

ANALYSING AIR POLLUTION AND ITS MANAGEMENT THROUGH THE LENS OF THE UN SUSTAINABLE DEVELOPMENT GOALS: A REVIEW AND ASSESSMENT

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ABSTRACT

This paper provides a high-level assessment of the causes and impacts of air pollution and its management through the lens of the United Nations Sustainable Development Goals (SDGs). Through a literature review and expert assessment process the impact of air pollution as a barrier to achieving the SDGs is considered. The enabling contribution of air quality management is also assessed. The assessment considers the individual goal level as well as providing a synoptic overview of the 17 interconnected goals. The issues of air quality, air pollution and its management are not clearly identified in any of the 17 headline goals but to varying degrees are directly or indirectly present in some of the underpinning targets or indicators within the SDG framework. Air pollution is identified in this assessment as a direct barrier for each of the individual goals whilst air quality management is assessed as an enabler for 8 goals and provides co-benefits for the other 9. The importance of addressing air pollution as a negative constraint on sustainable progress is of fundamental importance, but the positive enabling contributions of clean air to the meeting of SDGs must also be recognised.

Keywords: air pollution, air quality management, sustainable development goals.

1 INTRODUCTION

This paper provides a high-level assessment of the causes and impacts of air pollution and its management through the lens of human needs, as collated under the United Nations Sustainable Development Goals (SDGs) [1]. The 17 SDGs and their 169 associated subsidiary targets were adopted by the UN General Assembly in September 2015 as the 2030 Agenda for Sustainable Development. The SDGs came into force on 1st January 2016, and collectively provide a universally applicable framework against which nation states, regions, cities and enterprises can assess and plan their contribution to developing a sustainable future for humanity. The goals are deliberately universal, transformational and inclusive, and also highly interconnected. Cumulatively, they describe the major developmental challenges facing humanity, serving as a route map to address an interconnected set of outcomes related to different dimensions of human needs. The SDGs refocus attention on a linked set of human needs aimed at, as UNDP [2] puts it, “Meeting citizens’ aspirations for peace, prosperity, and well-being, and to preserve our planet”. A major contribution of the UN SDGs is the framing of environmental management as a contribution to sustainable development and elevation of vision from satisfying minimal and constraining regulatory performance criteria towards meeting a diversity of human needs with appropriate “satisfiers” on a sustainable, or increasingly sustainable, basis [3]. This is consistent with the needs-based vision of sustainable development as initially outlined by the Brundtland Commission [4].

The SDGs are a United Nations initiative, representing the conclusion of a process involving all 193 Member States and global civil society. The SDGs thereby reflect an intergovernmental agreement to promote a sustainable development pathway to 2030 in succession to the UN Millennium Development Goals (MDGs). The SDGs cover a range of environmental, economic and social issues including poverty, hunger, health, education, gender equality, clean water, clean energy, work & economic growth, industry and



innovation, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate, life under water, life on land, peace, justice and strong institutions, and partnerships. They span issues of humanitarian, environmental and governance needs. Whilst the SDGs can be critiqued as being “motherhood and apple pie” or “all things to all people”, they are the output of a consensus brokered through the agency of the United Nations and represent a development pathway to a sustainable future. Everard and Longhurst [3] argue that the SDGs should be considered as an intimately interdependent suite and understood in a systemic context, addressing all goals as an interconnected set, with narrow focus on maximisation of one goal in isolation risking undermining other interdependent facets (as for example maximising water services water service to society in ways that degrade aquatic and terrestrial ecosystems including their capacities to produce food and disease-regulating services).

