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Research article

Comparative Assessment of Environmental Distributive Impact of Air Pollution on Least/ Most Deprived Areas of Leeds and London, UK

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Abstract

The environmental impact of air pollution due to fine particulate matter PM_{10} (suspended particles less than 10µm) and Nitrogen dioxide (NO_2) causes respiratory diseases and lung cancer resulting in thousands of premature deaths yearly. It is believed that the people living in economically/ technologically advanced areas are causing more pollution but are the least impacted due to healthy living conditions and facilities. In comparison, the people living in disadvantaged areas are not contributing largely to air pollution. Still, they are becoming victims of pollution caused by others in the least deprived areas due to air transportation/ lesser facilities/ reduced living conditions. This study has made an effort to analyse the statistics of NO2 and PM10 concentrations in Leeds and London in 2001 and 2011. Leeds data has shown that a marginal distributive impact based on the deprivation index is observed with an increasing trend from D1 to D10. Still, annual NO_2 concentration was within the WHO limit of 40 µg/m^3 in 2001 and 2011 with a decreasing trend, suggesting a good control of air pollution caused by fuel combustion in vehicles/ industries and maintaining a good number of green spaces. PM10 concentration in Leeds has been observed increasing from 2001 to 2011 but was still found under the permissible limits of WHO standards of 20 µg/m^3. On the other hand, London has been observed with greater environmental injustice and distributive impacts of air pollution. NO_2 concentration decreased from 2001 to 2011 under the WHO limit of 40 µg/m^3. Still, the most deprived areas were most impacted by air pollution though having lesser contribution than the least deprived areas exhibiting the environmental injustice. The PM10 concentration increased from 2001 to 2011 above WHO limits of 20 µg/m^3, again more in the most deprived areas and less in the least deprived areas. The study supports the conclusions from contemporary researchers that the people in the most deprived areas are impacted by the anthropogenic activities of the least deprived areas and are becoming victims of air pollution without their excessive contributions.

Keywords: Air Pollution, Distributive Impact Assessment, Environmental Equality/ injustice, Least/ Most Deprived, NO_2/ PM_{10} concentration.

Introduction

Environmental inequality has been observed among societies where benefits/ hazards of anthropogenic effects on the environment are not distributed equally. Hazard creators in the rich/ advanced localities are becoming the least deprived. People in disadvantaged/ less developed localities are becoming the most deprived and the victims of air pollution produced by others. Bad air quality increases mortality rates, especially in poor and socially deprived communities [1,2]. Air pollution has been ranked 9th out of 67 health risk factors globally [3]. The phenomenon gets pronounced and painful when the people living in the least deprived regions/ areas (rich countries/ cities with excellent amenities/ facilities/ technological advancements) produce more air pollution,

which is then get deployed due to air transportation to the most deprived areas (disadvantaged countries/ cities with minimal amenities/ facilities/ technological advancements) [4]. Thus, the people in the most deprived areas become passive victims of environmental injustice and the distributive impact of air pollution due to the fault of others [5-7]. The developed countries (China, USA, UK, Europe) are the producers of air pollution/ global warming and climatic variations, but still, they are the least impacted by air pollution. Whereas developing countries (Southeast Asian countries like India, Pakistan and Bangladesh) are the least producers of sources of pollution but are the most impacted countries in the world facing floods/draughts like calamities [9-11] The environmental injustices are pronounced inside the rich and disadvantaged cities/ areas and are observed worldwide and within the UK also and can be determined by a distributive impact assessment of environmental injustices [13-16]. The UK has improved air pollution in the last decade [17,18]. However, some areas are still more impacted than others due to increased population, number of vehicles, industries, reduced green areas, deforestation and disturbance to land uses [19-21]. It is, therefore, imperative to study the presence of environmental inequalities due to the distributive impact of environmental pollution and adopt corrective measures to keep the limits of NO_2 and PM_{10} under 40 **µg**/m^3 and 20 **µg**/m^3 as per WHO standards of air quality [22].

Methodology

This study collected data regarding the annual average concentration of NO_2 and particulate matter, PM_{10}, from ONS UK [23,24] and DEFRA UK [17,18] and analysed versus the deprivation index of people living in London and Leeds. In this study, an effort has been made to analyse the statistics of NO_2 and PM_{10} concentrations in the cities of Leeds and London in the years 2001 and 2011 by dividing the cities into five distinct areas based on the economic growth/ deprivation index/ environmental equality EE1 (the least deprived) to EE5 (the most deprived). The data set has been further organised in deciles D1 (the least impacted) – D10 (the most affected) based on the concentration of NO_2 and PM_{10}. The deprivation index is constructed from "unemployment, home ownership, car ownership, and overcrowding. Values show relative deprivation, ranging from deprived/'disadvantaged' (high positive values) to not deprived/affluent (high negative values)" [2].

Results and Discussion

Air Pollution - NO_2 concentration in Leeds 2001/2011

The analysis for Leeds shows the impact of environmental inequality and its distributive impact in different areas. Generally, an overall increasing trend of NO_2 concentration has been observed from the least deprived decile of D1 with a value of 30.2 µg/m^3 to D10, the most deprived with a value of 37.0 µg/m^3 in 2001 with an observation of little localised variation in D7 and D9 groups where it is even lesser than the least deprived people. Still, the deprivation index is more (Figure 1). A good decreasing trend of NO_2 concentration was observed in 2011 over the decade, with almost a 39% decrease in the D1 area and a 30% decrease in the D10 area. However, distributive impact/ inequality is still present, with an increasing trend observed from D1 with 18.5 to D10 with 36 µg/m^3 in 2011 (Figure 2).

