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AIR POLLUTION AS ENVIRONMENTAL HEALTH HAZARD: ELLA KISSI DEBRAH DEATH CASE- FIRST LEGAL ADJUDICATION AGAINST INVISIBLE KILLER

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Abstract[5]: *With the development of stringent environmental legislations and an increase in public awareness regarding the environmental impacts of various developmental activities; environmental forensics has been increasingly utilized for the investigation of an abundant variety of pollution that have been by chance or intentionally liberated into the environment, and to understand their emergence and help the courts in attributing responsibility. Pollution of air has wide-reaching impacts on the environment. Apart from this, in scientific literature air pollution-related numerous adverse effects on human health and well-being, and mortality due to air pollution is becoming well established. Though air pollution as an invisible killer is well recognized in various scientific studies, the issue is not referred to in any legal proceedings. But recently in the death case of Ella Kissi Debrah a nine-year-old who died on 15th February 2013 in London, UK, the judgment given South London Inner Coroner's Court attracted attention all over the world. The remarkable judgment for Ella's death case came on 16th December 2020 mentioning air pollution as the cause of an individual's death first time in any legal proceeding. In this article, the interesting fact file of the case is discussed from the perspective of air pollution-related environmental forensics with emphasis on the need for the development of air pollution-related environmental forensics and associated challenges. Other than that, this article provides an overview of the implications of the case with respect to the UK, children as most vulnerable to air pollution, development of air pollution-related environmental forensics, and how to alleviate the issue globally. The article also discusses the case with an Indian perspective and various mitigative measures.*

Keywords: *Environmental Forensic; Air Pollution; Ella Kassi Death case; Mortality; Disease burden; Economic Impacts*

INTRODUCTION

The environmental impacts of rapid industrialization and urbanization with the parallel rampant increase in population resulted in air, water, and resource contamination imposing serious risks to human health and the environment in general. Developed during the 1980s, environmental forensics is an emergent science that overlaps and focuses on applications of scientific knowledge/techniques of environmental and allied sciences for legal issues. The major scope of environmental forensics includes scrutinization of the source and release of the contaminants/pollutants in the surrounding environment, fate, and transportation; identification of the source and age of contaminants and potentially responsible parties; environmental legislations and legislative requirements; and deriving conclusions in cases related to environmental pollutions and impacts due to anthropogenic activities [1]. As per Oxford Bibliographies, environmental forensics can be defined as "The systematic and scientific evaluation of physical, chemical, and historical information for the purpose of developing defensible scientific and legal conclusions regarding the source or age of

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[5] The authors express gratitude to Dr. Deepak Rawtani (National Forensic Sciences University, Gujarat, India) for his constructive suggestions.
[1] (Toranzos and Cano 2018; Haddad 2004)

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a contaminant release into the environment" [2]. Environmental forensics also includes pollution dispersion modeling and health risk assessment studies. Usually, environmental forensics studies focus more on soil and water contamination rather than air pollution. However, air pollution is equally needs to be scrutinized and should tackled systematically.

Of all environmental pollution, pollution of air is becoming a major reason for health risks resulting in morbidity and mortality. An adult individual on average takes 12-15 breaths in a minute, inhaling 0.4 to 0.5 liter of air in each breath [3]. Thus, in a day, an adult individual takes 10.8 kiloliter/cubic meter of air inside the body which equals 13.5 Kg (considering the density of air 1.25 Kg/cubic meter) which is a substantial quantity in comparison to daily food and water intake and that's why pollution of air is the most priority environmental health hazard. To minimize the impacts of air pollution on human health and other environmental components, most countries in the world have framed policies to improve ambient air quality, implemented ambient air quality standards/ air quality index, and run ambient air quality monitoring programs. Despite all the efforts taken by governments the world over, the number of deaths due to air pollution presents a horrific picture.

As per the WHO reports, globally seven million people die every year due to air pollution including 4.2 million estimated deaths mainly due to smog in urban ambient air and rest due to indoor air pollutants mainly smoke [4]. Outdoor air pollution is increasing day by day due to industrialization and urbanization and that's why deaths due to ambient air pollution are higher compared to indoor air pollution. Indoor air pollution reduced in the last decades due to economic growth and various governmental initiatives to replace conventional fuel used for cooking and domestic heating with clean fuel as presented in Figure 1.

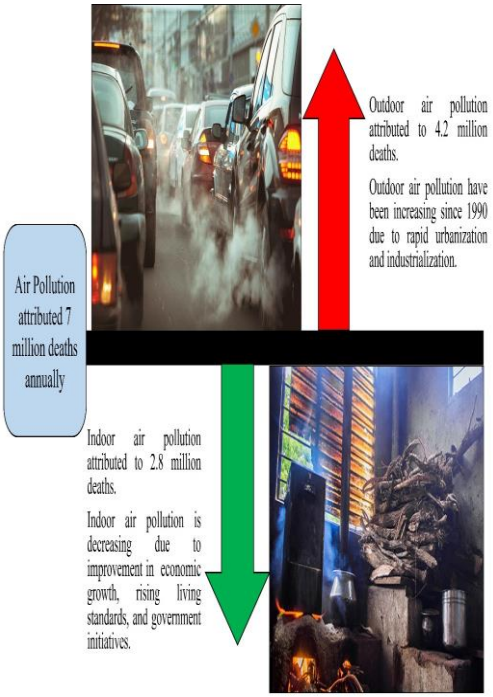

Figure 1: Deaths due to outdoor and indoor air pollution, 2016 [5]

Of the world population, approximately 91% resides in areas where the quality of air is inferior to WHO limits, especially in low- and mid-income countries of Southeast Asia and the Western Pacific; at the world level 9 of 10 persons have to breathe polluted air exceeding WHO limits [6]. Air pollutions increase mortality due to acute respiratory infections, chronic obstructive pulmonary disease, lung cancer, cardiovascular illness, stroke, etc. As per WHO estimates, in the year 2016, ambient air pollution-related mortality mainly due to ischemic heart disease and stroke (58% of total death), chronic obstructive pulmonary disease, and acute lower respiratory infections (18% of total death), and due to cancer of the lung (6% of total death) and others involves more than one causes [7]. In a study carried out by WHO's International Agency for Research on Cancer (IARC), it is concluded that ambient air pollution is carcinogenic for humans (lung cancer due to particulate matter), not only lung cancer but also cancer of the urinary tract/bladder [8]. In India alone, 1.67 million deaths in 2019 accounted for air pollution which is 17.8% of total deaths in the country [9]. Indeed, governments all over the world should take mortality and morbidity due to air

[2] ("Environmental Forensics" n.d.)
[3] (Nazaroff 2018; Kannan, n.d.)
[4] (WHO n.d.)
[5] ("Pollution and Health Metrics: Pollution by Country Data and Rankings" n.d.)
[6] (WHO n.d.)
[7] (WHO n.d.)
[8] (WHO n.d.)
[9] (Pandey et al. 2021)

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pollution seriously and necessarily strengthen air pollution monitoring networks and implement long-term policies with adequate funding to prevent mortality and disease burden due to the invisible killer and lessen the associated negative economic impacts as discussed in the article.