This paper considers the impact of air pollution as a barrier to achieving the SDGs and assesses the contribution that management of air quality can make to enable progress towards meeting the goals. Consideration is given within the analysis to the individual goal level as well as to selected subsidiary targets, referring to the need to consider the 17 goals synoptically. This paper starts from the position that air pollution is incompatible with sustainable development, and that its management is an integral part of a sustainable development pathway which should be explicit within the SDG framework. However, the issues of air quality, air pollution and its management are not clearly identified in the 17 goals that comprise the SDG framework, though air pollution features in three specific targets for: health (SDG 3); cities (SDG 11); and sustainable consumption and production (SDG 12). In each case air pollution, is merely one of the targets associated with each goal. As well as providing an end-point for sustainable development, the goals provide a framework through which thematic issues can be considered in terms of the barriers they create to inhibit achievement of the goals or alternatively to consider the opportunities for securing the goals in the quickest possible time. Lode et al. [5] view the SDGs as an opportunity to tackle air pollution at a global scale, stressing the importance of air pollution as a human health hazard.

Given the implications of poor air quality on human health and a range of other goals, Everard et al. [6] recognize air as a common good and, it could therefore also be argued, clean air constitutes a universal human right.



Figure 1: The UN sustainable development goals [1].

There is increasing urgency for air pollution to be better managed on a universal basis, from low, middle, and high-income countries all of which suffer differentially from poor air quality. According to the WHO Global Urban Ambient Air Pollution Database [7] more than 80% of people living in urban areas that monitor air pollution are exposed to air quality levels that exceed the WHO guidelines. As urban air pollution increases, the risk of stroke, heart disease, lung cancer, and chronic and acute respiratory diseases, including asthma, increases for the people who live in them [7]. WHO describe air pollution as the world's single biggest environmental health threat and ambient air pollution is estimated to cause 4.2 million premature deaths per year [8].

2 LITERATURE REVIEW STRATEGY AND INITIAL FINDINGS

An online search was conducted in early 2018 using the University of the West of England's library search facility which is connected to 130 specialist and general databases comprising full-text journals, books and reports databases that are discoverable at article and title level. Using the combined search term "air pollution and the SDGs" returned 959 journal articles, 62 books and e-books and 19 book chapters. The top contributing disciplines were environmental sciences (294 returns), economics (212), engineering (173) and public health (163 items). The abstracts of first 250 references were reviewed for a specific match to the key term. Only a handful of papers were returned that actually considered the combined term "air pollution and the SDGs" and not all of these were found to be in the peer reviewed literature. From this it can be concluded that the analytical framework provided by the SDGs has been used very sparingly to explore either the impact of air pollution or the contribution of air quality management towards goal attainment, though it is also recognised that lead time to publication may mean that ongoing studies linking these concepts are yet to feature in the peer-reviewed literature. A similar search was conducted in Google Scholar and ResearchGate. Google Scholar returned over 6,000 potentially useful results though, on further examination, the overwhelming majority were not specific to the combined search term. Most of the Google Scholar references had been identified through the UWE library search and the majority of assumed useful references were identified as considering only one or a small subset of the SDGs. ResearchGate returned 29 references for the combined search term of which only a handful were directly relevant and all of which had been identified by the UWE Library search and by Google Scholar. As a final element of the literature search strategy, the titles of papers presented at the annual Air Pollution conference in 2014, 2015, 2016 and 2017 [9]–[12] and the Sustainable Development and Planning 2017 conference [13] were screened to identify any references to "air pollution and the Sustainable Development Goals". No specific references using the combination of "air pollution and the Sustainable Development Goals", in short form or full, were identified in these texts.

Elder and Zusman [14] discuss the linkages between air pollution and SDGs in a Policy Brief for the Institute for Global Environmental Strategies. They identify a link between 10 of the SDGs and air pollution including implicit links at the target level in 14 of the 169 targets. They also note that air pollution can be indirectly related to other targets specified under various goals and targets but, in some obvious cases, there is no mention at the target level let alone the goal [14].

Farmer [15] considered the relationship of air pollution with SDGs covering poverty, hunger and gender equality and noted the importance of considering the goals as an integrated whole within policy development processes in institutions of government. Farmer concludes that government, including both central and local government bodies and their agencies, must become aware of wider opportunities in addressing SDGs that fall within their jurisdiction



for either contributing to or impeding delivery of other SDGs [15]; this linkage is particularly important for interactions between pollution and poverty.

