Pollution
The Commonwealth Human Ecology Council (CHEC)

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CONTENTS

Pollution

1. Introduction  Eva Ekehorn, Ian Douglas  page 4

2. The nexus between indoor air pollution, electricity generation, waste management, and water supply in Nigeria  David Omole  6

3. Pollution in Sri Lanka  Dulmani Atapattu  10

4. Undesirable environment in India  Bharat Singh  14

5. Litter, fly tipping and illegal dumping  Nigel Lawson  16

6. Noise pollution  Eva Ekehorn  21

7. Light pollution  Saman Waheed  24

8. Air pollution and the Commonwealth  David M Gomez  27

9. Urban air pollution-a Dhaka Perspective  Tariq Bin Yousuf  30

10. COVID-19 and urban air pollution  Ian Douglas  33

11. Preventing pollution impacts on public health and pandemic prevalence in urban populations: Urban Design 4 Pandemics  Donnell Davis  37

12. Indigenous sacred sites: A cautionary tale of destruction of significant cultural heritage sites by a mining corporation  Janine Pierce  42

13. Trees are our past and our future: Lessons from pollution of forests in Australia  Janine Pierce  47

14. Which solution towards managing regional water pollution problems?  Patricia Kabatabazi  51

15. Combatting river pollution: the continuing battle in the River Mersey catchment, England  Ian Douglas  54

16. Pollution and the impact on foreign fishing industry on Sardinella in West Africa  Badara Bajo, CanJarri McKinley  59

17. Projects conducted by the Marine Life Conservation Society to combat pollution in the Marmara Sea  Volkan Narci, Aysenur Semiz  62
1. Introduction Pollution

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The problems

During the COVID pandemic, many of us noticed a fall in the pollution from cars and industry. The sky was much bluer; the birds were heard singing and it was generally quieter. Our awareness of pollution as a problem has increased in recent years, and this was a reminder that things could change. This issue of the Journal will highlight many of the pollution problems around the Commonwealth and beyond, and also effective solutions to make the Earth healthier.

Pollutants damage the quality of air, water and land. All living things creatures —from one-celled microbes to blue whales and human beings — depend on the Earth’s supply of air and water. When these resources are polluted, all forms of life are threatened.

There are many types of pollutions, some natural and some totally man-made. A natural source are volcanoes, which can send clouds of ashes around huge areas, such as the Icelandic Eyjafjallajökull 2010 eruption which clouded most of Europe and made any airborne travel in 20 countries impossible. Another natural source are dust storms. On March 15, 2021, the largest and strongest dust storm in a decade swept across northern China from the Taklimakan Desert in the north-west of the country. In Beijing, sand swirled through the air, turning the skies into a hazy orange. In the city, the air quality index, which in 2020 averaged around 80, rose to the highest point in the scale: 999. The U.S. Environmental Protection Agency sets 301 on the scale as a severe health warning level. Salt plains can create severe storms of salt. Forest fires can destroy huge areas of land and send toxic ash pollution for miles.

These natural sources of pollution have been exacerbated by human activities, such as deforestation, poor maintenance of the soil and deranged ecosystems. Climate change will make these events more forceful and devastating with warmer temperatures and stronger winds. Human activities are seriously polluting the Earth. The contributions to this issue of the journal highlight many of these problems.

Our waste, and poor treatment of the waste, allows pollution from plastic and poisonous sources to enter the air and rivers, and from rivers tom move into the sea and the oceans. Plastic breaks down into small particles, and these can now be found from the Arctic to the Antarctic and from the glaciers in the Himalaya to the bottom of the oceans. Science shows that these particles, entering the food chain from plankton upwards, are hazardous not only to the fish but also to the human beings, entering the lungs and unborn babies (articles 3, 4, 16).

Electronic waste, if not treated carefully, can be harmful both through particles in air and poisonous drops into the water. However, much of the waste is dealt with by open burning and manual separation. The smoke and the metal residuals around the localities where this waste is treated become polluted and the workers and the neighbouring communities suffer ill-health effects (article 1).

The air we breathe is highly polluted in far too many places around the world. In both big cities with sprawling traffic and industry, and in rural areas with large-scale agriculture, the air is poisonous and seriously risks harming health. It is said that 7 million people in UK alone die prematurely because of breathing polluted air from motor vehicles, especially diesel vehicles, and particles from wear and tear of roads by tyres. Indoor pollution can be even worse polluted than the air outside, when cooking is done on coal, charcoal or wood fires, and heating is from kerosene, gas or wood-burning stove (articles 5, 6, 9, 10, 13, 14, 15).

Cities are also prone to light and noise pollution. Street lights may be good for security, but they do not need to light up the sky. Birds can get confused by the light, and loose the connections to other birds; their singing being drowned out by noise (articles 7, 11).

Agriculture can be a great contributor to pollution. Pesticides, fertilisers, and the treatment of the soil can all lead to severe implications for bees and pollinators as well as for humans.

Ways forward

So, after these starkly critical comments, are there any solutions? Yes, there are, and many solutions have reduced or eliminated deadly forms of pollution in the past. In London the burning of coal was stopped in 1955 which helped to get the air much cleaner. In 1962 Rachel Carson’s book Silent Spring was published, highlighting the devastating effect of DDT on birds’ eggs and their health. This led to increased activism to stop these practices and eventually to a ban on DDT in most countries from 1970 and onwards. The alkyl
mercury used to control fungus on seeds in agriculture in the 1930s caused several serious poisoning incidents and deaths of people who had eaten meat from animals that had eaten seeds treated in this way. This mercury treatment was banned in most countries from the 1970s.

The use of plastic has been increasing enormously, and in certain areas of use it have been extremely beneficial, but the waste is still a heavy burden. Restrictions have come in force to stop single-use plastic consumption, and some countries, like Rwanda, have banned it totally. For many years, rich countries have sent the plastic waste to developing countries, but many of them now refuse to deal with it and responsibility has to be taken by the user countries.

Electronic waste is attractive to the disassemblers because of the valuable metals it contains. Globally, nearly 54 million tonnes of e-waste were generated in 2019, but it contained about US$ 60 billion worth of raw materials if they could all be reclaimed. Some African countries, such as Rwanda, are beginning to establish efficient recycling and refurbishment plants.

The Montreal Protocol, signed in 1987 and ratified by 197 countries, banned the use of chlorofluorocarbons (cfc), used in refrigerators among other technology, to stop the depletion of the ozone layer over Antartica. The ozone layer is now recovering. The Kyoto protocol on greenhouse gases was signed in 1997 and again in the Paris agreement in 2015. Countries are now signing up to lower CO₂ emissions, and pressure to do so will increase at the COP 26 meeting in Glasgow, UK, in October 2021. Air pollution and climate change are closely linked as much of the air pollution come from burning of fossil fuel, and pressure on both sides will have affect.

So, there is hope for cooperation for new agreements on a better environment and specific targets such as ‘The Right to Clean Air’ proposal, already signed by several countries. But as many of the articles in this journal show, there are many, many more steps to take.

Combatting pollution requires all of us, in every country, to take action in our daily lives and in persuading politicians and business people to reduce, re-use and recycle materials and consumables.

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Plastic bans in Africa 2020 34 Plastic Bans in Africa

CLEAN AIR - A HUMAN RIGHT
The nexus between indoor air pollution, electricity generation, waste management, and water supply in Nigeria

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Introduction

Due to its regional influence and large population, Nigeria is a strategic country in Africa, the Commonwealth of Nations and the world. With a current population of more than 200 million people, which is expected to double by 2050, and an infrastructural growth that is not proportional to population growth (Omole & Ndambuki, 2014), Nigeria is on the precipice. The population's rapid growth has increased the demand for water and electricity (Omole & Ndambuki, 2014). It has also increased waste generation (Omole et al., 2016; Omole & Isiorho, 2011). Riding on the gap in providing needed public infrastructure, the citizens have had to cater to their infrastructural needs, albeit in unsustainable and environmentally unfriendly ways (Omole et al., 2016). Some of these practices have led to indoor air pollution and the attendant adverse effects on public health and the environment. In their literature review, Porta et al. (2009) summarised the associated health risks of living within two to three kilometres of landfills and incinerators. They reported, with a high level of confidence, the incidences of soft-tissue sarcoma, lung cancer, low birth weight and Non-Hodgkin's lymphoma. They also noted, at moderate level of confidence, the incidences of other health problems such as neural tube defects, abdominal wall defects, and other forms of cancer. Johnke (n.d.) also estimates that 0.7 – 1.2 mg of CO$_2$ is released, besides other gaseous substances such as carbon monoxide, nitrogen oxides, and TOCs, for every milligram of waste incinerated. Therefore, this paper seeks to identify some of the less-discussed unwholesome practices that also trigger air pollution in the ambience of households. It also underscores possible remedies to these problems and investment opportunities that could be explored in solving the issues.

The Infrastructural Gap and the link to Indoor Air Pollution

The provision of infrastructure has a direct impact on the quality and standard of living in every country. It is a significant cause of rural-urban migration (Omole & Ndambuki, 2015). Basic infrastructure includes the provision of potable water, electricity and waste management services. In Nigeria, however, these three basic infrastructures are grossly inadequate.

Power and Water Supply

It has been reported that the peak electricity supply from the national grid is just 5.4 GW (AE2I, 2019). The shortfall is bridged, mostly with the use of power generators in individual homes and businesses. It is estimated that there are 60 million power generators in Nigeria, and the combined power generated from these individual generators is 42 GW (AE2I, 2019). It is also estimated that these generators' purchase and fuelling cost $14 billion annually (Fakoyejo, 2020). These generators are the lifelines for the citizens and their businesses. It is critical to their lifestyles. In effect, most Nigerians are responsible for generating their power supply, mostly through fossil fuel-powered generators. Ordinarily, a generator ought to be kept outdoors at a safe distance from the household and with appropriate ventilation because of the fumes they emit. Emissions from the generators include carbon monoxide, which is colourless, odourless and toxic. However, some users keep these generators too close to their already poorly ventilated habitations (Fig. 1). Some keep these generators indoors during use to prevent them from getting stolen or having to go out of the house-stead late at night to turn them off. It is not uncommon to read about entire families dying indoors while they sleep due to these practices. It is estimated that about 1500 persons die annually from generator gas fumes (AE2I, 2019).

In their article, Omole & Ndambuki (2015) reported that only about 24% of the population is reached by public water supply. The others source for water through other means, including boreholes and groundwater sources. The pumps in these wells are powered using generators in most instances, thus further compounding the air pollution problems around such homes.
Studies in different States of the country show that over 36 metric tons of solid wastes are generated annually, but the waste collection capacity ranges from 50 to 80% (Omole et al., 2016). Because the rate of generation of wastes surpasses the collection rate, the net wastes are disposed of by the citizens using different methods such as burial, open dumps and burning. For those who set fire to their wastes within the neighbourhood, the fumes often go on for days, causing severe discomfort to neighbouring household inhabitants (Fig. 2-3). The impact of these fumes on public health is enormous. It can lead to chronic obstructive respiratory problems, cataract, diabetes, heart diseases, neurological disorders, and gestational problems such as pre-eclampsia (Manisalidis et al., 2020). Children below the age of five are mostly the victims.
Judging by the fact that the Government is overwhelmed by the challenges confronting the nation, it is only rational to consider alternative solutions. In their article, Omole and Ndambuki (2014) strongly proposed the triilogue model, which discussed the dynamics of relationship among society’s stakeholders - the Government, the private investor or non-governmental organisations and the citizenry. It was showed the importance of private sector participators (PSP) in resolving societal problems. It also demonstrated the economic gains that could be tapped while solving these problems that cause environmental pollutions. The Government is cash strapped to provide these solutions; however, private sector investors can come in with their investments while the Government provides regulatory oversight and an enabling environment for the PSP to operate. A successful example of this model can be found in past Lagos State Governments’ attempt to introduce PSP to the solid waste management chain (Jijoho-Ogun, 2011). Lagos has an average waste generation rate of 0.65kg/capita/day (Jijoho-Ogun, 2011). This results in 13,000 metric tonnes of solid wastes per day, going by the current population. The use of PSP in waste management in Lagos was very successful, going by the fact that the streets became cleaner, and there were general satisfaction and good feedback (Agboje et al., 2014). The PSP in waste management majored in waste collection and transport to designated landfills, recycling points, and incineration points, as the case may be. However, this model was not sustained as the succeeding Government (2015 and 2019) decided to replace the numerous PSPs with a single company (Ihua-maduenyi, 2016). Of course, the single operator became overwhelmed, the system failed, and the State reverted to heaps and waste accumulation in the environment (Awodipe et al., 2019). The accumulated waste led to sustained air pollution from large heaps of burning wastes within the metropolis. This example thus underscores the responsibility of the Government in ensuring consistency in policy. Otherwise, investor confidence is eroded, and working solutions are lost.