Even though huge death tolls due to air pollution the world over and air pollution-related mortality are proven in scientific studies; air pollution as the cause of death is never addressed in any legal proceedings. But recently, one legal proceeding in London City has gained attention all over the world which solved the mystery behind the death of a nine-year-old girl named Ella Kissi Debrah who died of a fatal asthma attack on 15th February 2013. On the 16th of December, 2020 a remarkable judgment was given by the South London Inner Coroner's Court mentioning air pollution as a contributory factor for the death of Ella Kissi Debrah, and with that, she became the first person in the United Kingdom and most possibly in the world for whom air pollution reported as the cause of death and proven in legal proceeding [10]. The case has opened a new dimension of environmental forensics and it is eye-opening for governments all over the world. The judgment came as a result of a years-long legal battle fought by her family and a grassroots campaign by her mother Rosamund Adoo Kissi-Debrah; an interesting fact file of the case described below.

HISTORY AND DETAILS OF ELLA KISSI DEBRAH'S DEATH CASE

Ella Kissi Debrah, a nine-year-old girl died in February 2013, after fighting a long battle for three years. She was living with her family in Lewisham, Southeast London, 25 meters away from South Circular Road which is a hotspot for high exposure to air pollution. Ella, hence exposed to air pollution constantly throughout her entire life; it is reported that between 2006 and 2010, at South Circular Road level of nitrogen dioxide in ambient air was constantly higher than the annual limit of 40μg/m^3 given by WHO. She had to walk along the road to and from her school. She suffered from severe and unstable asthma since the year 2010 and in the next three years, she was admitted 27 times to five different hospitals due to health problems and tragically died on 15th February 2013 at the age of nine due to a final acute asthma attack, she was taken to university hospital at Lewisham where she died due to cardiac arrest [11] [12]. Since 2010, her parents, especially her mother constantly seeking answers to what triggers/causes asthma attacks to her vibrant and healthy child. Ella's mother Rosamund filed a case in the High Court of London to seek the reason behind her daughter's death and first time, inspection was taken into hands for Ella's death case as a result of air pollution. The first inquest of the year 2014 was not enough to prove the reason, but the second inquest brought more powerful evidence. The 2014 inquest more focused on her medical care and the findings of the first inquest were that Ella died due to acute respiratory failure and severe asthma attack and something in the ambient air may have caused acute respiratory failure hardly answering it as air pollution [13]. Unsatisfied with the verdict, a grassroots campaign was launched by Ella's mother Rosamund; due to her constant efforts, the first inquest was quashed by the London High Court in May 2019, and in 2020 high court ordered a fresh inquest to examine the role of air pollution in the death case of Ella Kissi [14]. Figure 2 shows chronological details of Ella's death case.

Figure 2: Details of Ella's death case in chronological sequence

This second inquest was held before the Court of Inner South Coroner, led by Deputy Coroner Philip Barlow which lasted for 10 days from

[10] (Dyer 2020)
[11] (Dyer 2020)
[12] (London Inner South Coroner's Court n.d.)
[13] (Dyer 2020)
[14] (Dyer 2020)

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30th November to 11th December 2020 and concluded on 16th December 2020. During the inquest, the court examined submissions presented by various departments of the government of the United Kingdom i.e., the Department for Environment, Food and Rural Affairs (DEFRA), Department for Health and Social Care (DHSC), Department for Transport, also local authorities Lewisham London Borough Council as well as the Greater London Authority [15]. On behalf of Ella's Family, the inquest was led by Barrister Richard Hermer QC, also Indian origin Advocate Ravi Mehta who previously acted on behalf of NGO ClientEarth in the legal proceedings on breach of legislation related to air quality by the government of the United Kingdom [16]. The lawyers applied to the court to consider air pollution as a public health emergency, to prioritize efforts of the government to ensure public health; there is a pressing need to record air pollution as a cause of an Individual's death [17] [18].

SCIENTIFIC EVIDENCE PRESENTED DURING THE INQUEST

Important scientific evidence was presented for the inquest by Professor Stephen Holgate, an Immunopharmacologist and renowned expert on air quality from the Faculty of Medicine, the University of Southampton [19] who associated with Ella's Mother since 2015. He produced a report in 2018 revealing a high level of air pollutants detected at a south-east ambient air quality monitoring station (The Catford Monitoring Station which is one mile away from Ella's home) located near the home of Ella Kissi found to be higher than European Union's legal limit consecutively for three years before the death of Ella in 2013 [20]. The report has provided new evidence for the role of higher air pollution near a resident of Ella in her death resulting in the quashing of the verdict of the 2014 inquest that she died due to acute respiratory failure and the opening of a new inquest in 2020 to investigate role of air pollution [21] [22] [23].

Prof. Stephen Holgate linked the death of Ella Kissi with a higher level of air pollution reported at a nearby ambient air quality monitoring station. He testified that she was suffering from hypersecretory asthma; air pollution that irritated her lungs resulting in an overpouring of mucus, and hence she was admitted to hospital multiple times before her death. Her situation is like a 'Canary bird in a Coal Mine' [24], her death is due to the cumulative effects of a mixture of air pollution (particulate matter and NOx) she breathed during her life which triggered her final fatal asthma attack. He provided evidence before the court that indicates the reason for her situation getting worse during the winter months of 2012 was seasonal deterioration of air quality. The expert evidence submitted by Prof. Stephen Holgate on behalf of the family of Ella Kissi played a crucial role in the inquest [25] [26] [27] [28]. Further during the hearing of the inquest, he extremely denounced the Government of the United Kingdom i.e., the Department for Environment, Food and Rural Affairs (DEFRA) and Department for Health and Social Care (DHSC) for not working jointly on failure to control ambient air quality which is affirmed by Coroner Philip Barlow [29]. Professor Paul Wilkinson from the School of Tropical Disease, London also submitted scientific evidence at the inquest and confirmed to the Court that the health of Ella Kissi was impaired due to exposure to air pollution as she was living at South Circular Road in South London. At the location, ambient air is polluted due to traffic-induced air pollution which is above average even for London [30] [31]. One piece of evidence showed negligence of the council in looking after levels of air pollutants and if it had been examined in time, Ella would not have died. Also, some reports showed two air pollutants, Nitrogen dioxide (NO_2) and PM which were highly exposed and contributed to Ella's death, and so, judgment came in favor of Ella's mother

[15] (Dyer 2020)
[16] (Blackstone Chambers n.d.)
[17] (Sandra Laville n.d.)
[18] (The Guardian 2020)
[19] (University of Southampton n.d.)
[20] (BBC News 2020)
[21] (Dyer 2020)
[22] (Jazrawi n.d.)
[23] (The Guardian 2020)
[24] (Sandra Laville n.d.)
[25] (Dyer 2020)
[26] (Jazrawi n.d.)
[27] (The Guardian 2020)
[28] (Sandra Laville n.d.)
[29] (Sandra Laville n.d.)
[30] (Jazrawi n.d.)
[31] (BBC News 2020)

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and thus, it was proved that air pollution was linked with Ella's death [32].