The 2017 report on Air Quality in Europe published by the European Environment Agency [16] considered the relationship between the SDGs and air pollution as part of a chapter outlining the broad governance, policy and regulation of air quality at European scale. The report, citing UNICEF [17] noted that EU policies targeting air pollution and the reduction of its impacts contribute directly or indirectly to the achievement of 12 of the 17 goals, specifically SDGs 1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 14 and 15.

Examining the global disease burden caused by air pollution, the World Health Organization makes reference to SDG 3, 7 and 11 [18]. WHO describes air pollution as a clear marker for sustainable development and notes that policies to address air pollution generate a number of co-benefits for human health. This happens not only through air quality improvements but also other health benefits, such as injury prevention or enabling physical activity. In the framework of indicators that has been developed to monitor progress in meeting the 17 SDGs and 169 SDG-related targets, WHO has responsibility for three air pollution-related indicators [19]:

- SDG 3 Indicator 3.9.1: Mortality rate attributed to household and ambient air pollution;
- SDG 11 Indicator 11.6.2: Annual mean levels of fine particulate matter (PM_{2.5}) in cities (population-weighted); and
- SDG 7 Indicator 7.1.2: Proportion of population with primary reliance on clean fuels and technologies. for the sustainable energy goal.

Everard and Longhurst [3] provide a case study of the UK local air quality management (LAQM) process in order to explore the current operationalisation of the SDG framework. The case study explores opportunities and challenges in embedding the core principles of sustainable developing into operational practice. They identify a direct impact on SDG 3, 11 and 17 and indirect benefits for SDGs 6, 7, 8, 9, 10, 12, 13, 14 and 15. LAQM is described as supporting SDG 16. In total LAQM makes a direct contribution to 3 of the SDGs, an indirect contribution to 9 SDGs, plays a supporting role for 1 SDG and makes no contribution to 4 of the SDGs.

3 ASSESSMENT METHOD

For each of the 17 goals, an assessment of the current impact of air pollution has been identified from the literature and via expert opinion. This impact analysis is accompanied by an assessment of the contribution that the management of air pollution can make to meeting the 2030 deadline of the goal. Direct and indirect impacts at the goal level have been identified. Current and enhanced air pollution management interventions have been considered for each goal. Recognising the inherent interlinkage of the suite of SDGs the analysis it is important to note that there will be system impacts resulting from interventions at the individual goal level. The method adopted to complete this analysis is a quasi-Delphi process. A small expert group comprising those with air pollution and/or SDG knowledge was established. Through an iterative process over 4 rounds of information exchange, challenge, refutation, disagreement and agreement, a consensus on the likely air pollution impact and the opportunity for air quality management was established. This is recorded as the output of the method in the results and discussion section.



Table 1: Allocation of SDGs to primary categories.

Primary Focus	SDGs
Economic	8, 9, 10, 12
Social	1, 2, 3, 4, 5, 7, 11, 16
Environmental	6, 13, 14, 15
Cross-cutting	17

4 RESULTS AND DISCUSSION

For ease of reporting, the SDGs have been divided into three categories, those that have their primary focus on economic matters, those with a social focus and those with an environmental focus. This follows the approach of the Stockholm Resilience Centre, which presented a novel method for the examination of food through the lens of the SDGs [20]. SDG 17, Partnerships for the Goals, is overarching across all goals and is considered separately.

4.1 Economic subset of SDGs

SDG 8, Decent work and Economic Growth. Air pollution costs in high, low and middle-income countries are significant. These include direct health care impacts, productivity losses through ill health, crop losses, climate impacts and effects on the built environment. Air pollution contributes to absences from work due to ill-health and has a negative impact on economic growth through its effect on productivity. However, investment in new technologies with improved emissions performance can provides new work and sustainable growth opportunities. Particular opportunities exist with public transport, renewables and in energy conservation measures. Reducing the number of sick days attributable to air pollution will result in increased productivity. Two of the targets associated with SDG 8 are concerned with improved resource efficiency and the decoupling of economic growth from environmental degradation. Actions to address air quality management will bring co-benefits for these targets and the overall goal, which in turn will help mitigate local and transboundary air pollution.