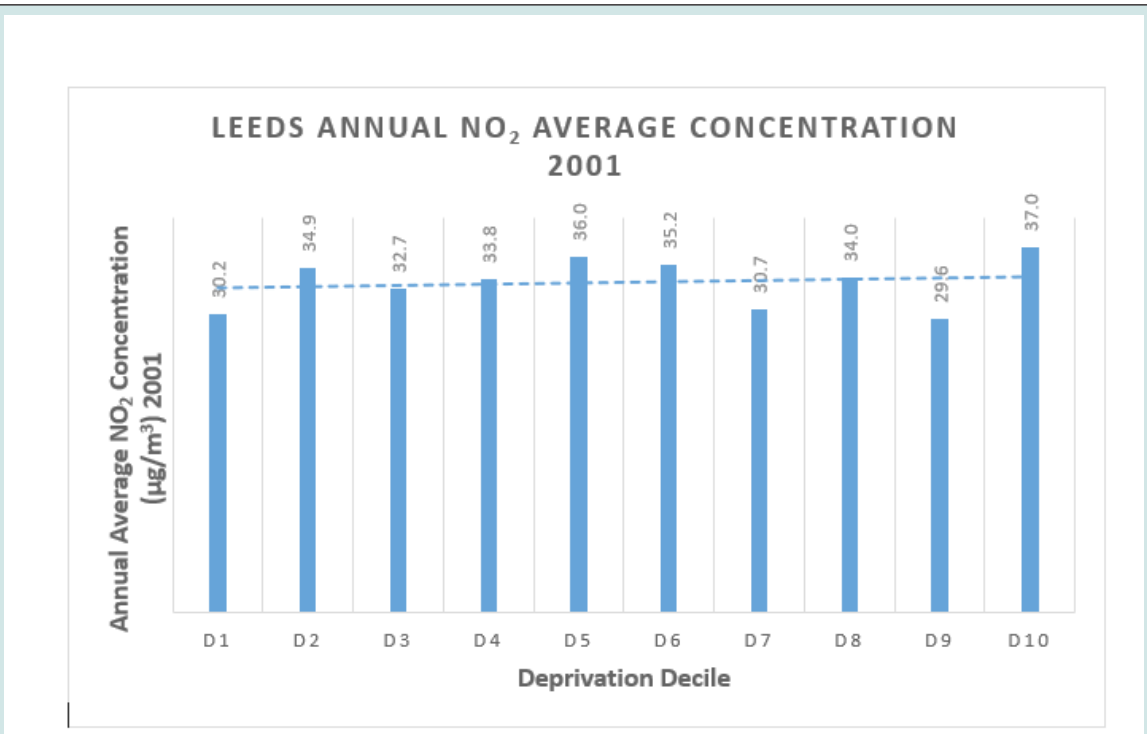

Figure 1: NO_2 concentration in Leeds in 2001

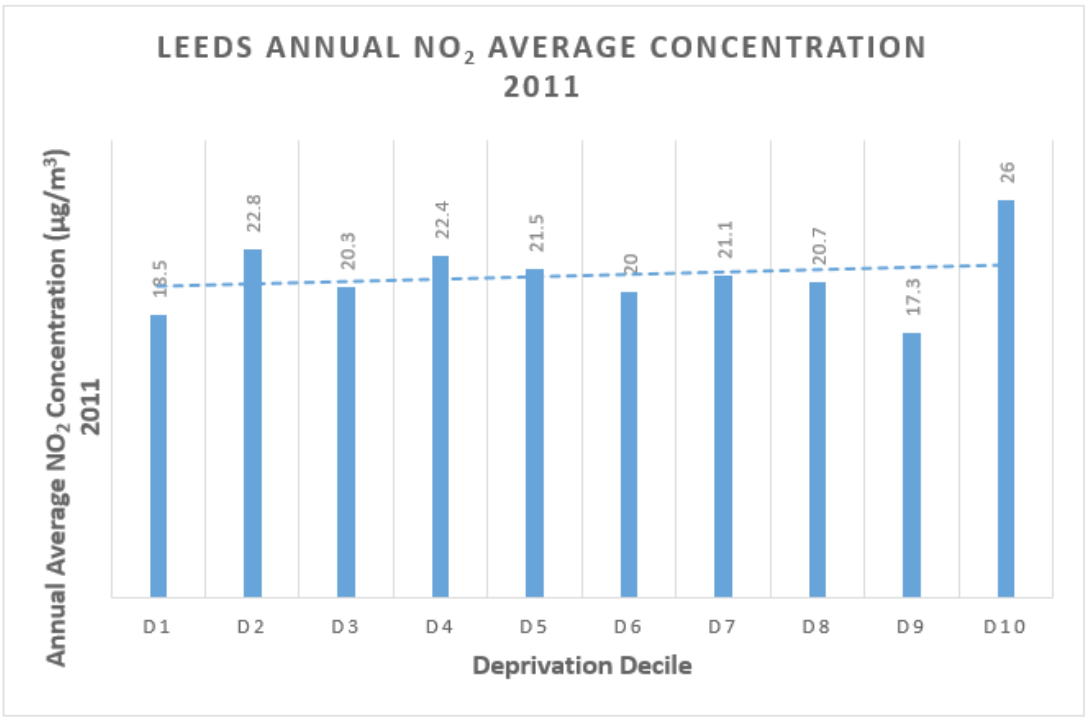

Figure 2: NO_2 concentration in Leeds in 2011.