THE JUDGMENT

Deputy Coroner Philip Barlow based on scientific and factual expert evidence presented during the inquest, gave the judgment stating that Ella had died due to severe asthma and excessive air pollution exposure. Ella's health issues developed from 2010 to 2013 during which she was exposed to Nitrogen Dioxide and Particulate Matter (traffic-caused) more than WHO guidelines at her residential area. The coroner also noted the government authorities failed to control the level of Nitrogen Dioxide within limits imposed by the European Union and Domestic legislation. It is also recorded in the judgment that Ella's mother has not been informed regarding the excessive level of air pollution which causing illness of her daughter and health risk and potential of air pollution to initiation and aggravate asthma". However, the argument from Ella's family that the failure of the Government to protect the public from hazardous air pollution should be considered a breach of the right to life, article 2 of the European Convention of Human Rights not addressed by the court in record of the inquest [33] [34].

THE IMPLICATION IN THE CONTEXT OF THE UNITED KINGDOM

Ella's case is eye-opening for the public health impacts of air pollution throughout the world. This is the first legal case that clearly shows how clean air is an important determinant of human health and how polluted air can be responsible for the death toll though it is proven in many scientific studies. For the inquest, Deputy Coroner Philip Barlow considered many scientific reports/papers and a report mentioning 35,500 untimely deaths in the UK due to air pollution which was prepared by the House of Commons Environmental Audit Committee in year 2010. However, no appropriate investigation was done before to discover the root causes of death and linking with air pollution, and so there lies obscure information behind it [35]. The judgment given in the inquest is the first of its kind in the history of the UK's legislation also the world.

The judgment 'air pollution as a causative factor for an individual's death' is groundbreaking globally and for the UK as well because as per the UK government's estimation yearly 28,000 to 36,000 deaths in the UK are attributed to long-term air pollution exposure [36]. In the UK air pollution is the biggest environmental threat to public health with strong evidence that air pollution aggravates asthma and triggers the development of lung cancer, strokes coronary heart disease, and other respiratory disease [37] [38].

In the year 2019, 60% of the population of the UK was exposed to air pollution higher than legal limits, legal limits for nitrogen dioxide were breached in 142 local authorities which can affect 7 million children and 5.5 million elderly people over the age of 65 and 33 million population as whole with an estimated yearly cost of more than 20 billion pounds due to health impacts associated with air pollution [39].

As shown in Figure 3, mortality due to air pollution is the largest environmental health threat worldwide specifically the developed countries air pollution has the highest share in mortality due to environmental pollution. All countries of the world are divided by WHO into 6 regions; Figure 3 provides % deaths due to various types of environmental pollution in different regions. For the European region, air pollution contributes to 68% of total deaths due to air pollution, whereas pollution of water contributes to only 1% of total deaths. This lower mortality due to water pollution is a reflection of stringent standards for water quality, water pollution, and its strict implementation also, well-established environmental forensics for water pollution. Still, for most of the European countries, mortality and morbidity due to air pollution is a major challenge.

In the context of London, as per the new data published by the Mayor of London in April 2019, two million London residents including 4,00,000 children are living in areas where ambient air quality is inferior compared to legal standards. The data further indicates that till 2016 more than 400 schools were in areas where nitrogen dioxide concentration in ambient air is higher than legal standards [40]. Therefore, the judgment of Ella's case will put

[32] (Dyer 2020; London Inner South Coroner's Court n.d.)
[33] (Dyer 2020)
[34] (London Inner South Coroner's Court n.d.)
[35] (Marshall 2020)
[36] (Richard n.d.)
[37] (GOV.UK n.d.)
[38] (Ballinger et al. 2017)
[39] (Cockburn 2020)
[40] (Mayor of London 2019)

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pressure on the Government of the UK and local authorities to prioritize solutions for air pollution-related problems and improve ambient air quality by setting more and more progressive air quality targets; framing policies to protect the public from traffic origin air pollution in urban areas [41].

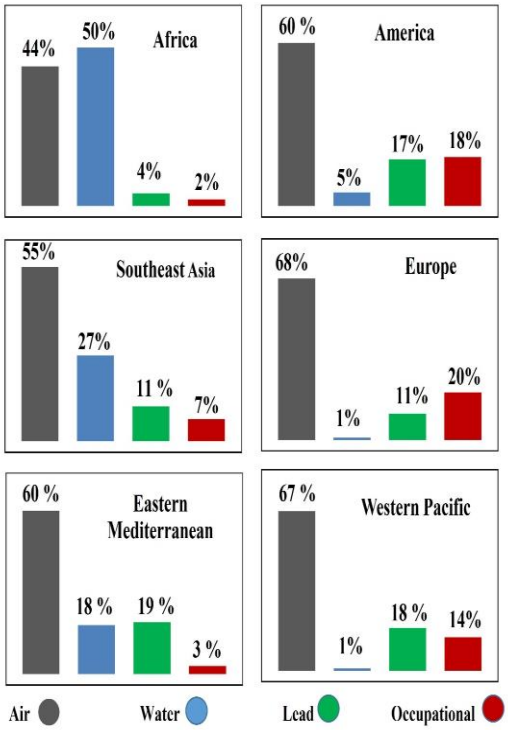

Figure 3: Percentage of death due to environmental pollution types in different WHO regions, 2019 [42]

The judgment is of immense significance as the repetitive failure of the UK government to comply with legal standards for air pollution, particularly nitrogen dioxide admitted by UK courts in three cases filed by NGO Client Earth [43] as well as recently by the European Court of Justice [44] [45]. The Court of Justice of the European Union (CJEU) in the judgment given on 4th March 2021 conceded that in certain areas of the country, there has been a 'systematic and persistent exceedance of nitrogen dioxide than the legal limits' since 2010, and failure of government to comply with legal duties [46] [47] to overcome the problem exposing the UK nationals (especially vulnerable) to a sincere public health risk of significant harm as proven in the Ella Kissi Death case. To address the issue the UK government established ambitious targets for ambient air quality through a historic environment bill that focused principally on protecting citizens from harmful health impacts of air pollution; also, the government provided the 3.8-billion-pound plan for deal with transport origin nitrogen dioxide pollution as well further work on protecting citizens from PM 2.5 pollution [48]. To improve the ambient air quality of central London, the Mayor of London launched an ultra-low emission zone scheme (ULEZ), according to which most vehicles must comply with ULEZ emission standards otherwise need to pay a forfeit for driving through ULEZ [49] [50].