SDG 9, Industry, Innovation and Infrastructure. Industrial emissions, power generation and transport are major contributors to air pollution. Polluted environments accelerate the corrosion of stone and metal work leading to increased repair costs. Actual or perceived pollution may inhibit industrial, commercial or service location choices. Emissions reductions programmes provide opportunities for costs savings in stone and metal work renovation, new technology substitution creates opportunities for new infrastructure developments with enhanced sustainability performance. Targets linked to SDG 9 are concerned with increased resource use efficiency and greater adoption of clean and environmentally sound technologies. Actions to address air quality management will bring co-benefits for this goal, which in turn will help mitigate local and transboundary air pollution.

SDG 10, Reduced Inequalities. The distribution of air pollution sources and the impacts of emissions are unequal. The elderly, the poor, the young and the already ill are most at risk, as are those downstream of major emission sources. Measurement of air pollution risk is unequal across the world with developed nations more able to carry the cost of monitoring and managing pollutant risk. Efforts to reduce emissions and concentrations will have beneficial effects on the exposure risk of those most sensitive in society. In turn this may



reduce gross inequalities in health outcomes. Managing pollutant concentrations potentially creates a more attractive environment for inward investment or endogenous growth opportunities. Reductions in air pollution will enable health care cost savings, enhance economic productivity through reducing the number of working days lost due to ill health. Each of these will contribute to reducing inequalities. Expert opinion indicates that those in poverty whether in high, middle or low-income countries, are likely to be responsible for the least emissions and may suffer disproportionately from the emissions of the well-off [21]. Action to reduce emissions and exposure to elevated pollutant concentrations reduce environmental injustice and inequalities. Actions to address air quality management will bring co-benefits for this goal which in turn will help mitigate local and transboundary air pollution.

SDG 12, Responsible Consumption and Production. Consumption driven economies demand industrial production, service provision and logistic systems in turn creating emissions that contribute to air pollution problems. Irresponsible consumption and production leads to “outsourcing” of poor air quality to other regions and countries. Construction and demolition are major source especially in rapidly developing cities/emerging megacities. Subsidies for fossil fuel use perpetuate oil based economic systems and resultant air pollution impacts. Responsible consumption in households and enterprises can reduce demand for products and services and in turn, reduce associated emissions. Actions to address air quality management will bring co-benefits for this goal, which in turn will help mitigate local and transboundary air pollution.

4.2 Social subset of SDGs

SDG 1, No Poverty. The aim of this SDG is to end poverty in all of its forms everywhere in low, middle and high-income countries. Poor people tend to suffer more from air pollution whilst their emissions tend to be smaller than their wealthier fellow citizens [21]. Polluted environments potentially are less attractive for economic investment thus reducing the opportunity for new enterprises to be established and employment opportunities to be created that can lift families out of poverty. Low-income families potentially are most at risk from air pollutant exposure and are least able to change their circumstances to avoid exposure. Those in poverty may also be more at risk from the health impacts in terms of symptom severity, duration and access to medicine as well as at greater risk of exposure. Efforts to reduce emission and limit exposure to adverse concentrations reduces the risk to crops thus enhancing food security. Food security is a critical step in enabling poverty eradication. Managing pollutant concentrations potentially creates a more attractive environment for inward investment or endogenous growth opportunities. Reductions in air pollution will enable health care cost savings, enhance economic productivity through reducing the number of working days lost due to ill health. Actions to address air quality management will bring co-benefits for this goal.

SDG 2, Zero Hunger. Air pollution has direct effects upon food resources reducing crop yields and increasing the risk of food insecurity. Nitrogen compounds, ozone and sulphur species are of particular concern. Poorly nourished, ill or low-income families are likely to be most at risk from air pollution impacts. Eutrophication of lakes and rivers, partly due to nitrogen species deposition, may lead to reduced availability of fish as food stuff. Farming practices that encourage the burning of crop residues can impact the crops growing in surrounding fields as well as increasing exposure to those working in the fields. Efforts to reduce emission and limit exposure to adverse concentrations reduces the risk to crops thus



enhancing food security. Actions to address air quality management will bring direct benefits for this goal which in turn will help mitigate local and transboundary air pollution.