In the energy sector, solar energy is gaining increasing attention in Nigeria (AE2I, 2019). Although the initial investment in solar energy solutions is high, and it may be beyond the reach of the average Nigerian, the PSP model in waste management could also be adopted as the way out. Private investors could be invited to create modular solutions for communities, housing estates, and industries. These investors will earn a return on their investments by selling energy in units to consumers. This will lead to less air pollution arising from fossil fuels used in electricity generators. It will also eliminate noise in the environment. However, strong regulations from Government are required in the PSP model. This is to control the exploitation tendencies of some investors. However, the Government itself also has the responsibility of maintaining an enabling environment through policy consistency, regardless of changes in administration.

Furthermore, the citizenry must also be carried along in the implementation of any proposed solution. User perception and acceptability must be gauged.
before a solution is implemented. This is because a proposed solution can fail if user acceptability is not gauged before implementation. For instance, in a study conducted to gauge public willingness to pay for public piped water services, only 54% of the sampled population were willing to pay (Omole, Ndambuki, et al., 2016). About 40% believe that it should be free, and it was found that some persons vandalised the water pipes to access illegally tap the water. This led to significant revenue losses for the water service company. Thus, it can be a considerable problem to embark on any solution without working along with the end-users, either by harvesting their input or re-orienting them through advocacy programs.

**Conclusion**

There are substantial environmental, health, and economic gains to be had if the solutions to air pollution problems arising from open waste dump fires and generator fumes are implemented. Due to the limited funds available to the Government, it was suggested that the input of PSP should be encouraged through the provision of consistent policy-making, fair regulations, and public advocacy. These three sectors of society need to play their respective roles to have workable solutions to indoor air pollution problems.

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3. Pollution in Sri Lanka

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**Introduction**

The Democratic Socialist Republic of Sri Lanka is an island off the south-eastern tip of the Indian Subcontinent. This biologically diverse country is recognized as one of the world’s biodiversity hotspots. Sri Lanka’s position, surrounded by the ocean was regarded as a blessing in many realms such as economic importance, geopolitics and the naturally strategic location throughout its history. Now, pollution is occurring on an unprecedented scale across the country causing extensive damage to the atmosphere and the ecosystem itself, threatening the biodiversity for which the country is so important. As a developing nation, Sri Lanka has improved its economy and has undergone rapid industrialization, which led to increased energy consumption.

Environmental degradation is at its peak as rising pollution levels impact the lives of its citizens. In this article, we discuss the various problems of pollution in the country and the measures being implemented by the relevant authorities to reduce their severity.

**Land Pollution**

Single Use-Plastics

Single-use plastic products made from fossil fuel-based plastics create one of the worst environmental risks throughout the world. As they are expected to be thrown away after a single use, these non-biodegradable products create havoc in the environment. The marine environment around the island is the most affected ecosystem due to unmethodical disposal. The popularity of single-use plastics rose immediately after it was introduced in Sri Lanka during the 1990s. However, by the time the negative and extreme impacts of it were brought to light, the country become heavily dependent on cost-effective and convenient single-use plastic goods. No replacements for them have yet been introduced for people to use.

The previous government under the leadership of Honourable President Maithripala Sirisena imposed a ban on the use of polythene below 20 microns in thickness in 2017. The objective and the intent of this ban was genuine. Nevertheless, the actions were deemed futile as there was a lack of coordinated monitoring and the former administration failed to sustain enforcement of the ban due to negligence and inefficiency. The country’s environment has been gradually deteriorating due to consumer single use plastic packaging disposal and burning in the open environment. The present government led by Honourable President Gotabaya Rajapakse announced that a ban on single-use and short-term use plastics will take effect on March 31, 2021. The Central Environmental Authority (CEA) of Sri Lanka aims to make Sri Lanka free of plastic and polythene waste.

**Deforestation**

The issue of large-scale deforestation has become an alarming concern in Sri Lanka. If destruction continues at this rate, the expected percentage in 2030, of thirty two percent forest cover, is, at this rate of reduction most unlikely to be achieved. The Special Task Force (STF) under the supervision of the Deputy Inspector General has initiated special operations to arrest perpetrators who cause destruction to the environment and deforestation. The general public is urged to come forward with information regarding environmental pollution or deforestation and report to the 1997 Special Centre established in order to gather information concerning the country’s national security.
Marine Pollution

A prominent feature of the coastal environment of Sri Lanka is the continental shelf which extends up to forty kilometres offshore. The coastal belt consists of several important and sensitive ecosystems such as coral reefs, sea grass beds, estuaries, lagoons, and beaches where turtles frequently nest. The ocean around Sri Lanka is also a rich habitat for marine mammals. However, it is distressing to witness the damage suffered by the beaches and the coastline around the country, particularly that caused by the improper disposal of plastic waste which is causing the worst pollution affecting any Sri Lankan ecosystem.

Around eighty percent of marine pollution is contributed by plastics and related debris that originates on land. Large garbage patches float on the waves, toxic micro plastics are consumed by fish and work their way up the food chain. The dead zones, created by the chemical pollutants, with low oxygen cause algal blooms have the capability to contaminate ecosystems. Due to marine pollution, at least 700 species in the ocean are severely affected. The impact of marine pollution on seafood is a matter that has not been adequately discussed in Sri Lankan society despite its importance. Micro plastics generated through plastic waste can be ingested by fish, and ultimately end up in the human food chain. As there is a possible risk, a monitoring program should be introduced by the authorities focusing on marine debris in order to examine the possibility of food contamination.

However, the island wide lockdown between March-May 2020 had a significant contribution in reducing plastic waste accumulating in the ocean waters. The Marine Environment Protection Authority (MEPA), the main government body responsible for preventing, controlling and managing marine pollution in Sri Lanka reported that the plastic pollution on the beaches (Fig.2.) has been reduced by forty percent while nitrate and phosphate levels have decreased by thirty percent.

Disposal of Face Masks

There is a risk of another type of waste: the disposable face masks that is seen everywhere during the prevailing pandemic. Countries such as Hong Kong and China has seen increasing number of face masks disposed and washed onto beaches and Sri Lanka faces the same potential risk.

Presently, there is no proper system in place, nor clear guidelines, on how to dispose of the face masks. Collecting and disposing of the masks in an
environmentally friendly manner is not an arduous task. It can be implemented from the household to the public space where collection centres can be set up. A simple waste management mechanism would be sufficient to prevent this potential risk.

**Oil Spills**

The New Diamond oil super tanker, a crude carrier which caught fire on the East Coast of Sri Lanka in September 2020 was an eye-opening incident to the Sri Lankan authorities (Fig.3). Fortunately, thanks to the joint efforts of Sri Lanka and India, a major environmental disaster was avoided. An oil spill would influence the economic activities of coastal communities in which approximately two million Sri Lankans reside and depend directly on fishing for their livelihoods. As more than eighty percent of the country’s tourist hotels are built along the coast the impact of an oil spill would affect even more livelihoods.

The Marine Environment Protection Authority has the authority to implement the Sri Lanka National Oil Spill Contingency Plan in case of a spill. The plan includes provisions to mobilize support from institutions such as the navy, coast guard, and the Sri Lanka Ports Authority. The MEPA must upgrade its oil spill contingency plan to include chemical spills, to be added to the national plan. The direly needed strengthening of its capacity to address major oil spills is long overdue. The Marine Pollution Prevention Act, No. 35 of 2008 needs amending in accordance with the current international maritime conventions. The Act has not been updated since 2008 and the conventions pertaining to marine pollution control must be included. The success in amending the Marine Pollution Prevention Act should be monitored by the relevant governmental agencies implementing the international instruments dealing with marine environmental monitoring ratified by Sri Lanka. Given Sri Lanka’s proximity to India, Maldives and Pakistan regional cooperation is vital to respond to maritime accidents and the risk of spills. A robust framework under the South Asian Association for Regional Cooperation (SAARC) to deal with issues that affect countries in the region.

**Mangroves**

Mangroves are a crucial part in coastal ecology and in sustaining coastal communities and securing their livelihood. They reduce the harmful effects of coastal erosion, storms and flooding and are one of the most cost-effective methods of managing disaster risk along coastlines. A significant contribution of Mangroves is the ability to regulate the climate through carbon capture. Mangroves store most carbon in their root systems and in the surrounding soil concealing it for decades (Fig.4). One of the action groups under the Blue Charter of the Commonwealth is on mangrove ecosystems and livelihoods. Sri Lanka has been the lead advocate of the Mangrove Action Group since 2019. Under the guidance of the mangrove ecosystems and livelihoods action group, over 14,000 hectares were allocated for mangroves and the country made a voluntary commitment to identify all potential suitable areas for mangrove restoration and design a way to replant trees in these areas by 2030.
Sri Lanka is also an active member of the Commonwealth Clean Ocean Alliance, Marine Protected Areas, Ocean Observation and Sustainable Blue Economy, Coral Reef Protection and restoration and Sustainable Coastal Fisheries Action Groups under the Blue Charter of the Commonwealth.

The South Asia Cooperative Environment Programme (SACEP) along with The World Bank and Parley for the Oceans launched “The Plastic Free Rivers and Seas for South Asia” regional project to support South Asia curb marine pollution and increase their efforts on eco-innovation to reinvent plastic use and production. This partnership was aimed at fostering greater collaboration among the SACEP member states to ensure sturdy preventive measures are taken to address incessant plastic pollution issues.

The United Nations Conference on the Human Environment in 1972 resulted in the creation of the United Nations Environment Programme (UNEP). The declaration placed environmental issues at the Centre point of international concerns and marked the start of a global dialogue on the wellbeing of people around the world. Over the course of time, nations placed the importance of environmental conservation at the forefront and included it in their constitutions. The Indian Constitution expanded the jurisdiction to ensure the protection of the environment. The United States of America modelled public interest litigation and moved to include a chapter on the environment in the new Constitution. The environment is not a fundamental right in Sri Lanka, but there is a directive principle to be utilized in judicial review.

**Conclusion**

Different types of pollution, mangrove degeneration, coral reef destruction, soil degradation, overfishing, industrialization, unplanned developments, deforestation, clearance of rainforest and other forms of environmental disaster have led Sri Lanka to an unpredictable future. If the general public learnt a proper lesson from the COVID-19 pandemic, it is that it is possible to plan for a sustainable lifestyle without compromising the quality of life. Various tasks can be accomplished without depending heavily on the resource base. People are capable of learning how to live with less.

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4. The challenges of environmental pollution in India

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Pollution has touched every aspect of our lives, according to WHO, almost 12.6 million people died because of environmental pollution in 2012 (World Health Organisation, 2016). 75% of these deaths were concentrated in the South Asian and Southeast Asian regions. Some forms of pollution, such as atmospheric smogs, water contamination and noise are easily identified. However, small nanoparticles, such as micro-plastics in fish or crustaceans, can enter the human food chain either by inhalation or by ingestion (Waring et al., 2018). Other non-visible pollutants have entered our food chains, e.g., the formalin (a potential carcinogen) that is widely used in India to extend the shelf life of fish, and BT genetically modified cotton seeds added to some edible oils that possibly may lead to skin and epithelial and kidney disruptions. Nanoparticles produced by fuel burning, particularly in diesel vehicles, in the air cause air pollution. Higher exposures to such pollution, especially in crowded towns and cities, significantly increase people’s chances of getting brain cancer and are linked to huge reductions in intelligence, dementia and mental health problems in both adults and children (Maher, 2019). If enough of a potential contaminant enter soil or water, concentrations can become harmful, as happens when excess use of fertilizers in agricultural fields damage nearby water bodies.