Comparison of NO_2 concentration in Leeds with WHO Standards

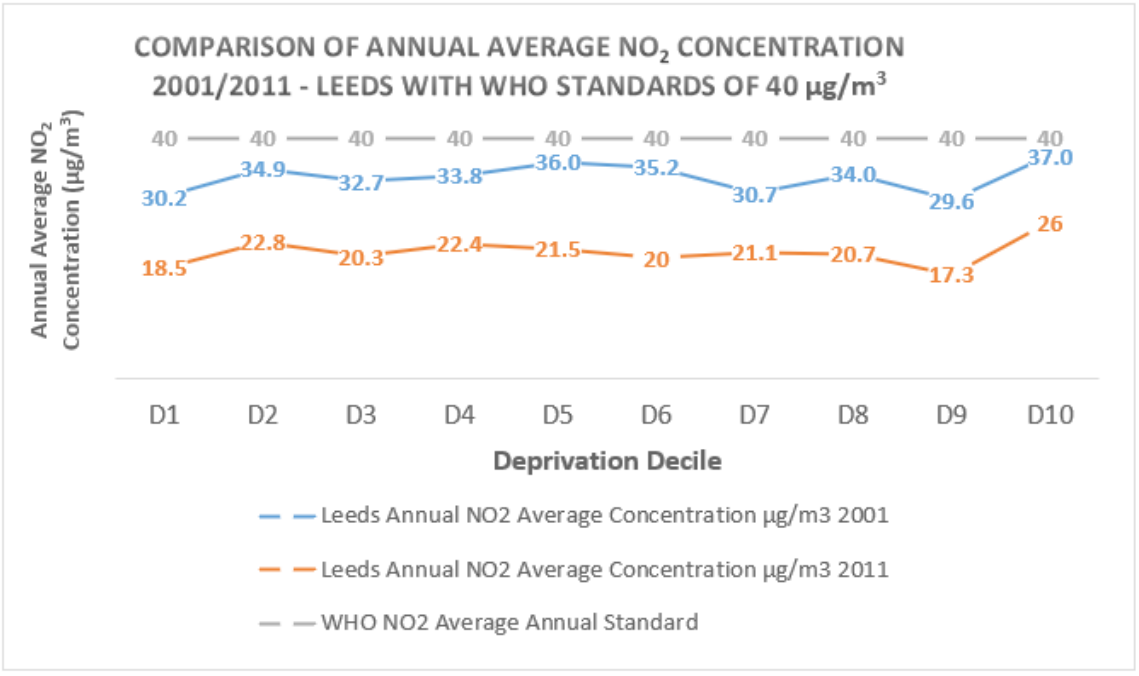

Figure 3: Comparison of annual average NO_2 concentration 2001/ 2011 - Leeds with WHO standards.

It is a good observation that the average annual concentration in Leeds is reasonably below the WHO standard of 40 μg/m^3 [22], achieving a reduction target in the last decade (Figure 3).

Distributive Impact of PM_{10} Concentration in Leeds 2001/ 2011

Leeds data exhibited an increasing trend of PM_{10} concentration in the last decade, 2001-2011. An unequal distributive impact is visible in D1-D10 with a value of 15.9 - 17.5 μg/m^3, with unique variations in D7 and D9 showing less impact on most deprived people in 2001 (Figure 4). An increase of 3 to 5 % in PM_{10} concentration in D1 and D10 groups has been observed from 2001-2011 (Figure 5), which is not a good sign though it is well under the permissible limit of the WHO standard of 20 μg/m^3 [22] (Figure 6).

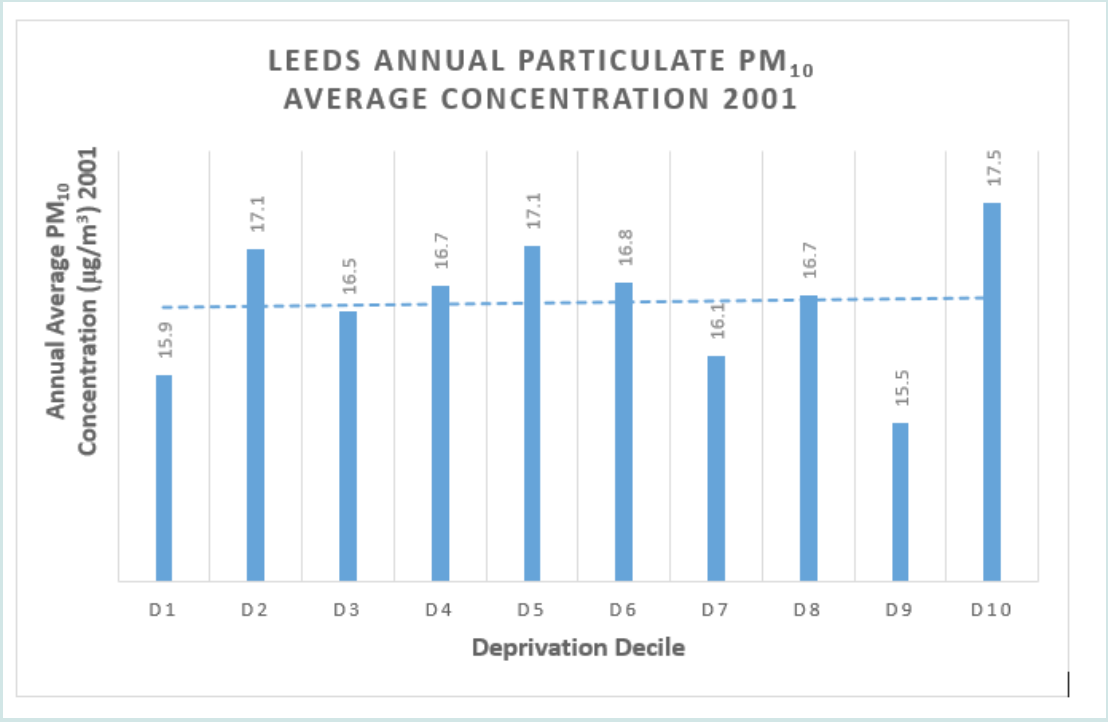

Figure 4: PM_{10} Concentration in Leeds in 2001.