SDG 3, Good Health and Well-being. Air pollution is a major risk to human health with impacts on the respiratory system, cardiovascular effects and increasing evidence of a life time health impact. The elderly, the already ill and the very young are most at risk from exposure to traditional air pollutants. Emerging evidence suggests that air pollutants may play a role in neurological (dementia and reduced cognitive ability) and epigenetic diseases. Pregnant women may be more at risk and their exposure may also impact the foetus with impacts on birth rates, birth weights and infant mortality. Air pollution can reduce the attractiveness of physical activity. Efforts to reduce emission and limit exposure to adverse concentrations reduces the risk to health. Targeted interventions will allow national and international inequalities in exposure to be addressed. In summary emission reduction efforts will lead to improved health and reduced expenditure on pollution related health care costs. Actions to address air quality management will bring direct benefits for this goal.

SDG 4, Quality Education. Air pollutants can affect the neurological and cognitive development of the young. Indirect air pollution effects on education include issues of food insecurity and poverty status, both affected by air pollution, and collectively may reduce the benefit of educational opportunities. In highly polluted environments smog events may lead to short term school closures. Efforts to reduce emission and limit exposure to adverse concentrations reduces the longer term and short-term risks to people, especially the young, benefiting from quality educational opportunities. Improving air quality will result in fewer days of education missed due to pollution related illness or school closures. Actions to address air quality management will bring co-benefits for this goal.

SDG 5, Gender Equality. This SDG seeks to achieve gender equality and to empower all women and girls. In low and middle-income countries woman are more at risk from exposure to indoor air pollution associated with cooking practices. The WHO estimates that some 3 billion people cook using polluting open fires or simple stoves fuelled by kerosene, biomass (wood, animal dung and crop waste) or coal [22]. Around 3.8 million people a year die prematurely from illness attributable to the household air pollution caused by the inefficient use of fuels for cooking [22]. Efforts to improve the emission performance of cooking practices in low and middle-income countries will improve indoor air quality and improve health and wellbeing particularly for women. Actions to address air quality management will bring co-benefits for this goal.

SDG 7, Renewable Energy. Air pollution has a direct association with this goal. Wood and coal traditionally are cheaper sources of energy, but both are associated with high levels of emissions of air pollutants. Waste burning is common for heat and cooking in developing countries and is, for example, a major and unregulated emission source in Delhi and other mega cities. The effectiveness of renewable energy systems can be reduced by air pollution, for example smog, dust or haze will reduce the effectiveness of PV installations. Renewables sources of energy are quickly establishing themselves as a cost-effective alternative to fossil fuel combustion. This brings significant public health benefits from reduced risk of short or long-term exposure to adverse pollutant concentrations. Targets for access to energy, energy efficiency and renewable energy are indirectly linked to air pollution and provide opportunities to reduce emissions through energy substitution and efficiency measures. However, measures to improve access to energy supply will need to be implemented sustainably if the benefits of these actions are to be felt in reduced emissions of air pollutants. Actions to address air quality management will bring co-benefits for this goal.

SDG 11, Sustainable Cities and Communities. Air pollution impacts negatively affect the external perception of cities especially mega cities. Death rates and ill health rates are



affected by citizen exposure to pollutant mix and concentrations. Adverse air pollution concentrations reduce the use of outdoor space and restricts demand, development and use of active travel infrastructure, necessary for the development of sustainable cities and communities. Efforts to improve the liveability of cities allied to emission reduction programmes will reduce the risk of exposure to adverse concentrations and improve the fraction of population morbidity and mortality resulting from air pollution. Emission reduction programmes can enhance the demand for and stimulate the development of active travel infrastructure. Health co benefits such as increased physical activity and reduced sedentary behaviour can be associated with a decrease in emissions through a reduction in vehicle use. Actions to address this goal will help mitigate local and transboundary air pollution. Actions to address air quality management will bring co-benefits for this goal.