Further, it is important to note that though London has the world's largest air quality monitoring network, to bolster air quality monitoring Mayor of London on 15th March 2021 announced to development sensor network with an investment of 1.5 million pounds jointly with Bloomberg Philanthropies. The 195 air quality sensors will be set up across London and daily real-time air quality data will be displayed on a new website 'Breath London' along with data from the existing monitoring network. Thus, on completion residents of London will be provided with real-time air quality monitoring data from more than 300 monitoring sites, apart from 60 sensors will be allocated to community groups. At schools, hospitals and other priority locations air quality sensors will be installed; data from nine sensors already installed at different hospitals displayed on the 'Breath London' website from 15th March 2021. The initiative with many more endeavors focuses on areas where residents are subjected to inferior air quality including low-income neighborhoods, Blacks, Asians, and other minorities dispensing solutions for health and environmental inequality [51].

IMPLICATION IN CONTEXT OF CHILDREN AS MOST VULNERABLE

As per the WHO Report on Air Pollution and Children's Health published in October 2018, air pollution, both ambient and household seriously affects the health of children all over

[41] (Jazrawi n.d.)
[42] ("Pollution and Health Metrics: Pollution by Country Data and Rankings" n.d.)
[43] (Blackstone Chambers n.d.)
[44] (ClientEarth n.d.)
[45] (Court of Justice of the European Union n.d.)
[46] (ClientEarth n.d.)
[47] (Court of Justice of the European Union n.d.)
[48] (The Guardian 2020)
[49] (Mayor of London 2019)
[50] (Transport for London n.d.)
[51] (Mayor of London 2021)

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the world especially in low- and middle-income countries. As children breathe more rapidly than adult individuals they are likely to absorb more pollutants and hence more vulnerable to air pollution-associated health effects such as impaired neurodevelopment and lower cognitive ability, motor development, damage to lungs, suffering from asthma and childhood cancer, great chances to suffer from chronic cardiovascular diseases at a later stage, etc. According to the report at the world level, 93% of the children (1.8 billion including 630 million below the age of 5 years) below the age of 15 years exposed to ambient air have PM 2.5 concentration higher than WHO guidelines. For children below the age of 5 years, 98% in low- and middle-income countries whereas 52% in high-income countries are exposed to PM 2.5 concentration higher than WHO guidelines.

WHO estimated that due to health implications caused jointly by indoor and ambient air pollution around 6,00,000 children below the age of 15 years died in 2016 while in low- and middle-income countries it caused 50% of acute lower respiratory infection in children below the age of five. For children below the age of 5-year air pollution is a major health risk causing one out of every 10 deaths [52] [53]. In the context of this report, WHO Director-General Dr. Tedros Adhanom Ghebreyesus stated that each child should be provided pollution-free air to breathe to grow and fulfill their full potential [54]. By observing air pollution as a causative factor for the death of Ella Kissi, the UK Coroner laid down a clear obligation on governments all over the world that necessary protection measures must be taken so that the most vulnerable youngest generation should not suffer like Ella Kissi. Governments and the world around us must ensure for future generations their human right to life, live in a healthy environment, and breathe pollution-free air.

ELLA'S DEATH CASE - PRECEDENT FOR FORTHCOMING BATTLES

The judgment given in the 2020 inquest would set up a new path for activists working for air quality in the UK and the world around. It is reported in different studies that London residents who are socio-economically deprived are more likely exposed to polluted air [55]; according to a study conducted by the European Environmental Agency, for the year 2017 concentration of nitrogen dioxide exceeded than limit prescribed by the European Union in nearly half of neighborhoods with lower social economic backgrounds compared to two percent only for richer areas of London. Imperial College London Scientist Dr. Gary Fuller who wrote the book 'The Invisible Killer' did a lot of research from 2010 to 2016 on air pollution in London and noted that in London air quality has not improved equally at all locations, for some locations noteworthy improvement observed but for other no change observed, or traffic origin air pollution exacerbated.

The social injustice and inequality concerning air pollution were further highlighted in a study carried out by the University of the West of England in the year 2019 indicating wealthier neighborhoods of London are more responsible for air pollution whereas poor and socially deprived are receiving higher exposure to air pollutants. A study conducted by City Hall revealed that in the most deprived areas of London nitrogen dioxide concentration was 24% higher compared to non-deprived areas, areas with black and Asian residents, and mixed residents are higher air pollution exposure due to nitrogen dioxide.

Ella's Mother who campaigned and fought a legal battle for air pollution to be decided as the cause for Ella's death by the coroner's court, now further continues the campaign till air will become clean and benefits of improved air quality available to all communities without inequality. Ella's Mother now works as WHO's advocate for health and air quality and is vocal for air quality and other environmental issues in her hometown Lewisham [56]. Air pollution is not just linked with asthma-like Ella's case but there are many more health issues associated with air quality, hence Ella's death case brought air quality activists together and they are highlighting poor air quality as inequality and social injustice [57] [58].

ELLA'S DEATH CASE WITH PERSPECTIVE OF AIR POLLUTION-RELATED ENVIRONMENTAL FORENSIC

[52] (WHO n.d.)
[53] (WHO n.d.)
[54] (WHO n.d.)
[55] (Slawson 2021; Chakelian and Calcea n.d.)
[56] (Chakelian and Calcea n.d.)
[57] (Chakelian and Calcea n.d.)
[58] (Slawson 2021)

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Though air pollution is an invisible killer reported in many scientific studies [59] and worldwide there is a huge death toll due to air pollution as well as economic losses due to air pollution-related morbidity as described in preceding sections, the issue is not well addressed by legislative and administrative authorities worldwide [60]. Ella's death case clearly emphasizes the necessity for the development of air pollution-related environmental forensics to prove air pollution is a causative factor in a person's death. Dr. Gary Fuller, author of the book 'The Invisible Killer: The Rising Global Threat of Air Pollution - and How We Can Fight Back' mentioned in the book that there is no lack of evidence related to harm caused by air pollution to global public health but there is lack of administrative and political willingness [61]. Development and strengthening of environmental forensic aspects for air pollution-related mortality and morbidity is the need of the hour to safeguard not only global health, particularly urban lives but also the future of our planet. Ella's death case reiterates collective actions from local and national government authorities to fight against this invisible killer, persuade the public, and intensify forensic study for the application of the 'Polluter Pay Principle' to make air polluters bear the cost for mortality and disease burden due air pollution caused by them [62].