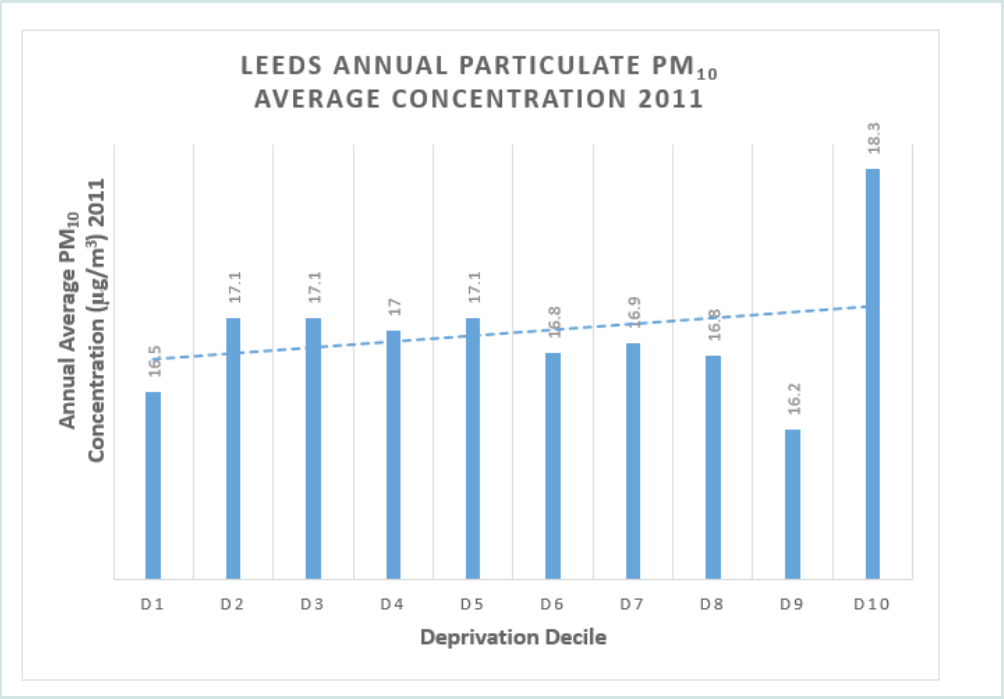

Figure 5: PM_{10} Concentration in Leeds in 2011.

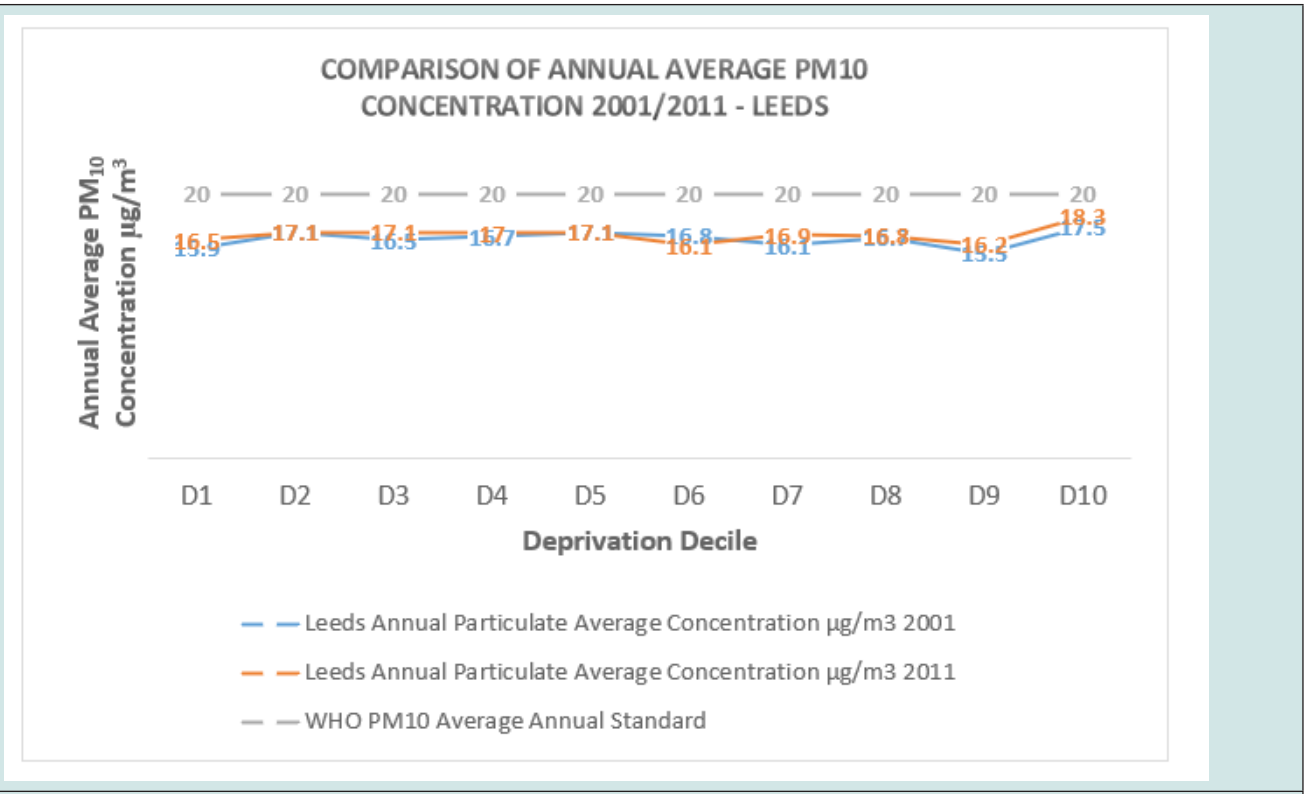

Figure 6: Comparison of PM_{10} Concentration in Leeds.