SDG 16, Peace, Justice and Strong Institutions. Air pollution's contribution to climate instability will result in reduced access to key resources such as food or fresh water and may lead to resource conflict at the local (i.e. access to grazing) or international scale (i.e. the increased risk of water wars). In turn this instability may lead to increased numbers of environmental refugees. The UK newspaper *The Guardian* and other media outlets reported in 2016 that thousands of Chinese citizens were heading to pollution-free regions of the country as a pollution haze descended on the country's northern industrial heartland [23]. These individuals can be described as air pollution refugees. In some ways this mirrors the way in which the demographic distribution in West European and North American cities evolved with the richest living in the areas of least pollution, benefiting from the prevailing wind direction, and the poorest living in the most polluted which included the contribution brought from the richest areas of the city by the prevailing wind. The classical example is the rich West End of London and the poor East End. Policies to address emission reductions from fossil fuel combustion will help reduce the risk of conflicts over scarce resources. Improving resource efficiency and minimising emissions through a concerted programme of consumption management also will reduce emissions. Actions to address this goal will help mitigate local and transboundary air pollution. In particular air quality management initiatives requires strong state environmental institutions and countervailing civil society engagement to ensure the environmental justice is a goal of policy and that effective regulatory systems are designed, implemented and enforced to improve air quality. These actions are necessary in high, middle and low-income countries. Actions to address air quality management will bring co-benefits for this goal and will address environmental injustices.

4.3 Environmental subset of SDGs

SDG 6, Clean Water and Sanitation. Air pollution has direct impacts on this goal. Water courses are affected by dry and wet deposition of acidifying sulphur and nitrogen compounds. Action to address sanitation can lead to local bioaerosol and odour emissions from sewerage waste water treatment works and indirect emissions from energy to run purification and sewerage works. Efforts to reduce emissions will have beneficial impacts on water quality. Direct and indirect pathways of airborne emissions to water will benefit from emission reduction programmes. Improved sanitation systems will address odour problems. Actions to address this goal will help mitigate local and transboundary air pollution impacts. Actions to address air quality management will bring direct benefits for this goal.

SDG 13, Climate Action. Air pollution has direct impacts on this goal. Fossil fuel combustion in industry, commerce, transport, agriculture and the home, is a major contributor to climate change with impacts on health, security of food supplies, access to fresh water and impacts upon the marine environment. Emissions mitigation will reduce the impact on natural



and human systems. A changing climate may lead to changes in energy demand, for example in air conditioning, and lead to changes in annual pattern of emissions. A changing climate may also lead to change in the relative abundance and location of secondary pollutants such as ozone or volatile organics. Dispersion patterns for pollutants may also be affected by a changing climate. Actions to address this goal will help mitigate local and transboundary air pollution impacts. Actions to address air quality management will bring direct benefits for this goal.

SDG 14, Life Below Water. Air pollution has direct impacts on this goal. Marine and freshwater life is at risk from acidification and eutrophication associated with releases from fuel combustion, diffuse pollution from road run off and agricultural emissions. Accumulation of metals and persistent organic compounds in fresh and marine environments will create risks for the food chain. Emissions reductions will reduce the impacts on water bodies and improve resource utility for recreation, food and drinking. Actions to address air quality management will bring direct benefits for this goal.

SDG 15, Life on Land. Air pollution has direct impacts on this goal. There is a direct impact on vegetation from ambient concentrations and from dry and wet deposition pathways as a result of fuel combustion and other sources of emissions. These effects include stomatal blocking via particle deposition reducing photosynthesis rate, impact on vegetation, including crops, productivity from elevated ozone concentrations. Vegetation can be an effective barrier to particle movement in the air and certain gases will be absorbed by vegetation. Certain types of vegetation can be a source of organic compounds contributing to regional haze (for example the Blue Ridge Mountains of Virginia). Action to address this goal will help mitigate local and transboundary air pollution impacts whilst actions to address air quality management will bring direct benefits for this goal.