With perspective to Ella's death case and air pollution-related environmental forensics, it is important to note the opinion of Prof. Roy Harrison, environmental health, and air quality scientist from Birmingham University. According to him, the judgment given for Ella's death case just confirms what is already known to the scientists, and does not change science in any way [63]. However, this is the first case in which eminent expert Prof. Stephen Holgate was involved who prepared all evidence to find a link between Ella's death and the level of air pollution[64] which played a key role in the judgment given. According to Prof. Roy Harrison, it would be still difficult for a doctor to provide a death certificate with air pollution as a causative factor; even though this case has opened new possibilities. It is extremely difficult to establish a link between the death of an individual and air pollution and the same exactitude study would require for other such cases [65].

As per Katie Nield, a lawyer associated with 'Client Earth,' the decision given in Ella's death case is about the cause of Ella's death; not determining culpability. However, the judgment given in the case is significant for the government's responsibility in protecting the public health [66]. According to David Wolfe QC, a Lawyer specializing in public law, from a legal perspective, the decision given is not constraining on other courts, but still, the case is important as the first legal case that recognized air pollution as the cause of death of an individual [67]. Prof. Jonathan Grigg, another expert who witnessed the case, believes that after this case it would be difficult to ignore the role of air pollution. Whereas Prof. Gavin Shaddick, who is UK governmental adviser for air pollution researchers working on epidemiological studies at national and global scales believes that it is often difficult to understand and communicate the harmful impacts of air pollution on citizen's health, still the case points out considerable and growing evidence for the adverse health impacts of air pollution in UK and world over [68].

ELLA'S DEATH CASE FROM AN INDIAN PERSPECTIVE

With the economic development that India observed during the last few decades, the ambient air quality of Indian cities aggravated due to the increase in vehicles and construction activities continuously in Indian cities, hence ambient air pollution has become a major health hazard and killer in urban India whereas household air pollution still a health hazard in rural India [69]. In India, after the Air (Prevention and Control of Pollution) Act, of 1981, the national ambient air quality monitoring program started in 1984 under the central pollution control board. Currently, the national air quality monitoring program has a network of 793 ambient air monitoring stations in 344 cities/towns across the country [70]. Recently in India, under the Smart City Mission, the Ministry of Housing and Urban Affairs launched the National Clean Air Program

[59] (Sofia et al. 2020)
[60] (Sofia et al. 2020)
[61] (Fuller 2018)
[62] (Fuller 2018)
[63] (Marshall 2020)
[64] (BBC News 2020)
[65] (Marshall 2020)
[66] (Marshall 2020)
[67] (Marshall 2020)
[68] (Marshall 2020)
[69] ("India Takes Steps to Curb Air Pollution" 2016)
[70] (CPCB n.d.)

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(NCAP) across the country in year 2019 as a long-term time-bound national strategy to tackle air pollution [71]. The NCAP though focused on urban air quality was criticized for lacking in legal mandate it aimed to reduce the level of PM 2.5 in urban ambient air and more engagement at the state and local levels [72]. Apart from this, India initiated improved vehicle emission standards by shifting to Bharat Stage VI (BS-VI) to improve urban ambient air quality in upcoming years [73]. However, still much improvement is required for air pollution-related health as well as economic impacts in India.

As per the WHO data, in the year 2012, 1.5 million people died due to air pollution [74], which increased to 1.67 million deaths in the year 2019 accounting for 17.8% of total deaths in the year [75]. In India, in comparison to 1990 for the year 2019 household air pollution-related deaths declined by 64.2% but deaths due to ambient air specifically particulate matter increased by 115.3% [76]. The mortality rate due to different diseases caused by air pollution in India is given in Figure 4. Exposure to ambient particulate matter is responsible for around 0.98 million deaths whereas household air pollution accounted for 0.61 million deaths in the year 2019 [77], PM 2.5 India belongs to the countries with the highest exposure, compared to 2010 annual average PM 2.5 exposure (population-weighted) increase by 6.5% [78]. According to the World Air Quality Report published by IQAir a Swiss air quality technology company, 22 Indian cities are listed as the 30 most polluted cities in the world whereas India's capital city, New Delhi is the most polluted capital in the world [79]. As per Johannes Lelieveld, Director at the Max Planck Institute for Chemistry, in the year 2025, India's capital New Delhi will have a record for the world's maximum number of untimely deaths due to breathing of polluted air. It is estimated that 32,000 citizens will die in Delhi due to air pollution[80].

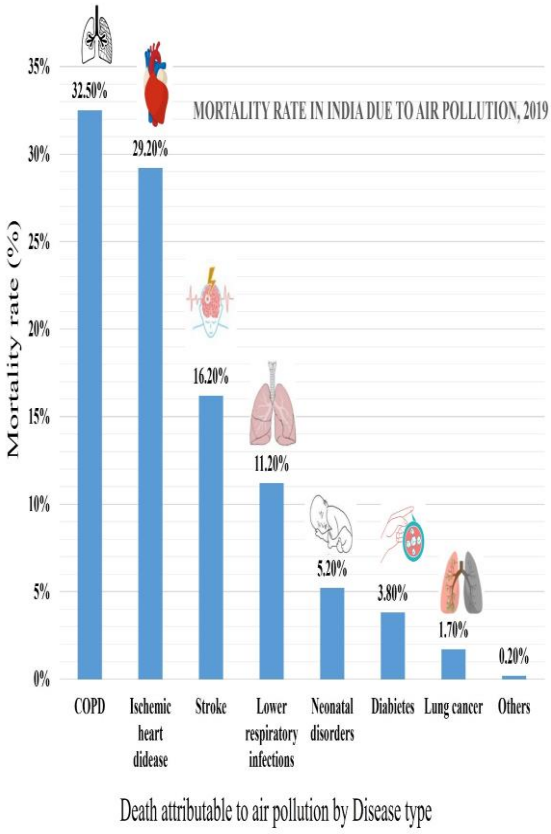

Figure 4: Mortality rate in India by different diseases and health problems caused due to air pollution [81]