The major sources of today’s pollution are agriculture and food production; conventional energy generation; industry, manufacturing and transport; and waste disposal. Together these processes cause a range of detrimental effects on the environment and human lives. Pollution caused by these anthropogenic factors accounts for a larger share than natural sources of pollution such as volcanic eruptions, wildfires, floods, earthquakes and landslides.

Of all forms of pollution, air pollution is globally the most worrying. Around 7 million people across the world die prematurely due to it, around 1.6 million people in India die due to cardiovascular disease, mainly caused by air pollution, WHO says almost 90% of the global population is breathing unhealthy air (WHO, 2021). These alarming facts are undoubtedly the result of a long list of anthropogenic sources. The rise in concentrations of carbon monoxide (CO) in the air has caused carboxylic haemoglobin, which results in hypoxia having serious health issues. Almost 15 million tonnes of airborne carbon dioxide (CO₂) in India originates from thermal power plants. Vehicles in the metro city cause almost 70% of the CO.

Indoor air pollution contributes to sick building syndrome, which, in India, accounts for more than 50% of pollution we face daily. The main causes of indoor pollution are tobacco, smoke, and cooking, almost half a million premature deaths annually are due to it. The main epicentre is in rural India, where households still burning coal to cook food. Due to the patriarchal nature of Indian society, this has led to serious distress amongst rural women in India. We should not forget the acid rain that threatens aquatic life (lowers the pH level) and damages forests, making tress stunted and resulting in low growth.

The capital of India, Delhi will be soon called a non-family, hardship posting for diplomats because of smog. They will have to be paid compensation just to live in Delhi. In the Air Quality Index, the levels of PM₂.₅ and PM₁₀, are observed on a scale of 1 - 999, beyond which the scale does not work. The problem becomes so severe during the month of November due to completely human factors like stubble burning, industrial and vehicle emissions that levels may go above 999. In the first half of the 20th century, London often witnessed smog, followed by New York. Now New Delhi has record smogs. However, these Delhi smogs are not due primarily to smoke from coal burning they consist of yellowish/brownish photochemical smog (due to the reaction of nitrogen dioxide with light, in which ground-level ozone can be formed). The direct damage to respiratory conditions impacts even on the healthy people, not just those already suffering from lung diseases.

Another chronic pollution associated with India is water pollution. Out of the 75% of water available on earth, only 3% of it is freshwater, and out of that 3%, 70% is present in the form of glaciers. Only 30% of the 3% freshwater is available to us for drinking. The problem with water pollution arises because only 66% of India’s total wastewater is treated and everyday 38 million litres of wastewater go untreated into water bodies. Eutrophication, deoxygenation of water affects aquatic life and human life. The radioactive waste caused by radioactive elements and their ineffective disposal leads to isotopes of potassium and radium, which can cause cancer cells in the human body.

Another aspect is pollution by rubbish disposal on land. This may include e-waste, metal waste, solid-liquid waste, pesticides, radioisotopes dumped in landfills. Per capita waste generated in India is about 870gm/day, only 5% of the waste is composted, the remaining 95% is dumped in land fills. According to the
economic affairs department of the Government of India, by 2047, India will require a landfill area equivalent to 1400 km\(^2\) (equivalent to the combined land areas of Delhi, Mumbai, and Bengaluru).

So, is landfill a solution? The story of Ghaziabad, India, tells us the truth. The dumping height has increased to about 65 m in landfill areas, the informal waste-handling (rag-picking) sector is in distress. A lot of health impacts are seen around the area, even causing deaths. So, are these above-mentioned facts and stories concerning social order? Are we, and the Government doing anything to address these issues?

At the government level, the government has taken up the issue as concerning and has acted accordingly. The Environment Protection Act, 1986, is the chief law to regulate and make policies on environmental issues and their prevention. We need long-term measures instead of short-term band-aid solutions to the environmental problems. It is always better to go for a preventive approach rather than a cure for immediate actions on pollution problems.

Steps such as the Graded response action plan for Delhi & NCR (National capital region), set out a guided plan to mitigate the air quality level from severe to better. The encouragement of more and more public transport systems will also help to curb the poor air quality level, at the same time Bharat VI standards hybrid vehicles and the national electric vehicle policy are being promoted by the government. These policies will exchange the existing vehicles that have old standards and low fuel efficiency and high carbon emissions, with more fuel-efficient and natural gas-based vehicles.

The stubble burnings in India during the months of October-November are also major causes of smog. Thus, the government has been helping farmers to stop stubble burning by giving them credit facilities to buy or rent machine harvesters and engaging in a community-level program to make farmers aware of the issue and spread such awareness through farming communities.

The central and state pollution control board has been monitoring the trends in ambient air quality. The National air quality program (NAMP) consists of 683 observing stations covering almost 300 cities and towns in India. The monitoring of pollutants is carried out for 24 hours with a frequency of twice a week, providing almost 104 observations in a year. The states have been made competitive in trying to achieve high levels in the environmental performance index, in which numerically marking is given to a state’s policies regarding the policies and its implementation on pollution prevention policies.

For water, sewage treatment at, both primary and biological levels need to be facilitated. The government through the national river conservation plan, Namami Ganga, smart cities, and AMRUT (Atal Mission for renovation and urban transformation), has been working effectively to develop proper infrastructure for the same. For the problem of landfills, a landfill tax must be levied on the waste dumpers and holistic waste treatment must be swiftly expanded.

The problem does not stop here. We as individuals are not able to differentiate between issues concerning our ecosystems and health. We tend to forget the impacts that coming generations will be facing. We have been irresponsible living beings in using and managing our ecosystem. We just care about the problem when it becomes severe. Is this the way we really going to be sustainable? The international agreements on climate actions and sustainable developments have been barely realized by developed nations.

Political will is one factor but along with it, the citizen’s will is also another factor. We as global citizens have failed ourselves and our surrounding biodiversity. This shows that, despite having the highest level of intelligence amongst the living organisms on Earth, we have been working without using our brains to control and prevent pollution.

Still, a lot can be done, the only ingredient required is our will, which will act as a driver to mitigate these challenges along with a commitment from the government, which will act as the promoter of preventing these issues. As responsible global citizens, it must be our duty to respect the ecosystem. The Environment has blessed us with tons of resources that are needed by humans, but humans overuse or misuse them. We must stop this attitude towards nature and act in the best faith.

References
World health organization (WHO) (2016) An estimated 12.6 million deaths each year are attributable to unhealthy environments (who.int)
WHO (2021) Air pollution (who.int)
5. Litter, fly-tipping and illegal dumping

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The Problem

Litter consists of waste products that have been discarded incorrectly, without consent, at an unsuitable location. In the UK, fly-tipping (“on the fly” “on the move”) is defined as the illegal deposit of any waste on to land that does not have a licence to accept it. More widely disposing of waste away from designated managed facilities is termed “illegal waste dumping”.

Litter is a serious environmental problem which affects the quality of life. An estimated 30 million tons of litter is dropped in England every year. Litter is not just unsightly but is a danger to both humans and to wildlife. Impacts include blocked drains causing floods, an increase in the rat population, harm to animals, land contamination, damage to vehicle tyres, fires and severe injuries or health problems caused by drug related litter which is of particular concern in many inner-city areas where social exclusion is acute.

Litter can exist in the environment for long periods of time before decomposing and can be transported over large distances into and through the world’s oceans. Drug, medical and sanitary waste along with pieces of broken glass and metal shards are a distinct concern given that their capacity to seriously injure people and affect human health.

Litter costs money

Picking up and removing litter in Britain cost about £1 billion per annum. Significantly, these costs fail to take account the enormous contribution made by an army of volunteer litter pickers associated with nature conservation groups throughout the UK. In addition to the costs of dealing with litter the Environment Agency, local authorities and the Highways Agency spend an additional estimated £150–250 million annually to investigate and clean up fly tipping incidents. (Fig. 1).

![Figure 1 Fly tipping in the Mersey Valley, Manchester May 2020](image)

For the 2018/19-year, local authorities in England dealt with over 1 million fly-tipping incidents, an increase of 8% from 2017/18. Nearly two thirds (62%) of fly-tips involved household waste. The most common size category for fly-tipping incidents was equivalent to a ‘small van load’ (33% of total incidents), followed by the equivalent of a ‘car boot or less’ (30%) (Defra, 2019).

Attitudes to, and perceptions of, litter

It is worrying that only 30% of people in Britain consider litter to be a problem and that a survey by Keep Britain Tidy considered that 86% of sites meet an acceptable level of cleanliness, (as reported by The Association of Public Service Excellence collects site cleanliness data for their Street Cleanliness Report from several local authorities who voluntarily provide the data (Association for Public Service Excellence 2019)). However, in the Litter Strategy for England (2017) Marcus Jones MP, the then UK Parliamentary Under Secretary of State (Minister for Local Government), Department for Communities and Local
Government said that a survey recently found that 81 per cent of people are angry and frustrated by the amount of litter lying all over the country (Populus (May 2015): Public Perception on Litter in the UK).

Fig. 2: Recorded Fly-tipping, January 2017 to July 2020 (after Dixon and Tilley, 2020)

Following the first national lockdown in March 2020 there was initially a substantial fall in fly-tipping relative to the expected amount. During June, when lockdown regulations were relaxed, fly-tipping increased rapidly. July saw a return to close to the expected number of incidents (Dixon and Tilley, 2020). At the same time, local councils in England reported more than usual quantities of household waste in their collections, but less commercial waste. Incidents of fly tipping in England are regularly reported by concerned individuals, with photographs, on the ClearWaste website (ClearWaste.com) which gives a good idea of the types of problem that arise every day.

In Ireland, COVID-19 is thought to have led to increased littering. The 2021 Irish Business Against Litter (IBAL) survey showed that for the first time in 13 years, less than half of the 40 towns and cities surveyed across Ireland we deemed ‘clean’. This is 25% less than in 2019, and 80% fewer than in 2017, when 80% of towns and cities were clean (Covid litter sees number of towns deemed ‘clean’ drop [rte.ie]). In north Ayrshire in Scotland, a similar increase in littering in 2020 was reported, with a surge in numbers of volunteers helping an Irvine litter-picking group to collect 1,180 bags of rubbish that year.
Issues with illegal dumping in Asia and Africa

In Africa, several factors, such as education, indigenous origin and access to social allowances, influence people’s readiness to dispose of waste properly and to recycle. In Korea, the cost of using municipal solid waste facilities encourages illegal dumping. While in Japan illegal dumping declines as the financial penalties for dumping increase. However, waste treatment facility improvement did not always have an impact on illegal dumping.

Illegal dumping of construction waste has long been a problem in Malaysia illegal dumping activities is a critical issue, with SWCorp, the solid waste management authority, closing 851 of illegal dumping areas in a single year (Rahim et al., 2017).

In India, only 67% of the solid waste generated in poor neighbourhoods of Delhi, and 97–99% in other neighbourhoods is collected and taken to landfills. About 557,000 tons of solid waste are illegally dumped in Delhi’s streets, roads and open areas (Nagpure, 2019).

In Sub-Saharan Africa only 55% of waste is collected compared to 90% or more in Europe and North America. Indiscriminate dumping of waste is a symptom of struggling waste management systems, but it also occurs within well-managed waste systems (Niyobuhungiro and Schenck, 2020). In South Africa, for example, 59% households, predominantly in more affluent areas, have access to kerbside collection; 2% use communal containers; 34% deposit their waste at communal dumps and 5% dispose their waste ‘in their own means’.

International waste transfer and dumping

Much municipal and industrial waste is traded internationally. Wealthy countries transfer waste to countries where it is cheaper to recycle or legally dump wastes. However there have been illicit negotiations because treating or disposing of hazardous waste material might cost an average of $2,000–$3,000 per ton in a wealthy industrialized country, it could be a meagre $2.50 a ton for the same material in an African country. Not surprisingly, there have been many scandals of illicit hazardous waste exports in the region. Political instability also accounts for the importation of hazardous materials, as demonstrated in the period 1999-2001 in Somalia and Guinea-Bissau (Margai and Barry, 2011). Foreign companies and governments may sometimes take advantage of situations during which they can avoid governmental resistance, public opposition, or large expense in their negotiations to relocate or transfer their waste products.

