change COP27 among the youth found that air pollution and general air quality were the top issues that concerned this particular demographic group. [105] Children and teenagers, particularly those from LMICs and regions severely affected by pollution impact, have taken action in raising awareness of the experiences of themselves and their older counterparts, even raising the issue on the international stage. [106] In some cases, anti-pollution activism is treated as a natural extension of climate action, in which the youth has for long played a crucial, avant-garde role. [107-108] The enthusiasm and drive of young people are being catalyzed by national and international institutions, as well as non-governmental organizations, that are increasingly recognizing and promoting youth engagement in environmental matters, including in combating pollution worldwide. [109-110]

Since pollution has a significant impact on human health and may lead to reduced Disability-Adjusted Life Years (DALYs) and overall lifespan, medical professionals, as well as medical students and junior doctors in training, often feel the obligation to follow the directives and recommendations of international regulatory bodies, first and foremost the WHO, while advocating for health-centered policy decisions and educating their patient cohorts. [111] As members of the youth, medical students have the capability of mobilizing their peer community to take an active stance and organize grassroots activities on pollution reduction. For instance, medical students in Brazil hosted an online event that aimed to educate their peers on the struggles of Indigenous populations living in their country, and one of the focal points was the particular vulnerability of this social group to pollution. High digital literacy among the global youth can be advantageous when planning and executing educational and advocacy actions to reach wide and diverse audiences, including people from disadvantaged regions. [112] Such activities have the potential to sensitize future medical professionals on the particular risks that they might need to screen patients for when establishing disease susceptibility and/or etiology. [113] Recently conducted studies point to the benefits of implementing courses in Environmental Health in medical curricula, and it might prove to be beneficial for medical students themselves to advocate for the introduction of such modules. [114-115]

11. Pollution in Medical Curriculum

The detrimental impact of pollution on the health of individuals residing in any given environment is deeply concerning. Consequently, there exists an urgent imperative to incorporate pollution-related education into medical school curricula, equipping future physicians with the essential skills and knowledge required to address patients' ailments stemming from pollution and actively contribute to the pursuit of pollution elimination. [116]

The profound alterations in global climate presently experienced by our world have disrupted the natural order, placing human health at significant risk due to the declining state of ecosystems. Consequently, it is imperative for medical professionals to discern the intricate connections between health, environmental factors, and ecosystems, enabling them to provide sustainable solutions for their patients. This vital objective can only be accomplished by integrating pollution studies into medical school curricula. [117]

It is both surprising and heartening to witness medical students raising their voices amidst the uncertainties surrounding the future resulting from worsening global climate change. They now advocate for curricula that support the inclusion of climate-related courses addressing pollution. In 2018, prominent medical institutions like the American Medical Association, alongside the World Health Organization (WHO), issued multiple calls for physicians and trainees to heighten their awareness of the risks associated with pollution and climate change. [118]

Medical schools should not delay their response to the threats posed by pollution and climate change. It is of utmost importance to ensure that future physicians are adequately equipped to deliver exceptional care and make a substantial positive impact on their communities and the world. Including pollution in the medical school curriculum stands out as an effective and rewarding approach to reducing pollution and ultimately eradicating it, while concurrently guaranteeing that affected individuals receive the highest quality care and health advice possible. This solution serves as a win-win for all stakeholders involved. [117]

12. Pollution Reduction for Post-Pandemic Recovery

Within the context of environmental health, the unforeseen circumstances brought about by the COVID-19 pandemic presented an intriguing paradox: a temporary reduction in environmental pollutants during the lockdown period followed by a resurgence of pollution once production activities resumed. [119] The pandemic-induced restrictions led to a notable decrease in the concentration of particulate pollutants and NO₂, although temporarily. [120]

To develop more effective policies and management approaches in combating pollution, a comprehensive understanding of the pre-and post-pandemic environmental impacts is essential. [X] Additionally, the pandemic period has caused profound implications on global health, particularly through the accumulation of substantial quantities of plastic pollution, predominantly stemming from the utilization of personal protective equipment (PPE). Consequently, the presence of microplastics and nanoplastics has significantly disrupted the global ecosystem, rendering nature susceptible to various forms of harm. [121]

Given the critical threat posed by plastic pollution, stemming from the widespread use of face masks, gloves, and other protective gear, it is imperative to explore eco-friendly alternatives that could provide a safer response in the event of future pandemics. While acknowledging the limitations of bioplastics, they present a viable option worthy of consideration. [X]

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