Air Pollution - NO_2 concentration in London in 2001 and 2011

Greater London is a highly impacted region of environmental inequality and pollution. A very visible increasing trend of NO_2 in D1 with values 31.8 µg/m³ to 42.6 µg/m³ in D10's most deprived area was observed in 2001, as shown in Figure 7. NO_2 concentration in London showed a decreasing trend (28% in D1 to 16% in D10) in 2011 though the distributive impact of environmental inequality is still visible from D1 to D10 (Figure 8).

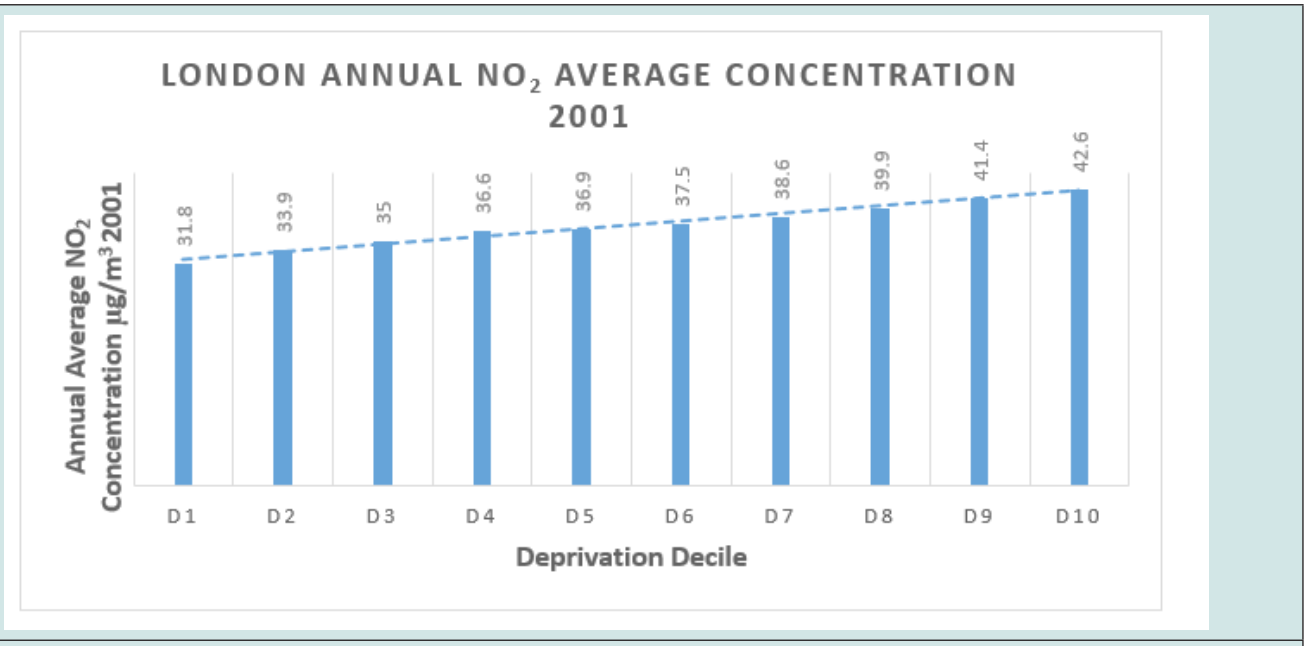

Figure 7: NO_2 Concentration in London in 2001.