A specific example of the problems that arise comes from Abidjan, Cote d’Ivoire. In 2006, the “Probo”, a Panamanian registered, Greek-owned ship chartered by Trafigura, the world’s third largest independent oil trader with global assets and employees in over forty countries, carried toxic hydrocarbon wastes to Amsterdam, where proper treatment and disposal of the materials would have cost 500,000 Euros. However, a deal was made with a subcontractor in Ivory Coast to dispose of the wastes for just 18,500 Euros (Margai and Barry, 2011). Upon arrival in Abidjan, a road tanker took a first from the Probo to a waste dump in the southern part of the city. Over the following days, tankers disposed the rest of the wastes at 16 other sites around Abidjan. The toxic wastes contaminated areas around the dumps. By September 18th, 2006, health care professionals had treated over 44,000 people affected by the contamination. Fifteen people are said to have died shortly after exposure to the contaminants whose local effects of the hazard were most evident in low-income neighbourhoods. As elsewhere, ethnic minorities and long-term deprived residents with limited access to basic amenities faced the greatest risks of exposure.

Tackling fly-tipping and illegal dumping

a) Changing people’s perceptions of what is acceptable.

All litter is avoidable, and the vast majority could be either used or recycled. A study of litter in Wales found that most litter is food and drink related with much of it resulting from the relatively modern habit of eating and drinking whilst on the move.

b) Reconsidering the way fast food is packaged and distributed.

In Wales, UK, food waste accounted for 19% of fly-tipped material; with plastics, glass and metal packaging accounting for 34%, by weight, most being dense plastics including plastic and glass bottles, plastic tubs and trays, other dense plastic and cans. Other organic material in litter (10%) mainly contained pet excrement. Garden waste accounted for 2% and textiles 3%. Fine material made up less than 5% of the material, with plastic bags (1%) and coffee cups (2%) accounting for the remainder. However plastic bags and coffee cups had a wider visual impact than their small percentage by weight suggests (WRAP Cymru 2018).
c) Ways of encouraging the disposal of waste-to-waste management facilities.

Fly-tipping will occur where perceived benefits exceed perceived costs; where weaknesses in collection and disposal services provoke those with waste to get rid of; and where those producing and disposing of waste are ignorant of their responsibilities for or methods of disposing of it lawfully. The principal causes of fly tipping relate to the inconvenience of transporting waste to an authorised site, landfill tax, reductions in the economic return on spent goods when for example the price of scrap metal has fallen, and the disposal costs imposed at registered waste management facilities.

Provision of alternatives to fly-tipping can make a difference. People dump household appliances because they cannot repair them, and they must pay for collection and disposal. If repairs were readily available and not expensive, items might be refurbished, re-used and recycled. In London in five social housing areas, a European Union LIFE+ funded pilot scheme, The Repurpose Project, aimed to encourage re-use of items through the development of centres (referred to as Loops) for the repair, sale and purchase of old items. Each Loop also trained local people in how to repair items and educated them about the benefits of re-use. The Loops were run largely by volunteers directed staff by employed by Groundwork, an urban land reclamation and community development organisation. The project alleviated the fly tipping problem, supported the circular economy and developed skills within the community.

An interesting example, and cautionary tale, concerning waste management in Africa is that of the waste management activities of the marginalised Zabbaleen community in Cairo whose principal economic activity is municipal solid waste (MSW) collection and recycling.

Over the decades, the Zabbaleen have created what is arguably one of the world’s most efficient waste management systems with some 80 percent of the MSW collected by them being recycled. However, their livelihood has now been jeopardized by the official privatization of municipal solid waste (MSW) services through contracts with technology-intensive private multinational corporations and an official policy of moving the Zabbaleen and their MSW recovery, sorting, trading and recycling activities further out of the city, on the grounds that this will turn their neighbourhoods into cleaner and healthier living environments. Unfortunately, the failure of the replacement MSW management to efficiently process a high proportion of the waste has resulted in more landfill and waste piling up in Cairo’s streets with consequential health and environmental problems (Fahmi and Sutton 2010; Figures 4, 5 and 6).

Figs. 4, 5 and 6 Waste management by Zabbaleen 2000.
Another example of waste recycling by community groups is the project by the Vastu-Shilpa Foundation and CHEC in Ahmedabad, India in 2006. The project’s teams experimented with innovative designs such as using plastic bags to make ropes to tie down roofing sheets, using broken crockery as floor tiles and turning glass bottles into windows. More advanced techniques were also developed, including using fly-ash from a local power station to make a plasterboard like material.

New ideas are also need in tracing illegal dumping and fly-tipping. In SW Spain novel real-time GPS tracking of scavenging birds was used to detect illegal urban dumps quickly and effectively (Navarro et al., 2016). The team investigated the spatial movements of yellow-legged gulls (Larus michahellis), a scavenging gull species keen on human organic waste. Gulls quickly found new opportunities to scavenge and the GPS information enabled the illegal waste dump sites to be mapped and police.

**Responsibilities and actions**

All the people in towns and cities, whether residents or visitors have an individual and household responsibility to dispose of waste properly and safely. Such a responsibility can become a partnership with the local government if the municipal authority is well enough financed and staffed to provide an efficient, reliable waste collection service. However, even in many of the wealthiest parts of the world. Cities struggle to cope with littering. Community volunteers often endeavour to collect the debris that the council misses. The problem of litter should not exist. It is a behavioural problem, mainly because people fail to carry their waste to a disposal point. Individuals should always take their waste to an appropriate receptacle. Councils should provide and maintain adequate disposal points.

Many councils in less affluent areas are short of funds for their basic services. The shortage arises because central governments tend to hoard funds to meet their perceived national goals, rather than release funds to ensure adequate public health and safety provision by urban area governments for their communities and people. If public health provision is poor, the effects of disease outbreaks become more severe and more costly.

Internationally, it is the responsibility of both national governments, international agencies and multi-national corporations to ensure that operations in third countries, such as mining and oil extraction, do not cause pollution, and to recompense affected communities if accidents occur. It is also their responsibility to keep waste on their territory, not to export it to other countries. The ultimate goal must be to eliminate waste but practising the principles of the “circular economy”.

**References**


WRAP Cymru *The composition of litter in Wales 2018*
6. Noise pollution

Eva Ekehorn  
Trustee & Hon Sec, Commonwealth Human Ecology Council

It is a hot summer early morning. Windows opened to get some fresh air. Birds singing and a light breeze. You sleep nicely.

And then, there is a low murmur of something coming nearer and nearer. The sound gets stronger, and it vibrates against the wall. And then you wake up to hear the aircraft coming just over the roof and descending towards the airport. It is getting quiet again.

But then there is the next aircraft, and the next and then they are coming every 90 seconds. Time is getting close to 7 in the morning. The noise is unbearable. You can either close the window and suffer in the heat or put your pillow over your ears and cry a little.

I am not alone living under the flight path to Heathrow, we are some 1.6 million. There are at least two flight paths into the airport from east and from west and the planes takes alternative routes, so some parts of the day are fine. If there is an easterly wind blowing, the flights are coming in from the west, and people living in Windsor and Datchet will have most of the noise during the day

But, with the COVID-19 pandemic much of this changed, as the lockdown meant that many people were staying home and not travelling. The flights around the world dropped. The sky became an intensive blue; the birds could be heard singing all morning; as well as one could hear the wind in the grass. There were hardly any flights for a long time. There were also fewer cars on the roads so a walk along the streets was peaceful. It was a wonderful time.

The leaders of Heathrow have taken some action to financially support people near the airport to insulate lofts and obtaining more noise protecting windows. That is a right step both for noise reduction and for climate change. But it is not enough. Hounslow Heath, which is quite close to the airport, is a beautiful place, with creeks, juniper trees, meadows, foxes and rabbits, but if you walk there when the planes take off, you feel the pain in your ears and you cannot hear anything for minutes. There is rather dense housing near there, and you wonder how they cope. School children cannot play outdoors when the flights are coming in along the flight path across their playing fields.

This noise must be a problem for all people living close to airports around the world. In some developing countries you see the slums directly adjacent to the landing path. As world-wide flying has expanded to around 40.3 million individual flights in 2019 (ref 1), the noise it creates is usually not discussed to anything like the same extent as the CO2 emissions. However, noise can be as bad for human health as other forms of pollution.

Researchers measure noise in terms of pressure, intensity, and frequency. Sound pressure level (SPL) represents the amount of pressure relative to atmospheric pressure during sound wave propagation that can vary with time; this is also known as the sum of the amplitudes of a wave. Sound intensity, measured in Watts per square metre, represents the flow of sound over a particular area. Although sound pressure and intensity differ, both can describe the level of loudness by comparing the current state to the threshold of hearing; this results in decibel units on the logarithmic scale. The logarithmic scale accommodates the vast range of sound heard by the human ear (ref Wikipedia).

So, what is noise: WHO says the following: “What is noise? Noise is an unwanted or objectionable sound. Generally, the acoustic signals that produce a pleasant sense (music, bells) are recognized as “sound” and the unpleasant sounds as “noise” (for example: produced by a machine or airplane). It can be a pollutant and environmental stressor, and the meaning of sound is important in determining reaction of different individuals to the same sound. One person’s music is another’s noise. The human ear is an instrument that detects vibration within a set range of frequencies. Air, liquid or solids propagates vibration; without them, sound does not exist. Sound does not exist in the vacuum. The higher the level of pressure of the sonorous wave, the shorter the period of time needed to be perceived by the ear.” (ref 3)

How we take on noise disturbance are so wide and different, depending on what we hear. Sitting in a crowded music hall, hearing the last movement of Beethoven’s 9th symphony, as many of us find this being ‘sounds’, is very different from hearing the aircraft coming over, but is it much difference in noise level? Hearing your neighbours playing music you don’t like is different from hearing them playing something you like, even if it is on the same sounds level.

When the COVID pandemic is suppressed, will we go back to ‘normal?’ There is a lot of talks about the new ‘normal’, where we try to keep that experience of a blue sky and bird song alive, but will it be so? Will we really stop flying as much as we did before? Will it really be necessary for Heathrow to expand with a third runway? At the moment this proposal has been turned
down based on environmental reasons, but Heathrow still plans to overturn the decision.

The people living in areas closest to the airport are almost certain to experience noise levels at or above 65 decibels. Currently around 492,000 people experience 65 decibel noise or above from Heathrow, according to research published in 2016. A third runway would increase take-offs and landings from 480,000 each year to around 740,000. A Heathrow spokesperson said: “As part of our extensive consultation process, we are proposing options that would reduce the airport’s noise impacts. Our plans are designed to ensure that fewer people will be affected by noise than were affected in 2013, thanks to quieter planes, quieter airport design, quieter operations and a 6.5-hour ban on scheduled night flights.” (from a Heathrow statement)

“The government has all the public support they could possibly want for radical climate action. Cancelling Heathrow is the easiest measure available. It will cut millions of tonnes of CO₂ and improve the health prospects of millions of people all at the stroke of a pen.” (Ref 2). This may not be possible but cutting down on flying would at least improve the situation for millions of people around the world.

Noise has to be taken seriously. It is not only people who suffer, birds and animals do too. Trees and bushes can dampen the noise from car tyres on the road which can be lowered by certain road covering. Communities are sometimes shielded from noise from trains by walls. Noise from ships and drilling in the deep sea disturb the creatures, such as whales and dolphins, living there, and they can lose their ways through the oceans.

If we can come back after COVID to a new normal, it would mean that we should fly less and use cleaner public transport. This would be good, not just for the drop in CO₂ emissions and cleaner air, but it would also be good for the environment, wildlife and our own health. So, let us a hear the sound from the birds singing, the waves from the sea and the winds in the willows!

“Noise is an unwanted or objectionable sound”

Fig.1 Aircraft approaching Heathrow

References:
   https://www.eea.europa.eu/themes/human/noise/sub-sections
### MAGNITUDE AND EFFECTS OF SOUNDS

This abbreviated table correlates common sounds with effects on hearing.