Untimely deaths and morbidity due to air pollution attributed to lost output and economic loss in India which is estimated to total 36.8 billion US$ (1.36% of Indian GDP) for the year 2019 whereas healthcare costs due to air pollution-related diseases estimated to be 11.9 billion US$ (0.44% of Indian GDP). Mortality due to air pollution accounts for 28.8 billion US$ whereas morbidity accounts for 8.0 billion US$ economic loss; whereas air pollution whole together resulted in 26.5US$ per-capita economic loss in year 2019 [82]. Apart from, Particulate matter (PM10 and PM 2.5) as well as gaseous pollutants SOx and NOx, tropospheric ozone has been arising as a secondary pollutant with significant contribution to air pollution-related mortality

[71] (Press Information Bureau, GOI n.d.)
[72] (Health Effects Institute and Institute for Health Metrics and Evaluation's Global Burden of Disease project 2020)
[73] (Health Effects Institute and Institute for Health Metrics and Evaluation's Global Burden of Disease project 2020)
[74] ("India Takes Steps to Curb Air Pollution" 2016)
[75] (Pandey et al. 2021)
[76] (Pandey et al. 2021)
[77] (Pandey et al. 2021)
[78] (Health Effects Institute and Institute for Health Metrics and Evaluation's Global Burden of Disease project 2020)
[79] ("World's Most Polluted Cities in 2020 - PM2.5 Ranking | AirVisual" n.d.)
[80] (Sinha n.d.)
[81] (Pandey et al. 2021)
[82] (Pandey et al. 2021)

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and morbidity. Globally every year around 2,30,000 chronic respiratory disease deaths occurred due to ozone [83] whereas 0.17 million deaths due to ambient ozone were reported in India for year 2019; deaths due to ambient ozone increased by 139.2% in 2019 compared to 1990 [84]. Apart from this, India also represents great vulnerability to air pollution-related mortality of children/infants. According to the *State of Global Air 2020* report, more than 116,000 infants in India died within a month of birth in 2019 due to air pollution both outdoor and indoor [85].

The issue of mortality and morbidity has been recognized by the Government of India. The Ministry of Health and Family Welfare set up a Steering Committee on air pollution and health-related issues, the committee undertook a study and submitted a report to the Government of India in year 2015. The report is the first official government document that emphasizes the impacts of air pollution on citizens' health rather than environmental issues associated with air pollution highlighting the role of air pollution in increasing the rate of cardiovascular diseases [86]. Also, additional targets are included by the Indian government in India's national non-communicable disease (NCDs) program as per the global action plan of WHO for the prevention and control of NCDs 2013–2020. Since in India air pollution originates from diverse sources and henceforth multifaceted efforts are required to avert air pollution-related mortality and morbidity; improvement in indoor air pollution observed due to governmental efforts [87]. Still, many exertions are required from the government to strengthen ongoing efforts by formulating policies with an allocation of adequate funding for the long-term not as expenditure but as decisive investment to tackle the issue as the government's responsibility to protect the health of their citizen as highlighted in Ella's death case and for strengthening environmental forensic for the Invisible Killer.

MITIGATIVE MEASURES FOR AIR POLLUTION-RELATED MORTALITY AND MORBIDITY

For the 21st century air pollution has been identified as the single major environmental health risk; and also the fifth major health risk factor in the recent declaration of the UN General Assembly for non-communicable disease prevention and control [88]. Apart from this, the issue is addressed in the Sustainable Development Goals set in 2015, the target 3.9 of goal 3 is about the reduction in mortality and illness due to air pollution [89]. The mortality and morbidity due to air pollution as aforementioned and proven legally the first time in Ella's death case emphasized dealing with this invisible killer with environmental forensic approaches. Environmental forensics should have proceeded to identify the polluters and reduce air pollution by controlling/regulating the ultimate cause of air pollution. At a time, there are many challenges to dealing with the management of air pollution and linking air pollution to the cause of individual death and endangering health by environmental forensic approaches. These challenges are a lack of a strong air quality monitoring network, real-time availability of data, harmonized air pollution policies, financial problems, maintaining the authenticity of data, informing the citizens about ambient air quality, and aware them of the harmful effects of air pollution, etc. The problems of air pollution and related health effects should be dealt with by collective and coordinated efforts of public, local, and government authorities; not just pollution control authorities but numerous other government authorities such as power, road and transport, rural development, agriculture, finance, etc. [90].

For urban air quality, transportation is the main source of air pollution, therefore there is a need to change travel practices and more focus should be given to electrical vehicles, public transportation, and active transport [91]. Active transport with short urban journeys by walking or by bicycle provides dual benefits of reduction in urban air pollution as well as additional health gain due to physical activities. A study indicates that active transportation possibly will avert 99 untimely deaths per million individuals in Delhi and 21 untimely deaths per million individuals in London; with saving of 34 to 74

[83] (Campbell-Lendrum and Prüss-Ustün 2019)
[84] (Pandey et al. 2021)
[85] (Health Effects Institute and Institute for Health Metrics and Evaluation's Global Burden of Disease project 2020)
[86] ("India Takes Steps to Curb Air Pollution" 2016)
[87] (Pandey et al. 2021; "India Takes Steps to Curb Air Pollution" 2016)
[88] (Campbell-Lendrum and Prüss-Ustün 2019)
[89] (Pandey et al. 2021; "India Takes Steps to Curb Air Pollution" 2016)
[90] ("India Takes Steps to Curb Air Pollution" 2016)
[91] (Campbell-Lendrum and Prüss-Ustün 2019)

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times higher disability-adjusted life years compared to those saved just by air pollution reduction [92] [93]. Apart from transportation, air pollution from energy sources should also be addressed with clean energy sources, which would reduce global CO_2 emissions by nearly 20% and thus combat global warming. At a time lessening air pollution-related mortality by half and generation of approximately US$ 3 trillion in revenue/year which can diverted for delivering health and social benefits to aggrieved people [94].

In the judgment given for Ella's death case, the failure of government and local authorities to control air pollutants within the statutory limits set by EU and national laws was acknowledged [95]. Thus, judgment given for the case is pronounced about the responsibility of governments all over the world to take this issue seriously for framing policies with allotment of needed finance. As air pollution has proven potential for lowering the survival of children with many undermining health effects that reduce their ability, thus air pollution can impede the future human capital of any country [96]. Thus, investment by the government for protecting citizens would provide a twofold gain, a decrease in mortality, disease burden, and economic losses; at a time the resultant cost saving would help to build new human capital thus future economic gain [97]. It is observed from the case study of the USA (California state), that investment in air pollution control strategy provides potential benefits for human health and the economy. Each dollar spent since 1970 returned with the economic benefit of 30US$ [98]. Similarly, for the USA, lead removal from gasoline reduces lead concentration in ambient air which is also linked with improved economic output by lessening the impacts of lead on the mental development of children, and improvement in creativity and intellect [99].