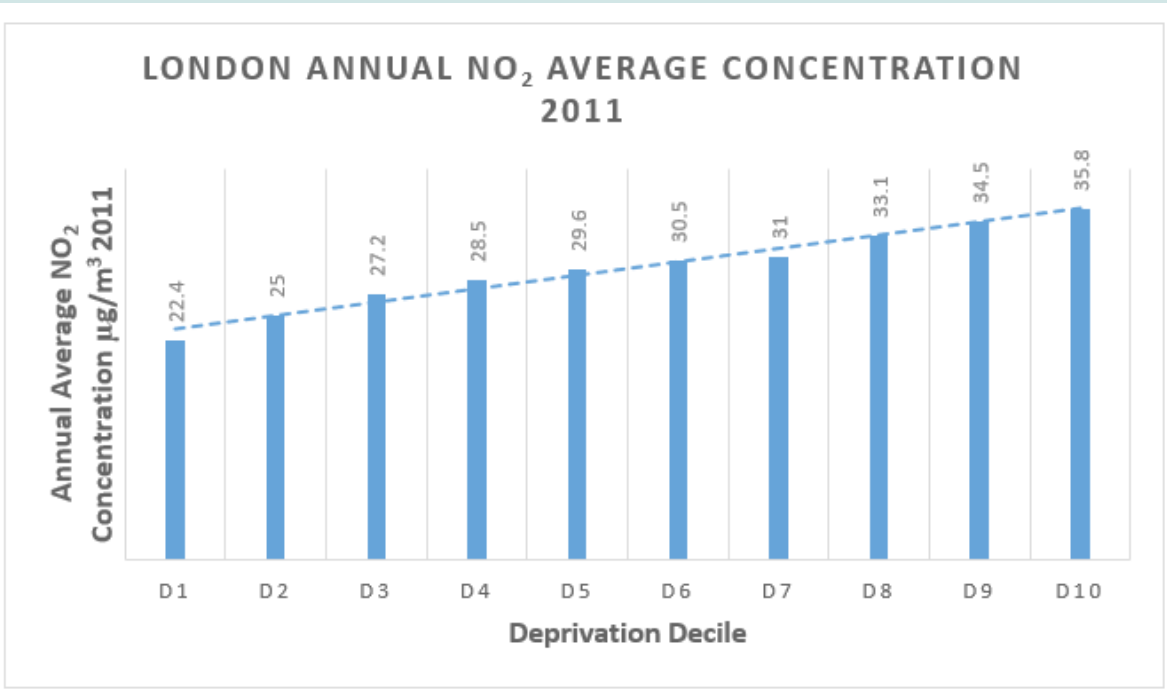

Figure 8: NO_2 Concentration in London in 2011.

Comparison of NO_2 concentration in London with WHO Standards

The average annual concentration of NO_2 in London is below the WHO standard of 40 µg/m^3 [22]. Still, it has exceeded in the areas of D7-D10 deciles in 2001 but decreased in 2011, thus following the target of reduction in the last decade, although the values are still on the higher side, as shown in (Figure 9).

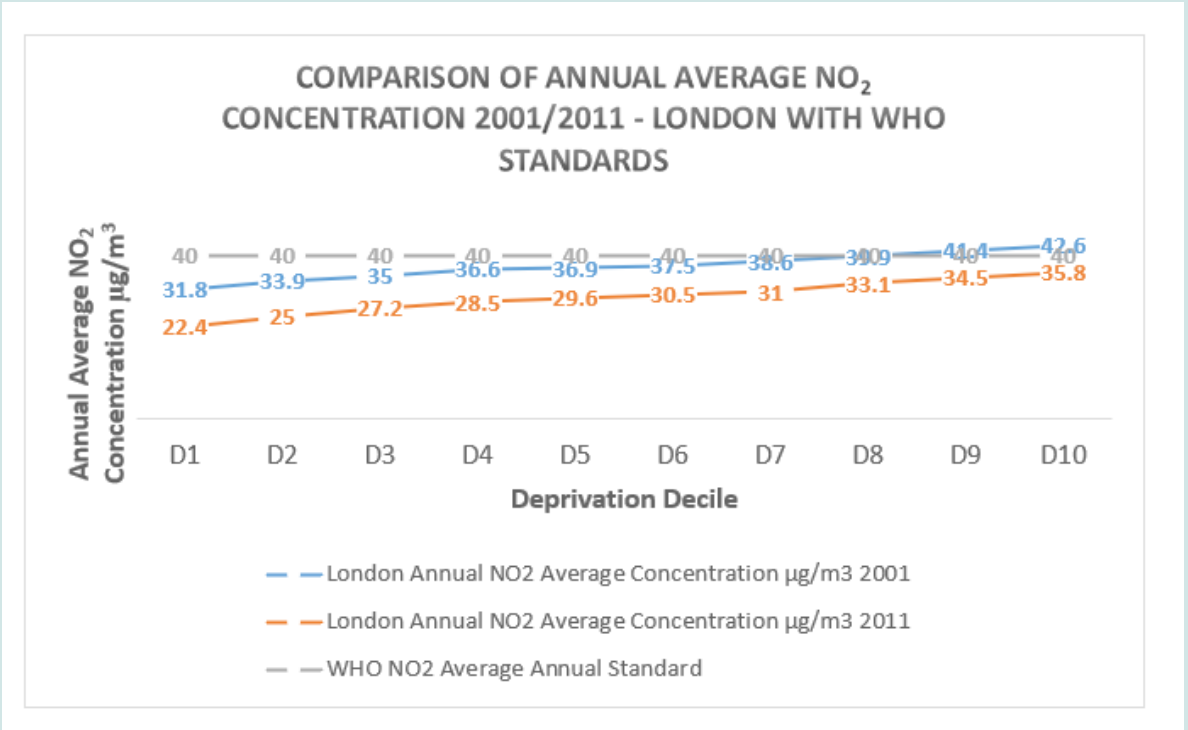

Figure 9: Comparison of NO2 concentration in London with WHO standards.

Distributive Impact of PM_{10} Concentration in London in 2001/ 2011

A visibly bad/ inequal distributive impact has been observed in London for the concentration of PM_{10} from D1 to D10 in 2001 (Figure 10). The concentration increased 2011 by 16 to 22%, demonstrating the environmental inequality trend in 2011 (Figure 11). The PM_{10} concentration exceeded the threshold of WHO standards in 2011, whereby values in all decile groups have crossed the permissible limit adding to the respiratory diseases and mortality rates of the whole population in London, especially the most deprived areas [25-27] (Figure 12).