<table>
<thead>
<tr>
<th>Sound Description</th>
<th>Effect on Hearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet suburb or quiet conversation 50 dBA</td>
<td>No significant effect –</td>
</tr>
<tr>
<td>Conversation in a busy place, background music or traffic 60 dBA</td>
<td>Intrusive –</td>
</tr>
<tr>
<td>Freeway traffic at 15 metres 70 dBA</td>
<td>Annoying –</td>
</tr>
<tr>
<td>Average factory, train at 15 metres 80 dBA</td>
<td>Possible hearing damage –</td>
</tr>
<tr>
<td>Busy urban street, diesel truck 90 dBA</td>
<td>Chronic hearing damage if exposure over 8 hours –</td>
</tr>
<tr>
<td>Subway noise 90 dBA</td>
<td>Chronic hearing damage, speech interfering –</td>
</tr>
<tr>
<td>Jet take-off 300 metres 100 dBA</td>
<td>More severe than above –</td>
</tr>
<tr>
<td>Stereo held close ear 110 dBA</td>
<td>More severe than above –</td>
</tr>
<tr>
<td>Live rock music, jet take off 160 mts 120 dBA threshold</td>
<td>As above, human pain</td>
</tr>
<tr>
<td>Earphones at loud level 130 dBA</td>
<td>More severe than above –</td>
</tr>
<tr>
<td>Toy cap pistol, firecracker close ear 150 dBA</td>
<td>Acute damage (eardrum rupture)</td>
</tr>
</tbody>
</table>

7. Light pollution

Saman Waheed  Chairperson of the Ideation Hub of Global Youth, India

Definition

Light pollution, also referred to as photo-pollution or luminous pollution, is an increasingly adverse phenomenon that has far-reaching effects at a global level. Light pollution is described as the presence of anthropogenically artificial light in the natural atmosphere at night. Light pollution can exist wherever there is any source of non-natural light being used. It is the excessive, intrusive, misguided and unrestrained use of artificial light in a way that affects the quality of natural light.

The concept of light pollution may sound very contemporary; however, the process is not novel at all. With the increasing globalization that came accompanied with rapid urbanization, the use of artificial light has multiplied manifolds. It is not constricted to one region or place but sprawls over major areas in Asia, Europe and North America. This observation gained global prominence back in 2001 when the World Atlas of Night Sky Brightness published a map wherein one could see wide regions of the continents glowing with light while remote areas such as the cold deserts of Siberia, the Sahara along with Amazon in utter darkness (Cinzano et al., 2001).

In 2010, Hölker et al. demonstrated that the use of artificial sources of lighting was growing by 20 per cent every year but this surge depended upon the geographical area. In the same article, it was also promulgated that it is high time that nations initiated some action to control light pollution to save energy, living beings and the environment.

Types of Light Pollution

To find ways to curb light pollution, one must understand the various types of this pollution.

- **Light Trespass:** Also called spill light, light trespass, as is evident from the name, is the phenomenon whereby a light source/fixture casts its light beyond the specific property it belongs to, thereby throwing light on other areas. Identifying light trespass is a complex process as there is no hard and fast rule of where and how much illumination beyond a property line is extra. Common examples include streetlamps casting light on a room in someone’s house through a window; wall lights pointing towards the sky and not the ground; or a security camera light that illuminates areas in its vicinity.

- **Glare:** Glare is a visual symptom that occurs when stray light, or light in the visual field, is brighter than the light to which the eyes have become accustomed. Glare can reduce contrast, colour perception, and visual output depending on its strength.

There are three types of glare:

1. **Discomfort Glare:** This is also called psychological glare and is the most well-known type. It happens when lighting irritates a person but does not impair vision or cause long-term physical pain.
2. **Disability Glare:** This is also called veiling glare. It happens when stray light disperses in the eye, forming a veil over the retina and impairing vision. Glare decreases contrast, colour, and spatial vision, possibly resulting in dangerous driving. Older drivers are more likely to suffer more from it.
3. **Blinding Glare:** It is also called absolute glare or dazzle and happens when artificial light obscures the field of vision, making it impossible for the eye to see anything other than the light source. Visual performance may stay negatively impacted for a long time after an incident.

- **Sky Glow:** Sky glow is caused by both natural and anthropogenic sources; the major one being poorly built and targeted artificial lights. When light is unintentionally or intentionally released directly into the atmosphere, it is dispersed by dust and gas molecules, resulting in a bright orange dome over the night sky. It diminishes the difference between stars and galaxies in the sky, thereby making it harder to see and identify heavenly bodies even with a telescope. These domes likewise influence the polarization of twilight, which nocturnal creatures use to explore. Clouds, snow, trees, and the amount of residue and gas atoms in the environment can enhance sky glow.

- **Light Clutter:** Light clutter occurs when numerous bright lights are clubbed together in a specific area, creating chaos and drawing attention away from the objects around and ahead. This can be noticed on roads which are lit by streetlights along with illuminated billboards and property signs. As a result of this, there may be a risk of grave casualties, because traffic and navigation signals may get lost in this clutter of lights. Other types of light pollution, such as light trespass, glare, and sky glow, are exacerbated by clutter.

- **Uplight:** Uplight is basically the wasted light that instead of providing illumination on the ground...
and around goes up and eventually gets lost in space. It is caused due to the same light sources that can cause light trespass and light clutter. Atmospheric scattering is not conducive for astronomical research as it artificially brightens the night sky, rendering distant celestial light sources difficult or impossible to see.

**Causes of Light Pollution**

The foremost cause of light pollution is the unwarranted use of light when and where it is not at all required. Thus, architecturally poor lighting systems in civil and commercial spaces can aggravate this pollution. Open light sources can cause much photo-
pollution with more than half of the light going up into space or illuminating sides without directly falling on the ground. Causes of light pollution include busy roads; car headlights; garage lamps and lighting lamps on residences.

**Effects of Light Pollution**

Light pollution can have many unfavourable effects on the environment and may perniciously impact the migratory patterns of birds, sleep cycles of humans and navigation routes of other animals.

- **Amphibians**: The dome-like sky glow affects the vision of amphibians resulting in confusion and a dishevelled sense of reality, thus eliminating feeding and mating opportunities. Their innate qualities that shield amphibians from natural predators and the elements are also harmed.
- **Birds**: Natural sources of light are sometimes drowned out by artificial ones that attract the attention of the birds, resulting in them being fixated upon that source. This causes the migratory birds divert from their original path, forcing them to fly for long hours, resulting in immense exhaustion, collapse and eventually death being preyed upon by other animals.
- **Environment**: According to a study by the International Dark-Sky Association (IDA), artificial lighting at night can release up to 12 million tonnes of carbon dioxide into the atmosphere yearly.
- In a research by the National Oceanic and Atmospheric Association in 2010, luminous pollution can also pollute the air by inhibiting the formation of a natural radical that helps to purify the air at night. Artificial light from houses, vehicles, and streetlights affects nitrate radicals and delay the cleansing process by 7%. Artificial light also induces a 5% rise in ozone emission chemicals.
- **Energy**: The uplight as well as non-shielded lights cause a lot of wastage of energy. According to a 2007 IDA survey, 30% of all light generated by artificial outdoor lighting systems is unnecessary, equating to 22 Terawatt Hours (TWh) of wasted electrical energy each year, enough to light over 11 million homes and power over 777,000 automobiles.

- **Humans**: Circadian rhythms govern both human behaviour as well as physiological processes including brain wave patterns, hormone production, and cell regulation. The rhythms of an organism are affected by the amount of light and darkness in its environment. Disrupting these rhythms can lead to several mental health issues, such as anxiety, depression and insomnia and physical health issues such as cancer (breast and prostate), diabetes, heart problems, immunological disorders and obesity. Light pollution has a major effect on melatonin levels. Darkness activates the hormone, while light suppresses it. Anxiety and mood disorders, insomnia, and an elevated oestrogen/progesterone ratio can all be symptoms of melatonin deficiency.
- **Mammals**: Bats, raccoons, coyotes, deer, and moose, for example, can find it difficult to find food at night due to excessive lighting. They run the risk of being attacked by natural predators, as well as having a higher mortality rate due to night vision deficiency. Their fertility may be reduced, which causes a sharp decline in their populations.
- **Reptiles**: Light pollution has a major effect on reptiles such as sea turtles. Female turtles lay their eggs on quiet, remote beaches, but bright coastal lights make it difficult for them to find safe places to lay their eggs compelling them to lay their eggs in a dangerous environment or in the ocean. Hatchlings naturally crawl toward the darkest portion of the beach, which has been lit by moonlight and the starlit ocean for centuries. Artificial illumination on the beach or near the shore confuses the hatchlings and causes them to wander away from the ocean. Predators may eat the hatchlings; cars may drive over them; they may drown in swimming pools; or they may die of dehydration or exhaustion.
Ways to Curb Light Pollution

In comparison to other forms of pollution, light pollution can largely be controlled by certain good energy conservation practices.

• Use covered light fixtures for outdoor lighting, so that light does not waste by travelling upwards and sideways.
• Cut-off lighting that focuses light on the ground, as all sources ideally should, can enhance visibility.
• Remember to turn off all outdoor as well as indoor lights before you retire for the day or are not at home.
• Start using compact fluorescent lamps (CFL) and LED bulbs that produce warm white lighting.\(^7\)
• Motion sensitive lights should be used in public places so that no light and electrical energy is wasted.
• Awareness programmes should be launched by the individual agencies and/or state and national governments to familiarize citizens with light pollution issues and what can be done to reduce them and conserve energy. Thus, the problem of light pollution can be tackled if we all unite and become mindful to preserve the natural state of the earth to make it habitable for all species.

References

\(^1\) This can also at times cause the collision of birds with these artificial sources, when they fly towards it with their impaired vision due to light clutter or trespass.
\(^2\) Founded in 1988, it is a non-profit organization recognized as the authority on light pollution and night-sky conservation.
\(^3\) Nitrate radical, a form of nitrogen oxide, breaks down vehicle and factory emissions at night, thereby preventing them from becoming smog/ozone pollution/harmful irritants.
\(^4\) Since sunlight kills nitrate radicals, the process only occurs at night.
\(^5\) the physical, mental and behavioural changes that occur in a 24-hour cycle.
\(^6\) the naturally occurring hormone that regulates the sleep and wake cycle
\(^7\) Many LED lights give out a short blue wavelength light that disperses easily into the atmosphere, which causes eye strain, impairs night vision and contributes to light pollution.
8. Air pollution and the Commonwealth

By David M Gomez Director, Ramphal Institute

Air pollution significantly affects the environment and health of people in Commonwealth countries, including small island developing states (SIDS), yet the issue has not received the same policy priority or attention as climate change in the majority of these countries. As one senior level diplomat from a small island state remarked during a recent consultation, “we are not concerned with air pollution, our focus is climate change.”¹ Those sentiments were, unfortunately, echoed by other leading diplomats and even regional climate change officials — “air pollution is really not an issue that many SIDS work on!”² This is unexpected, especially given the significance of climate change to the very existence of SIDS, and it speaks to a significant misunderstanding of the relationship between air pollution and climate change as well as environmental sustainability. It also shows that for some Commonwealth countries, the policy priority with regards to climate change is not human health but averting the existential crisis that global climate change foreshadows. The misalignment in priorities on these two closely related policy areas suggests that Commonwealth countries are likely to undermine their climate change objectives, or at the very least diminish their ability to exercise global climate leadership on the matter, because they will miss effecting key behavioral changes at home.