Thus, it can be said that the myth that treatment of air pollution is costly even for a developing economy, should be broken. The economic loss due to air pollution-related mortality and disease burden is more as compared to the cost of mitigation of air pollution and investment in air pollution control could yield manyfold advantages. The judgment 'air pollution as a causative factor of individual's death' in Ella's death case is eye-opening and groundbreaking for legislative and governmental authority the world over. The judgment opens a new path for environmental forensics to find such evidence behind the causes of air pollution-related mortality and morbidity reported worldwide. This emerging field and its development can assist in many parameters like, how monitoring of air pollutants is carried out, how much awareness and information is to be shared with the public regarding perilous levels of pollutants, what measures are taken by officials, and when and where monitoring is done.

CONCLUSION

Air pollution-related mortality and morbidity are well-addressed in scientific literature and amongst the environmental pollutants, air pollution has the largest share in pollution-related premature deaths and disease burden worldwide. Today, environmental forensics mainly focuses on traditional types of water pollution and micropollutants released in the environment, particularly soil and water environment. Health impacts of air pollution though well studied by researchers globally, however, this crucial issue is still inadequately addressed with an environmental forensic approach and still has not gained substantive focus when air pollution is considered as a cause of individual deaths. Apropos to this, Ella's Death case and the groundbreaking judgment given for the case opened doors for many other perspectives in the jurisdiction of the UK and countries the world over for dealing with this invisible killer. The case demonstrates how the link can be established for other such unsolved cases as well as what are the challenges for establishing air pollution as a cause of individual death in legal cases though well established in scientific studies. This is a landmark case from which judiciaries of other countries should take an example as it is the first case in which air pollution is considered as a cause of death. Other than that case highlights the need to consider air pollution as a priority issue by local authorities and governments worldwide to protect their citizens, particularly children as the most vulnerable and future of any country. The case indeed introduces a wide-scale need to address air pollution-related mortality and morbidity with environmental forensic

[92] (Campbell-Lendrum and Prüss-Ustün 2019)
[93] (Woodcock, Givoni, and Morgan 2013)
[94] (Campbell-Lendrum and Prüss-Ustün 2019)
[95] (London Inner South Coroner's Court n.d.)
[96] (Pandey et al. 2021)
[97] (Pandey et al. 2021)
[98] (Pandey et al. 2021; "India Takes Steps to Curb Air Pollution" 2016)
[99] (Grosse et al. 2002)

approaches because many unrevealed cases need to be solved.

REFERENCES

[1] Ballinger, Ann, Tanzir Chowdhury, Chris Sherrington, and George Cole. 2017. "AIR POLLUTION: ECONOMIC ANALYSIS." *Air Pollution: Outdoor Air Quality and Health* NICE guideline [NG70] by National Institute of Health and Care Excellence: 87.

[2] BBC News. 2020. "Ella Kissi-Debrah 'living on Knife Edge' before Death." *BBC News*, December 8, 2020, sec. London. https://www.bbc.com/news/uk-england-london-55235398.

[3] Blackstone Chambers. n.d. "Inquest into the Death of Ella Adoo-Kissi-Debrah." Blackstone Chambers. Accessed April 12, 2021. https://www.blackstonechambers.com/news/inquest-death-ella-adoo-kissi-debrah/.

[4] Campbell-Lendrum, Diarmid, and Annette Prüss-Ustün. 2019. "Climate Change, Air Pollution and Noncommunicable Diseases." *Bulletin of the World Health Organization* 97 (2): 160–61. https://doi.org/10.2471/BLT.18.224295.

[5] Chakelian, Anoosh, and Nicu Calcea. n.d. "Ella Adoo-Kissi-Debrah and the Great Smog of Modern London." Accessed April 15, 2021. https://www.newstatesman.com/politics/environment/2020/12/ella-adoo-kissi-debrah-and-great-smog-modern-london.

[6] ClientEarth. n.d. "Top Court Confirms UK Has Broken Air Pollution Law." Accessed April 13, 2021. https://www.clientearth.org//latest/press-office/press/top-court-confirms-uk-has-broken-air-pollution-law.

[7] Cockburn, Harry. 2020. "60% of Population Living with Air Pollution above Legal Limits." The Independent. September 6, 2020. https://www.independent.co.uk/climate-change/news/air-pollution-england-defra-labour-who-nitrogen-dioxide-luke-pollard-b404484.html.

[8] Court of Justice of the European Union. n.d. "CURIA - Documents." Accessed April 13, 2021. https://curia.europa.eu/juris/document/document.jsf?text=&docid=238474&pageIndex=0&doclang=EN&mode=lst&dir=&occ=first&part=1&cid=3502431.

[9] CPCB. n.d. "CPCB | Central Pollution Control Board." Accessed February 11, 2021. https://cpcb.nic.in/about-namp/.

[10] Dyer, Clare. 2020. "Air Pollution from Road Traffic Contributed to Girl's Death from Asthma, Coroner Concludes." *BMJ* 371 (December): m4902. https://doi.org/10.1136/bmj.m4902.

[11] "Environmental Forensics." n.d. Oxford Bibliographies. Accessed February 2, 2021. https://www.oxfordbibliographies.com/view/document/obo-9780199363445/obo-9780199363445-0071.xml.

[12] Fuller, Gary. 2018. *The Invisible Killer: The Rising Global Threat of Air Pollution - and How We Can Fight Back*. Melville House UK.

[13] GOV.UK. n.d. "Public Health England Publishes Air Pollution Evidence Review." GOV.UK. Accessed April 5, 2021. https://www.gov.uk/government/news/public-health-england-publishes-air-pollution-evidence-review.

[14] Grosse, Scott D, Thomas D Matte, Joel Schwartz, and Richard J Jackson. 2002. "Economic Gains Resulting from the Reduction in Children's Exposure to Lead in the United States." *Environmental Health Perspectives* 110 (6): 563–69.

[15] Haddad, Robert I. 2004. "Invited Editorial: What Is Environmental Forensics?" *Environmental Forensics* 5 (1): 3–3. https://doi.org/10.1080/15275920490424006.

[16] Health Effects Institute, and Institute for Health Metrics and Evaluation's Global Burden of Disease project. 2020. *State of Global Air 2020 A Global Report Card on Air Pollution Exposures and Their Impacts on Human Health*. Boston, MA:Health Effects Institute: Health Effects Institute. https://www.stateofglobalair.org/.

[17] "India Takes Steps to Curb Air Pollution." 2016. *Bulletin of the World Health Organization* 94 (7): 487–88. https://doi.org/10.2471/BLT.16.020716.