4.4 Partnerships for the goals

SDG 17. There are various examples of ineffective or slow institutional responses to identified risk at both the national and international scale. A lack of partnership working to address air pollution and climate action at local, national and international level leads to policy gaps and lack of engagement. Global (e.g. UN), regional (e.g. EU), national and local partnerships raise awareness of issues, identify priority actions and implement change management processes to regulate emissions and concentrations and promote behaviour change initiatives. City level partnerships on emission reduction efforts raise awareness of the current impacts of fossil fuel combustion from transport, industry, commerce and domestic sources as well as global climate change. There is a risk that in addressing the suite of SDGs growth, e.g. SDG 8, will be defined in narrow economic terms and will fail to be sustainable. In such a case the benefits of partnership working for managing air pollution will not have been realised. Partnership actions to address this goal can help mitigate local and transboundary air pollution whilst actions to address air quality management will bring direct benefits for this goal in demonstrating partnership working in practice.

In summary, when viewed through the lens of the SDGs air pollution can be identified as directly affecting each one of the goals and can act as a barrier to attaining an individual SDG or the suite of SDGs. However, action to manage air quality can bring direct or co-benefits for achievement of an individual SDG or the set of goals. Table 2 provides an impact analysis in which air pollution is identified as a direct impact and thus a barrier to achieving the suite of SDGs. Conversely air quality management action provides direct or co-benefits in attainment of the goals and can be considered an enabler of goal attainment.



Table 2: Impact analysis outcomes.

Sustainable development goal	Impact of air pollution as a Barrier to SDG attainment	Direct or co-benefit for SDG attainment though improved air quality management
1 No poverty	Direct	Co-benefit
2 Zero hunger	Direct	Co-benefit
3 Good health and wellbeing	Direct	Direct
4 Quality education	Direct	Direct
5 Gender equality	Direct	Direct
6 Clean water and sanitation	Direct	Direct
7 Renewable and clean energy	Direct	Co-benefit
8 Decent work and economic growth	Direct	Co-benefit
9 Industry, innovation and infrastructure	Direct	Co-benefit
10 Reduced inequalities	Direct	Co-benefit
11 Sustainable cities and consumption	Direct	Co-benefit
12 Responsible consumption and production	Direct	Co-benefit
13 Climate action	Direct	Direct
14 Life under water	Direct	Direct
15 Life on land	Direct	Direct
16 Peace, justice and strong institutions	Direct	Co-benefit
17 Partnerships for the goals	Direct	Direct

5 CONCLUSIONS

In conclusion, the foregoing synoptic analysis has considered the overall impact of air pollution as a barrier to achieving the goals and the role of better air quality management as an enabler for transformational change. One may argue, like Lode et al. [5], that the 2030 Agenda merely “constitutes a non-binding, soft law framework with no proper enforcement and compliance mechanism”. Whilst this may be true, the SDGs remain the only globally consensual pathway to a more sustainable future. It is unfortunate that there is no individual SDG that directly addresses air pollution and its management. However, given that the above analysis has identified air pollution to be an issue cross cutting through each of the SDGs this may not be as significant an issue of concern as first thought. In fact, it may provide an opportunity to address the issue synoptically. In order to take advantage of this opportunity further research is necessary to better understand how policies to address the goals collectively as well as at the individual goals can be devised and implemented so as to ensure that air quality improvements are embedded in individual goal and target action plans. Commitments to meeting the global SDGs must not be at the expense of air pollution. The SDGs are particularly significant in reasserting the vision of sustainable development as one of meeting intergenerational human needs, consistent with the framing by the WCED [4] though subsequently somewhat “lost in translation” through regulatory transposition in intervening decades [3]. The importance of addressing air pollution as a negative constraint



on sustainable progress is of fundamental importance, but the positive enabling contributions of clean air to the meeting of SDGs needs also to be recognised.

ACKNOWLEDGEMENT

This work has been funded by the University of the West of England as part of its contribution to the global effort to achieve the Sustainable Development Goals by 2030.

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