The Ramphal Round-table series (webinars) convened between May 2020 and March 2021 alongside the series of complementary policy briefs published on the various causes of air pollution—road, shipping and aviation transport; agricultural practices including biomass burning; cooking using ‘dirty’ fuel sources; fossil fuel energy sources—revealed that the urban poor, particularly women, children and vulnerable groups in the Commonwealth are disproportionately affected by air pollution and this will continue to be the case because cultural and behavioral practices which contribute to emissions harmful to human health continued unabated. A handful of municipal authorities are fighting back and have implemented innovative measures aimed largely at reducing the harmful emissions from road transportation, but such measures are both disparate and lack robust national frameworks for amplifying their combined effects.³ Moreover, as the case of Delhi, India shows, at certain points of the year, the threat is posed, as much if not more, by biomass burning. The situation in Delhi and other parts of India and the Commonwealth has been bad for decades and led one author to argue that the pollution amounted to “slow murder.”⁴

Unfortunately, it is the urban poor that endures the ‘slow murder’, and the symptoms may include anything from chronic asthma, to shortness of breath, coughing, headaches, and itchy allergic eyes. By some estimates “in India alone, more than half a million people die prematurely every year due to poor … air quality.”⁵ The challenge for Delhi’s authorities is that they “have no control over the influx” from the regions burning biomass. The irony of the situation is that for all Delhi’s efforts at curbing the harmful emissions from road transportation, unless the authorities from the ‘producing regions’ can be effectively engaged in addressing the problem, Delhi’s urban poor will continue to suffer. In other words, unless changes in the behavior of people in all parts of Indian society can be shifted, the problems in Delhi will persist. In short, ambient air pollution cannot be mitigated by addressing any single source of the problem and to make matters worse worse outdoor emissions invariably find its way indoor. Thus, as the level of outdoor air pollution rises more and more harmful emissions, as find their way indoor thereby increasing indoor air pollution levels. Segments of the population with access to more resources try to guard against this by installing air conditioners, ‘air scrubbers’, using clean cooking stoves, etc., while the poor are left completely exposed.

In other places like Dhaka, Ghana, Kenya, Nigeria and even London the urban poor likewise suffer disproportionately from harmful emissions. Behaviors, cultural practices, and lack of knowledge contribute significantly to the problems in most these places and compounds the problem for local authorities and in many cases prevent effective responses.⁶ For instance, in Ghana scraping out a basic existence is a driving force behind people behaviours and hence, despite elevated negative human health effects, many Ghanaians are forced to continue “‘urban mining” of copper and other rare earth meals from electronic waste.”⁷ As Muntaka Chasant explains, people “burn the plastic encased electronic waste (i.e., computers, appliances, televisions, etc.) and sheathed cables to recover copper and precious metals.”(Fig. 1) The challenges faced by Ghana’s urban poor are compounded by the use of biomass for cooking for many of Accra’s residents and growing urbanization. Remediing the harmful health effects of air pollution, indeed the problem of air pollution itself, in Ghana as in other places within the Commonwealth therefore
will require highly complex programs and policies which are able to effectively lift people out of poverty.

By comparison, the behavioral changes in London runs a different route. For all of London’s public transportation systems, the number of people driving their cars to and from work, is steadily increasing and with that the level of harmful emissions from cars, trucks, and motorcycles. In 2020 a UK coroner ruled that harmful emissions from traffic were the cause of death of at least one child. The City of London has now implemented a low emission zone (ULEZ) in central London, and this will be extended in October 2021 to the south and north circular providing for a larger contiguous area within which more stringent emission requirements will be in place. Cities like Kampala and Lagos are struggling to follow suit, even as the cost of air pollution was rose to a staggering US$2.1 billion in 2018, and with “the [loss] of many lives, particularly those of young children.” Arguably then air pollution in some of Africa’s large cities is undermining both economic development and livelihoods.

In small island developing states, the problem of air pollution is not readily evident, largely on account of the fact that wonderful sea breezes tend to blow away any ‘black carbon’ and other pollutants belched from arriving cruise and merchant ships and aircraft. For SIDS the cruise ships and aircraft bringing tourists and cargo are a lifeline of their economies. Still, invisibility does not equate with illusory, and even if the local populations in SIDS are not themselves directly significantly affected by the pollution from ships and airlines, the large number of these cruise and merchant ships calling on their ports negatively impact air quality and contribute to global green-house gas (GHG) emissions. SIDS heavily dependent on cruise tourism industries also tend to import and operate (collectively) significant fleets of diesel buses, vans and other vehicles, and they generally have diesel generated electricity as their main sources of electricity. Livelihood considerations in SIDS differ fundamentally from that in other Commonwealth countries, and SIDS are also likely to be affected more severely by global climate change. As such the policy and adaptation strategies required by local and national authorities also differ significantly, but it may nonetheless prove a gross mis-calculation for SIDS to believe that climate change can be the priority without addressing air pollution. As one UNDP study put it, “adaptation to climate change remains the key priority for SIDS. At the same time, activities which reduce fossil fuel dependence … are vital for SIDS to meet their sustainable development objectives.”

Addressing the matter of the adverse effects of air pollution on urban populations, particularly the poor, and public health systems in Commonwealth countries presents a unique opportunity for governments and local authorities to respond to development challenges in an integrated way. Commonwealth countries cannot effectively lift people out of poverty and achieve sustainable economic development by maintaining approaches which bifurcate air pollution and climate change – this approach will only deepen the nature of current relationships of urban poor with their environments. Rather, effective strategies for cleaner air which take into consideration the many sources of pollutants, and which embed this within the wider climate change debate are required. In other words, for many Commonwealth countries their current climate change

\[\text{Fig.1 Burning e-waste at an African metals retrieval site. Source: E-Terra Technologies}\]
goals are not fully attainable unless they consider air pollution. At the same time, the answer to the current air pollution problem facing many Commonwealth urban areas isn’t as simple as shifting to alternative, cleaner modes of transportation, distributing clean cooking technologies, or stopping stubble burning. While those measures may achieve some behavioral changes, they may not shift value-judgments and priorities by affected populations, especially the urban poor. To change the priorities, policy-makers in Commonwealth must reframe the climate change priority to fully consider air pollution. What’s more, prioritizing the latter provides a unique opportunity for the Commonwealth to exercise global climate change leadership.

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1) This response was received during a stakeholder consultation in February 2021.
2) Response received from a regional official when consulted on the matter of air pollution in early March 2021.
3) The United Kingdom is arguably the exception here and adopted a national Clean Air Strategy in 2019 which sets targets to cut emissions by 2030. However, some argue that this is not sufficiently far-reaching.
9) Anjli Raval, Josh Spero and Chris Campbell, “Pollution: the race to clean up the shipping industry,” Financial Times 30 May 2019, available online at https://www.ft.com/content/642b6b62-70ab-11e9-bf5c-6eeb837566c5. The authors estimate that the global shipping industry contributes around 3 percent of global greenhouse gas emissions annually.
9. **Urban air pollution - Dhaka perspective**

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Dhaka regularly ranked among top cities with the worst air quality. Emissions from motor vehicles and industries, construction works, transportation of soil and sand through the city, emission from brick kilns around the city, dusty road with filthy materials, household combustion of fossil fuel, burning of solid wastes etc. are identified as major sources of air pollution. Growing numbers of motorized vehicles are clogging up roads and deteriorating air quality. Besides the large number of cars, the uneven movement of motorized and non-motorized transports such as rickshaws slowing down the traffic result in pollution. Many vehicles operating inside the city are not fit and they release finer particles (PM$_{2.5}$) due to poor combustion of diesel and petrol. An estimation by Begum et al. (2013) using receptor modeling suggests that about 22 percent and 36 percent fine particulate matters (PM$_{2.5}$) are originated from the brick kilns and vehicular emissions respectively. About 758 brick kilns located in 8 clusters around Dhaka City releases approximately 118866 tons and 35662 tons of PM$_{10}$ and PM$_{2.5}$ (Afrin 2012). More than 36 percent of the country’s vehicle populations ply in Dhaka City. It is estimated that 6035 tons of PM$_{10}$ and 4288 tons PM$_{2.5}$ are emitted from vehicular sources within and around Dhaka (Afrin 2012). About 14,000 vehicles are using diesel as their fuel. Diesel driven vehicles are predominantly responsible for generating particulate matter. Buses and trucks account for over 80 percent of PM$_{2.5}$ emissions in Dhaka City and its surrounding areas (Afrin 2012; Anjumand 2010). Open burning of waste at both the residential level and at dumpsites release many atmospheric pollutants including particulate matter. The open waste combustion causes 29% of the total global anthropogenic PM$_{2.5}$ emissions (Wiedinmyer et al. 2014). Dhaka City alone is contributing about 75% of total waste generation among the major cities of Bangladesh. Since there are no MSW incineration facilities in Bangladesh; the huge fraction of the uncollected waste is burnt openly contributing to black carbon emissions. Moreover, roadside dirt is a significant source of coarse particulate matter (PM$_{10}$) especially during the dry season from November to February. Furthermore, concurrent construction works of mega projects are another source of air pollution inside the city.

World Bank’s “Unlocking Opportunities for Clean and Resilient Growth” report states that brick kilns cause 38% of PM$_{2.5}$ pollution in Dhaka, while motor vehicles cause 19% and road dust causes 18%. Soil dust and pollution from metal smelters account for 9% and 7% of PM$_{2.5}$ air pollution respectively. Monthly Air Quality Monitoring under CASE (Clean Air & Sustainable Environment) Project found 46.1 and 55.9 µg/m$^3$ PM2.5 concentration in two locations of Dhaka City in April 2017. Air quality declines during dry months (from October to April) but improves during monsoon period. Winter season is characterized by high concentrations of PM (178.1µg/m$^3$) due to operation of brick kilns and construction activities. In monsoon the PM concentration is less (30.2 µg/m$^3$) because of wash down of particulate matters in the atmosphere (Rahman et al. 2020).

In recent years, Dhaka’s air pollution becomes a major public concern as the Air Quality Index (AQI) of the city has been reported among the world’s worst cities for several times. Dhaka city ranked fifth worst in the world in terms of air quality according to the latest air quality index (AQI) put out by the U.S. Environmental Protection Agency in 2019. The AQI regards the range of 0–50 points as good air quality, 51–100 as moderately good, 101–150 cautionary, 151–200 as unhealthy, a range between 201–300 points indicate very unhealthy, and 301-500 indicates ‘extremely unhealthy’ air quality. Table 1 shows the air quality situation of Dhaka City. According to US Consulate in Dhaka Air Quality Monitor PM$_{2.5}$, it is found that during the COVID-19 pandemic, the air quality of Dhaka has been improved drastically due to shut down of educational institutions and mass transport, limited business activity, restriction in movement of people and vehicles etc. Dhaka has experienced the reduction of PM$_{2.5}$, and AQI 23 percent and 35 percent respectively compared to the concentration of 2019 (Islam and Chowdhury 2020).
<table>
<thead>
<tr>
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<th>Dhaka Air Quality Data PM(_{2.5}) (AQI)</th>
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| November’19 | 175–200 (10 days) Unhealthy  
200–300 (1 day) Very unhealthy |
| December’19 | 175–200 (12 days) Unhealthy  
200–300 (13 days) Very Unhealthy  
300–400 (1 day) Extremely unhealthy |
| January’20 | 200–300 (19 days) Very Unhealthy  
300–400 (4 days) Extremely unhealthy |
| February’20 | 200–300 (17 days) Very Unhealthy |
| March’20 | 200–300 (8 days) Very Unhealthy |
| April’20 | 175–200 (1 day) Unhealthy |
| May’20 | 125–150 (1 days) Cautionary  
150–175 (1 day) Unhealthy |
| June’20 | 75–100 (12 days) Moderately good  
125–150 (3 days) Cautionary |
| July’20 | 100–125 (9 days) Cautionary  
125–150 (1 day) Cautionary |
| August’20 | 75–100 (8 days) Moderately good  
100–125 (7 days) Cautionary |
| September’20 | 100–125 (7 days) Cautionary  
125–150 (2 days) Cautionary |
| October’20 | 125–150 (10 days) Cautionary  
150–175 (7 days) Unhealthy  
175–200 (2 days) Unhealthy |

(Source: https://aqicn.org/city/bangladesh/dhaka/us-consulate)

Air pollution and health have been a major focus in recent years. In Dhaka, air quality monitoring has shown that concentrations of PM\(_{2.5}\) and PM\(_{10}\) regularly exceeded national and international standards particularly in the non-monsoon period. According to World Bank estimates, in 2015 alone over 30,000 people died in Bangladesh’s urban areas due to exposure to PM2.5. Illness and mortality due to ambient air pollution is on an upward trend, following the pattern of rapid urbanization. The results of the air quality monitoring stations in Dhaka City and the AQI values of US Consulate Dhaka have shown that PM is the main air pollution problem in Dhaka, where local sources such as brick kilns, traffic, open air waste burning and small-scale industries are the most important sources.