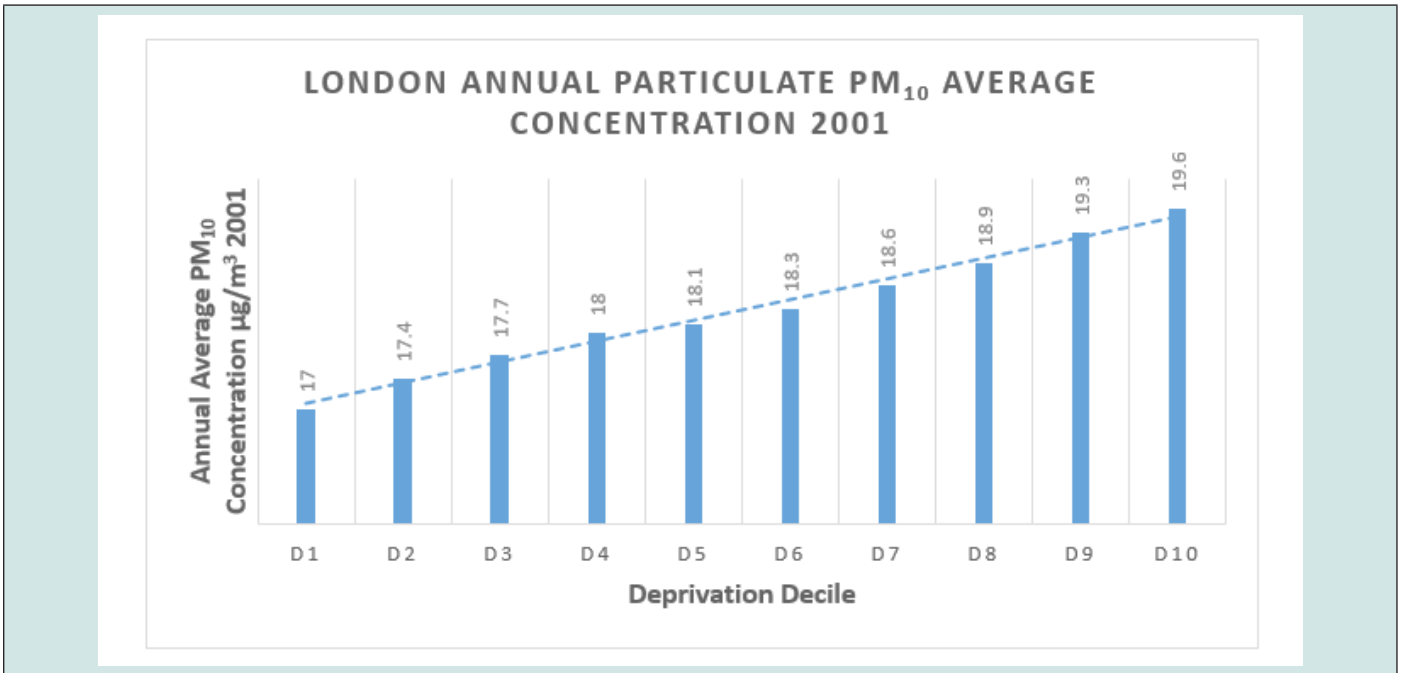

Figure 10: PM_{10} Concentration in London in 2001.

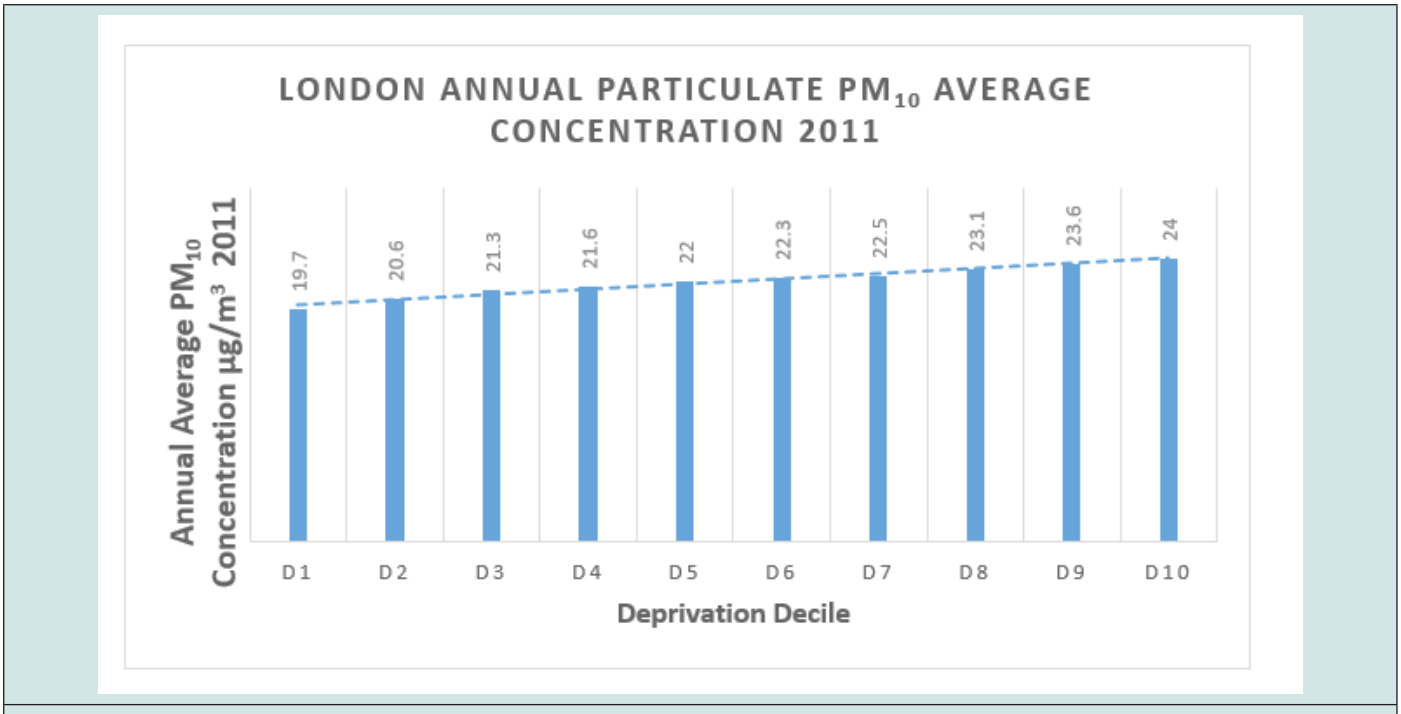

Figure 11: PM10 Concentration in London in 2011.