[18] Jazrawi, Hausfeld LLP-Wessen. n.d. "Landmark Air Pollution Decision in the Ella Roberta Adoo Kissi-Debrah Case | Lexology." Accessed April 8, 2021. https://www.lexology.com/library/detail.aspx?g=97992882-c694-47e2-8869-c6ad9da87147.

[19] Kannan, Rajagopal. n.d. "Breathing Rates and Breathing Air Constituents," 2.

[20] London Inner South Coroner's Court. n.d. "Inquest Touching the Death of Ella Roberta Adoo Kissi-Debrah." London Inner South Coroner's Court. London Inner South Coroner's Court. UK,London,Europe. Accessed April 5, 2021. https://www.innersouthlondoncoroner.org.uk/news/2020/nov/inquest-touching-the-death-of-ella-roberta-adoo-kissi-debrah.

[21] Marshall, Claire. 2020. "Air Pollution Death Ruling: What Comes Next?" *BBC News*, December 17, 2020, sec. Science & Environment. https://www.bbc.com/news/science-environment-55352247.

[22] Mayor of London. 2019. "Latest Data Shows Two Million Londoners Living with Illegal Toxic Air." London City Hall. April 1, 2019. https://www.london.gov.uk//press-releases/mayoral/two-million-londoners-live-with-illegal-toxic-air.

[23] ———. 2021. "Mayor Makes Major New Investment in Air Quality Monitoring in London." London City Hall. March 15, 2021. https://www.london.gov.uk//press-releases/mayoral/mayor-makes-major-new-investment-in-aq-monitoring-0.

[24] Nazaroff, William W. 2018. "The Air around Us." *Indoor Air* 28 (1): 3–5. https://doi.org/10.1111/ina.12423.

[25] Pandey, Anamika, Michael Brauer, Maureen L. Cropper, Kalpana Balakrishnan, Prashant Mathur, Sagnik Dey, Burak Turkgulu, et al. 2021. "Health and Economic Impact of Air Pollution in the States of India: The Global Burden of Disease Study 2019." *The Lancet Planetary Health* 5 (1): e25–38. https://doi.org/10.1016/S2542-5196(20)30298-9.

[26] "Pollution and Health Metrics: Pollution by Country Data and Rankings." n.d. *GAHP | Global Alliance on Health and Pollution* (blog). Accessed July 26, 2021. https://gahp.net/pollution-and-health-metrics/.

[27] Press Information Bureau, GOI. n.d. "Long-Term, Time-Bound, National Level Strategy to Tackle Air Pollution-National Clean Air Programme (NCAP)." Accessed February 11, 2021. pib.gov.in/Pressreleaseshare.aspx?PRID=1655203.

[28] Richard, Will. n.d. "UK Air Pollution Could Cause 36,000 Deaths a Year." Accessed April 14, 2021. https://www.kcl.ac.uk/news/uk-air-pollution-could-cause-36000-deaths-a-year.

[29] Sandra Laville. n.d. "Air Pollution a Cause in London Girl's Death, Coroner Rules in Landmark Case." The Irish Times. Accessed April 8, 2021. https://www.irishtimes.com/news/world/uk/air-pollution-a-cause-in-london-girl-s-death-coroner-rules-in-landmark-case-1.4439447.

[30] Sinha, Kounteya. n.d. "Delhi Will Record World's Largest Number of Premature Deaths Due to Air Pollution | India News - Times of India." The Times of India. Accessed July 29, 2021. https://timesofindia.indiatimes.com/india/delhi-will-record-worlds-largest-number-of-premature-deaths-due-to-air-pollution/articleshow/49000678.cms.

[31] Slawson, Nicola. 2021. "Rosamund Kissi-Debrah: 'We Need to Confront the Issue of Inequality and Air Pollution.'" February 24, 2021. https://www.standard.co.uk/futurelondon/theairwebreathe/future-london-rosamund-kissidebrah-confront-inequality-air-pollution-b920852.html.

[32] Sofia, Daniele, Filomena Gioiella, Nicoletta Lotrecchiano, and Aristide Giuliano. 2020. "Mitigation Strategies for Reducing Air Pollution." *Environmental Science and Pollution Research* 27 (16): 19226–35. https://doi.org/10.1007/s11356-020-08647-x.

[33] The Guardian. 2020. "Air Pollution a Cause in Girl's Death, Coroner Rules in Landmark Case." The Guardian. December 16, 2020. http://www.theguardian.com/environment/2020/dec/16/girls-death-contributed-to-by-air-pollution-coroner-rules-in-landmark-case.

[34] Toranzos, Gary A., and Raúl J. Cano. 2018. "Definitions and Historical Perspectives in Environmental Forensics." *Microbiology Spectrum* 6 (2). https://doi.org/10.1128/microbiolspec.EMF-0016-2018.

[35] Transport for London. n.d. "Ultra Low Emission Zone." Transport for London. Accessed April 15, 2021. https://www.tfl.gov.uk/modes/driving/ultra-low-emission-zone.

[36] University of Southampton. n.d. "Influencing Government Policy On Air Pollution | University of Southampton."

JFJ
Volume: 3, Issue: 2
July-December 2024
E-ISSN: 2584 - 0924

Accessed April 8, 2021. https://www.southampton.ac.uk/news/2016/04/health-impact-of-air-pollution.page.

[37] WHO. n.d. "Air Pollution." Accessed February 17, 2021a. https://www.who.int/westernpacific/health-topics/air-pollution.

[38] ———. n.d. "Ambient (Outdoor) Air Pollution." Accessed February 18, 2021b. https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

[39] ———. n.d. "More than 90% of the World's Children Breathe Toxic Air Every Day." Accessed April 14, 2021c. https://www.who.int/news/item/29-10-2018-more-than-90-of-the-worlds-children-breathe-toxic-air-every-day.

[40] ———. n.d. "WHO | Air Pollution and Child Health: Prescribing Clean Air." WHO. World Health Organization. Accessed April 14, 2021d. http://www.who.int/ceh/publications/air-pollution-child-health/en/.

[41] Woodcock, James, Moshe Givoni, and Andrei Scott Morgan. 2013. "Health Impact Modelling of Active Travel Visions for England and Wales Using an Integrated Transport and Health Impact Modelling Tool (ITHIM)." *PLOS ONE* 8 (1): e51462. https://doi.org/10.1371/journal.pone.0051462.

[42] "World's Most Polluted Cities in 2020 - PM2.5 Ranking | AirVisual." n.d. Accessed July 29, 2021. https://www.iqair.com/world-most-polluted-cities.