In Dhaka, dust pollution is a serious problem, contributing to (at least) 15% of the city’s air pollution. During the dry season, it is revealed that regional scale pollution (haze) including fine and ultra-fine particles also contributes to the high PM levels in Dhaka. Dust particles are very small and can be easily inhaled. They can enter the respiratory system and increase susceptibility to respiratory infections, and aggravate cardio-pulmonary disease. Even short-term exposure to dust can cause wheezing, asthma attacks and allergic reactions.

It is essential to find ways to control pollution at the source, protect people from exposure to dirty air and evaluate the health impacts. There should have commitments from the policy makers to deliver clean air for every citizen. Breathing clean air is an undeniable human right where all people can thrive and enjoy healthier more active lives. A writ petition was submitted at high court in December’2019 for protecting the citizens from the devastating consequences of air pollution. The high court has given 9 points directives to bring down air pollution level in Dhaka City. Those are stop road digging by the utility agencies, covering construction materials, spraying water on streets, fencing construction sites, stop burning of bituminous material/solid waste, discourage manual sweeping, enforce in fitness of vehicles, encourage concrete block use, promote road site plantation/grass turfing etc. Dhaka has joined the C40 Clean Air Cities Declaration Initiatives. Draft Clean
Air Act 2019 has been formulated for air pollution abatement and control, air quality improvement and protection of public health and environment. Dhaka is planning to introduce zero emission public transport, supporting walking and cycling, banning polluting vehicles plying in the city streets, wet suppression of dust by water spraying to soil surfaces, cover the trucks for preventing material from blowing and dropping, introducing green technologies in brick production and promoting concrete block, gradual introduction of mechanical sweepers instead of manual sweeping for removing dirt and debris from city streets and expanding landscaping and greening etc.

Problems and sources of air pollution are identified, solutions are widely recognized and many are currently being implemented. Yet, rapid and coordinated action is necessary to achieve meaningful reductions in air pollution.

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Photos showing various aspects of traffic caused air pollution and the roadside
10. COVID-19 and urban air pollution

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Poor air quality in our cities and towns

In 2016, 91% of the world population was living in places where the WHO air quality guidelines levels were not met. Ambient (outdoor air pollution) in both cities and rural areas was estimated to cause 4.2 million premature deaths worldwide in 2016. Some 91% of those premature deaths occurred in low- and middle-income countries, and the greatest number in the WHO South-East Asia and Western Pacific regions.

Air quality in Sub-Saharan African (SSA) cities has deteriorated since 1980 due to rapid population growth, increased vehicle ownership, greater use of solid fuels for cooking and heating, industrial expansion and poor waste management practices. Exposure to ambient air pollution is a major threat to human health in SSA being responsible for at least 176,000 deaths annually in a region where full vital statistics are difficult to collect.

COVID-19 and air pollution in China and in some Commonwealth cities

In the first few months of the pandemic reports appeared of the reduction of air pollution due to reductions in traffic and industrial activity during the first lockdowns. The first evidence of this came from Wuhan, China, the city where the virus outbreak began. During the Chinese New Year period (January 28th-February 9th) in 2020 the highest nitrogen dioxide (NO₂) levels were 150 µmol m⁻³ compared to 300 µmol m⁻³ during the same period in 2019. However, while NO₂ levels rose to around 500 µmol m⁻³ in the following two weeks in February 2019, in 2020 they remained around 150 µmol m⁻³ as the COVID-19 lockdown continued.

As the pandemic spread around the world, similar reports came a few weeks later from other cities, such as Kampala, Delhi and Birmingham. In India, in early 2020 Mumbai and observed a substantial decrease in NO₂ (40–50%) compared to the same period in 2019. In the province of Ontario, Canada, concentrations of nitrogen dioxide and nitrogen oxides were lower in during the 5-week state of emergency declared in March 2020 than they had been in the previous five years. In the UK levels of nitrogen oxides fell at most monitoring sites during mid-March and April 2020 when lockdown was in full force – but the level of decline ranged from of 20 to 80 percent between recording sites. Manchester’s city centre, for example, saw a 70 per cent reduction in nitrogen oxides.

The pandemic’s hidden beneficial impact

These observations on NO₂ declines led to optimistic statements about reductions in greenhouse gas emissions and in levels of other pollutants:

“Widespread changes as a result of COVID-19 could lead to a decline in the atmosphere of particles, nitrogen dioxide, carbon monoxide and possibly sulphur dioxide and tropospheric ozone”.

“It is very likely that there will be a global slowdown of greenhouse gas emissions, in particular carbon dioxide emissions, due to reduced energy consumption.”

There was a great hope in May 2020 that we could learn the lesson of how good clean urban air can be. We do not appear to have taken adequate note.

Were all the air pollution changes beneficial?

Although generally NO₂ concentrations fell during the March - April 2020 lockdown in the UK there were considerable site-to-site variations across the country, some locations showing far less reduction than others. A few sites, such as in parts of Edinburgh, even showed a modest increase. for example. This might be due to specific travel and vehicle movements.
However, unlike NO$_2$, decreases in the PM$_{2.5}$ concentrations, tiny particulates that can make the air appear hazy, were insignificant. Although vehicles are a source of these particles, they also come from domestic wood burning and chemical reactions involving emissions from industry and agriculture. Thus, that aspect of air pollution remained unchanged.

Possibly more worrying was that in many UK cities the marked decreases in nitrogen oxides had corresponding increases in ozone during lockdown. Ozone is a strong oxidant whose health impacts include throat irritation and airway inflammation. It may lower lung function and aggravate diseases such as bronchitis and asthma. Furthermore, ozone reduces plant growth and hence agricultural yields and chemically ages a wide range of polymers. So, two questions must be asked about the air pollution effects of the first lockdown: were these changes repeated during the second and subsequent lockdowns? Did NO$_2$ concentrations return to pre-pandemic levels?

China came out of lockdown earlier than other nations. By May 2020, air pollution had returned to China’s skies as factories accelerated production to make up for the time when they had to shut down. Even though NO$_2$ and PM$_{2.5}$ levels decreased during lockdown, levels of these pollutants were higher in April 2020 than they were in April 2019. By July 2020, the levels of NO$_2$ at some sites in the UK were still lower than those of on the same day in 2019: London showed a moderate difference, Bristol and Leeds, large decreases, Leeds no change and Manchester only a slightly lower value (Table 1). One of the factors at Manchester monitoring stations was a change in the composition of the vehicles making up the traffic movements, with a drop in car use being partly compensated by an increase in the Heavy Goods Vehicle fleet [HGV] passing the site (Topping et al., 2020).

**Table 1. Contrast in early July NO$_2$ levels in five UK cities.**

<table>
<thead>
<tr>
<th>City</th>
<th>July day 2019</th>
<th>July day 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>Bristol</td>
<td>34</td>
<td>11</td>
</tr>
<tr>
<td>Leeds</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Manchester</td>
<td>20</td>
<td>18</td>
</tr>
</tbody>
</table>

In the second UK lockdown in November 2020, most contaminants declined in concentration after the imposition of a second quarantine period, but nowhere near as much as in the first lockdown. Some cities experienced increases in pollution levels compared to normal averages. This discrepancy is thought to due to vehicular traffic staying relatively stable during the second lockdown as people avoided public transport and continued to drive to shop for food and permitted activities. Impressions of the third lockdown in January 2021 have been similar: no major diminution in car traffic, except at peak hours, and increased delivery van mileages.

These behavioural observations are important. The first lockdown showed that when everyone stopped using their cars, pollution dropped significantly and, if society so wished, greenhouse gas emissions could have been reduced remarkably. People could have continued to reduce vehicle use permanently to improve air quality, reduce the related health risks and slow global heating. Most decided not to do so.
In India, PM$_{2.5}$ and NO$_2$ level remained lower than pre-lockdown levels throughout April, May and June 2020. However, an upward trend in NO$_2$ is detectable in late June (Fig.1). As the lockdown eased and vehicles returned on roads, NO$_2$ and NO$_x$ pollution began to increase. However, PM$_{10}$ and PM$_{2.5}$ continued to drop during the unlock period, due to the reduction of construction and industrial activities as well as early monsoon rain that washed away the particulates.

The continuing health impact of air pollution

Air pollution causes around seven million deaths a year worldwide. Growth and concentration of the population in cities, as well as the way in which we consume energy in urban areas through transport or heating and air conditioning systems, among others, result in the emission of huge quantities of gases that are harmful to our health.

Delhi, the world’s most polluted city, suffered an estimated 54,000 avoidable deaths due to PM$_{2.5}$ air pollution in 2020: more than five times that said to be due to COVID-19 in that year. Jakarta, Indonesia, lost 13,000 lives to air pollution in 2020, more than double its COVID-19 casualty rate. Tokyo, whose urban air is relatively clean by Asian standards, registered 40,000 deaths from bad air in 2020, while losing 1,180 people to the coronavirus.

Poor air quality is the largest environmental risk to public health in the UK. In 2010, the Environment Audit Committee considered that the cost of health impacts of air pollution was likely to exceed estimates of £8 to 20 billion. Long-term exposure to air pollution (over years or lifetimes) reduces life expectancy, mainly due to cardiovascular and respiratory diseases and lung cancer. Short-term exposure (over hours or days) to elevated levels of air pollution can also cause a range of health impacts, including effects on lung function, exacerbation of asthma, increases in respiratory and cardiovascular hospital admissions and mortality.
Social injustice of air pollution impacts on people

There is a strong relationship between age, poverty, road NO\textsubscript{x} emissions and exposure to NO\textsubscript{2} concentrations in the UK. Urban areas with the highest proportions of under-fives and young adults, and poorer households, have the highest concentrations of traffic-related pollution. Households in the poorest areas of cities emit the least NO\textsubscript{x} and PM\textsubscript{2.5}, whilst the least poor areas emitted the highest, per km, vehicle emissions per household through having higher vehicle ownership, owning more diesel vehicles and driving further (Barnes et al., 2019).

This type of inequity is widespread. In India higher PM\textsubscript{2.5} concentrations occur in urbanized districts with higher percentages of scheduled caste people (SCs), young children, households in poor condition, and households without toilets. We also found significantly higher PM\textsubscript{2.5} concentration increases in less urbanized districts with higher percentages of SCs, female, children, and people with disabilities, as well as households with no toilets.

Conclusion: a call for clean air as a human right

As car ownership has grown with the expansion of the urban middle class around the world, air pollution in terms of NO\textsubscript{2} and particulates has expanded. The health of increasing numbers of disadvantaged and less able people is being threatened. Society has dealt with other forms of air pollution many times before. The 1955 UK Clean Air act was a response to the great smogs (especially December 1962 in London, which this author personally remembers); with the effects of lead in petrol which particularly hit young school children; with acid rain; and with the global problem of the hole in the ozone layer. Now the challenges of particulates from diesel engines and generally with carbon and other greenhouse gas emissions must be dealt with urgently. Let us make clean air a human right and build back greener to both protect the health of all of us and to set in train the urgently need changes to mitigate global heating.

Key references


This article considers the preliminary determinants causing the spread of zoonotic disease among humans, and the spread of human disease in cities. Zoonotic diseases that pass from animals to humans include Coronavirus, the current pandemic that changed our lifestyles and livelihoods since February 2020. Pandemics spread where intensive living conditions prevail, but more importantly where poor hygiene and polluted air, water and waste impact human habitat. Urban settings are home to most of the world’s people, but what can we learn about the design of our cities to prevent, mitigate and improve resilience to future pandemics? This article also examines Urban Design for Pandemics (UD4P) and provides a meta-analysis of monthly articles published in 2020.

Fig. 1. The interconnection between people pollution and pandemics focusing on action for better urban design.