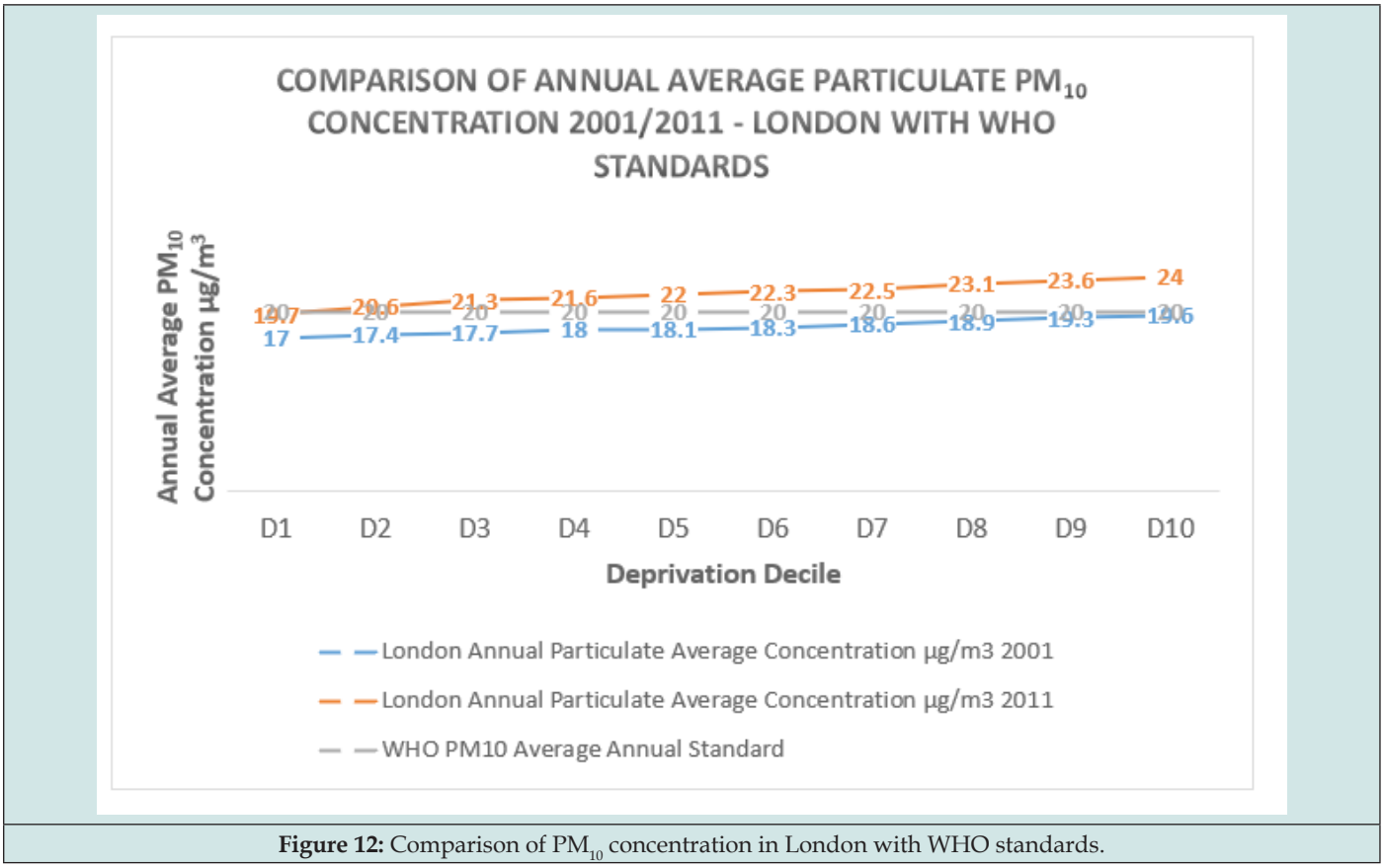

Figure 12: Comparison of PM_{10} concentration in London with WHO standards.

Conclusion

The study results conclude the unfair/unequal distribution of air quality in the most deprived areas in Leeds and London with an increasing trend in unfair distribution from least deprived to most deprived areas. However, London is most affected by this inequality due to more population/ pollution/ lesser green areas. The air population, the world's top killer, has decreased life expectancy by 1.8 years [28]. UK has been ranked 5th most polluted country in the EU with 31000 pre-mature deaths/ year due to the concentration of PM_{10} particulate matter mainly in most deprived/ populated areas [10,27]. Seven million died by smoking, but air pollution caused 8.8 million deaths in 2015 [25]. 2000 UK cities/ sites are dangerously polluted, especially the most populated/ deprived areas, with London at the top [11]. The study supports all these conclusions as NO_2 and PM_{10} particulate matter are causing fatalities in deprived communities more than any other killing agent. NO_2 concentration has decreased but persisted on the higher side, and PM_{10} concentration in the UK has increased in the last decade, causing environmental inequality in the most deprived areas. To cope with this inequality, different coercive options like increased use of public transport, more road tax on vehicles producing more pollution, congestion tax in populated areas to reduce the number of vehicles, creation of transport-free zones in city centres/ most deprived areas, increased emission tax on vehicles having less than Euro 6 standards, encouraging manufacturing/ purchasing emission-free electric cars, dispersed cities development to the suburbs, construction of ring roads to avoid traffic congestion in the cities can be a few solutions to control this menace of air pollution and environmental injustices.

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