Background

The rapid human population growth on Earth has displaced other species and their capacity to thrive in their natural habitats. The ‘natural systems on which human life depends’ are being undermined by Anthropocene behaviours where the healthy balance between people and nature is being lost (Brundtland, 1985). Safe fresh water, clean atmosphere, productive land, pristine oceans, and clean beaches are disappearing and the safe spaces for biodiverse ecocentric health are being encroached upon by unsustainable human development (Earth Laws, 2020). The footprints from human population explosions in towns and cities are greatly extended by monoculture food production (specific non-endemic crops) and intensive animal husbandry (meat production by narrow species livestock). This means that animals, once wild, are becoming part of our human habitat to survive. Some become more domesticated, like cats, dogs, pigs, chickens, horses, cattle, camels and goats, which result in cross-contamination of parasites, bacteria, virus, prion and diseases in humans, only previously seen in animals. 70% of new viruses are zoonotic, some traced to wild animals at wet markets. In this century alone, we have seen SARS, MERS, BSE (Mad Cow Disease), Hendra Virus and Coronavirus. (Pepper: 2020)

In summary, our human populations- with nearly two-thirds living in cities- are at greater risk of pandemic recurrence if good urban governance does not address: (1) prevention, (2) mitigation of severity, (3) management of impacts and (4) strengthening resilience, through evidence-based information, environmental stewardship, social cohesion, community-need physical systems, and diligent ongoing hygiene with regenerative urban design principles.

Now is the right time to consider lessons to redesign and retrofit our cities to enable resilience to pandemics (Fig.1).
Measuring Human Impacts of Pollution

In measuring our impacts to manage better, Carrying Capacity is seen as a valuable tool. It looks at more than the nine Planetary Boundaries (Rockström and Steffen, 2009 and 2015) to determining safe operating space for humanity. The key parameters are: freshwater; land-use; biodiversity; nitrogen; phosphorus; ocean acidification; ozone depletion; chemical pollution; and climate change. Globally we have already surpassed several of those safe boundaries.

Global measurements of Natural Assets may be abstract, but town and city level assessment are highly tangible. Water use and reuse, safe sanitation, greenhouse gas emissions, erosion and chemical runoff may be the responsibility of the local authority or state agency, but other matters may be regional, national or global. Pollution spreads through the environment, so we can only really measure its sources and not necessarily all the sinks, despite sophisticated modelling. The health and economic benefits of services provided for free by nature are Ecosystems Services. For example, in South East Queensland a mature tree may be considered as providing $22,000 per year for pollution management, noise abatement, carbon sequestration, shade, cooling, water retention, erosion mitigation, biodiversity protection, microclimate modification, spiritual health, and cultural value (Maynard et al., 2010). In Singapore, trees in public parks have plaques on their trunks to educate visitors on the contribution value of each tree to a healthy human environment (EAROPH: 2014).

At the local level, urban food footprints have expanded with greater travel and exotic tastes, increasing per capita carbon footprints. Water foot-printing (originating in Netherlands in 2000) and water-exporting also make the task of measuring impacts more complicated (Davis: 2016). Before Covid, city resource foot-printing was difficult, but in 2020 things changed significantly. International trade and movement were scrutinised, as life went back-to-basics in most places. Measurements were taken as city pollution diminished, greenhouse emissions reduced, and domestic living was measured. In one month, China (Beijing) reduced its greenhouse gas emissions by 24% (He et al: 2020). Sewage systems were analysed, detecting coronavirus in populations that allowed for suburbs, towns and cities to take precautionary action even if an outbreak had not yet been discovered through human symptoms and medical covid-testing (Logan City Council, 2020; Hurdley et al., 2020). Care closer to home is most valuable.

Public Health interventions: international lessons

Each country chose its course of early intervention. Leadership styles were as diverse as precautionary such as New Zealand, Singapore, Taiwan, and Iceland, or as denying as USA, Turkey, Egypt, the Philippines and Russia. This had significant impacts on the lives and livelihoods of people from the identification and spread of the disease, the severity, the medical response, and the humanitarian crises, to the global concern for rich developed countries, especially those losing 10% of their urban populations within a few months. Some the precautionary strategies of less developed countries like Botswana have been hailed as honourable and cost effective. The immediate response to epidemics must be to identify the culprit accurately and to isolate the source. Tracing the source and likely circle of contagion means that human behaviour must change to contain the spread. A total lockdown allows these to be determined quickly.
The International Monetary Fund graph (Fig. 2.) illustrates the diversity of national strategies for unlocking after isolation. Benchmarking behaviour helped understanding of the prevalence of Covid. However, the pressure cooker of complete isolation conflicts with the need for human social interaction.

The saving grace for social isolation in 2020 is that technology has allowed for interaction, albeit virtual. But only the privileged has that option. 21% of rural children Queensland do not have reliable access to internet to participate in regular online education, so in a rich society some of our children will be less prepared for the future. Technology allows immediate communications, QR code tracing, fast medical systems including emergency response and tele-surgery, online education, online business and trade, quarantine management, and online social support systems for the isolated and elderly. So, the situation in this pandemic can be favourably compared with the Spanish Flu of 1918. Historically, the great plagues and the Spanish flu killed people due to ignorance. One 2-hour parade after World War 1 caused 600,000 Spanish flu deaths in one capital city (SBS news: 2020). This is generally not the case today with news and regular communications, priority medical aid, and support systems.

In the Pacific, 24 countries have different Covid management strategies depending on governance, density of populations, hygiene risk and border control. Every two years, the military of 42 countries are invited to RIMPAC War Games in the Pacific, trialling their new machinery, techniques, chemicals and strategies. Postponed from May until August 2020, only 22 countries participated eventually, but the impact continued for the environment, people, and animals, exacerbating risks of Covid with thousands of troops from each country in-situ for up to two months. At least 26 US Navy warships reported cases of covid-19 infection, while troops from Thailand and other nations brought to Hawaii may have affected contagion rates. Apart from damage to the fragile marine and terrestrial ecosystems, 250,000 whales were deafened, endangered species died, small towns were taken over with onshore troops residing and celebrating war game victories. The whole fabric of life changes, but the USA military now owns significant land in Hawaii and infrastructure throughout Pacific countries. RIMPAC rituals seem to be a rite of passage for participants. Many of the Pacific countries are impacted adversely.

Vaccines are the long-term intervention. Different vaccines provide different assurances, and as of March 2021, no one vaccine is a panacea to (1) stop contagion, (2) prevent spread, (3) mitigate severity, (4) provide lifetime protection, (5) have no side effects. In the meantime, vaccines herald a safer environment so that we can resume some semblance of pre-2020 lifestyle. The lives of some families have changed so much that they choose to escape to rural areas that have no schools or hospitals – social infrastructure. But what is our concept of cities? What does a healthy city designed for resilience to pandemics look like?
Lessons from the pandemic on how to redesign for resilient cities.

Cities are the hubs of human habitation, centres for cultural identity, and places for social infrastructure such as hospitals, public transport, food markets, supermarkets, meeting places, and the engine rooms for national economies. But cities have been demonised as the places where the virus spreads.

In retrofitting our cities and designing for future resilience, we must consider the ugly, complex, wicked problems, starting with pollution, people and pandemics. We also need to be incorporating futures thinking for ongoing crises like climate change, food security, energy poverty, corrupt governments, and crime at a time in history we should be embracing humanity, sharing assets and sowing healthy seeds of hope. The United Nations Young Professionals 2020 Forum concluded that young people worry about inheriting the public debt from Covid, and investing in the futile urban systems. The WEF 2021 at Davos recommended positive ways forward, but steps need to be taken in every sector and in some ways, we are all responsible to care. The wicked problems start with the need for caring for the most vulnerable people – leave no one behind.

The right to shelter is important, and ‘home’ is the refuge from epidemics. Cities are responsible for their vulnerable peoples now including:

- international students and migrants who cannot return home, who are not entitled to government financial support, have no home or work opportunities, and rely on compassion from their communities for crisis food and shelter;
- health and aged-care workers in the frontline;
- those whose casual work stopped and permanent employees who negotiated hours as business and luxury industries dissolved during the economic shadow epidemic;
- women as carers and home-schoolers in domestic violence situations as economic stresses worsened; and
- emergency and quarantine workers now the high-risk category.

In Australia, an estimated 2.1 million people were said to be vulnerable before Covid (Rahill:2020), so the pandemic will have considerably increased that number. A city is only as strong as its weakest link. When we reconsider what our cities are for, apart from meeting the need for socialisation, they are economic forces and business hubs, and help give us our identity. Office blocks may still dominate the skyline but now we need to deal with an urban housing crisis. Many cities’ economic contributions are larger than those of small countries, and under certain mayors, cities behave like small countries (World Economic Forum, 2021).

A policy cycle approach to retrofitting urban areas for pandemics

All future policy development begins with leadership to articulate the preferred vision and enlist partnerships to implement desirable change. The fundamental components of planning for future urban growth are:

- **Prevention** includes better human hygiene, less pollution, better natural ecosystems health, and more biodiversity (regenerative principles). (Newman, 2010, Sachs, 2020)
- **Mitigation** includes refining urban working systems (office spaces), use of technology, revising public transport systems and ensuring safe social infrastructure like schools, hospitals, shopping, and socialising activities. (Urban Design Alliance, 2020)
- **Management** includes cleaner living, smaller local footprints, conscious consumption, precautionary hygienic human interactions, and fresh air (rather than quarantine hotels and hospitals with contaminated air-conditioning systems), emergency housing, open space recreation, public parks and outdoor exercise for all ages. (AHURI, 2020) (Daszak, 2020)
- **Resilience** includes balancing the future expectations, legal requirements, regenerative design inside and expanding past the urban footprint, reviewing trade and business with tourism and recreational activities, and adequate care for vulnerable peoples most impacted by Covid. (Queensland Parliamentary Inquiry, 2020)

This is an appetiser for how to articulate urban design for pandemics but a framework comprising toolkits of focussed culturally appropriate interventions can be provided. Now is the right time to consider lessons to redesign and retrofit our cities to enable future resilience.
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12. Indigenous Sacred sites: A cautionary tale of destruction of significant cultural heritage sites by a mining corporation.

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The following statement of acknowledgement of Country is a statement made publicly and supposedly adhered to throughout Australia today:

'We acknowledge Aboriginal and Torres Strait Islander peoples as the First Peoples of Australia. We pay our respects to Elders past, present and emerging. Our vision for reconciliation is a future where all Australians are united by our shared past, present, future and humanity'.

This commonly stated ideal and guideline for ethical and respectful behaviours towards Aboriginal people is often not adhered to. Consideration for Aboriginal culture and the land where culture is intrinsically embedded has often been overruled, not listened to, nor respected, nor understood. The Juukan Gorge story in the Pilbara Region of Western Australia (WA) is an example of this, as mining ventures have resulted in pollution and destruction of sacred spaces and cultural legacies that Aboriginal people have been preserving over generations.

Preserving sacred sites for Aboriginal peoples is of prime importance to them, both in their guardianship role to preserve country against the land being polluted and destroyed, and to preserve the cultural history and sacred spaces over generations, (‘Country’ for Aboriginal people means both a place of belonging and a way of believing). Aboriginal cultural history is integral to sustaining their community life and guidelines for living. Deeply embedded into Aboriginal spiritual values is the belief that the land is sacred, that the ancestral spirits are everywhere through the natural landscape, and that if sacred sites are destroyed the Ancestral spirits through being disturbed will no longer protect them. The deep belief relating to this is that by having not carried out their spiritual and cultural obligations to protect country, disharmony will result (Singh, 2001).

Rio Tinto mining company had gained ministerial consent to blast the Juukan Gorge area in 2013, in their quest to expand their iron ore mining operations. One year later during an archaeological expedition, it was realised that this site was twice as old as initially thought and was rich with many cultural artefacts and sacred objects. It has been determined that this area of the Hammersley range in WA was used as a place of refuge towards the end of the Ice Age, at around 12,000 to 18,000 years ago. There are also associated finds of bones from middens that had embedded signs of changes over time in fauna, that paralleled changes in climate. (A midden is a deposit of bones, botanical material, shells, or other artifacts associated with human occupation).

The Puutu Kunti Kurrama and Pinikura peoples (PKKP) heritage manager had advised Rio Tinto that this site was estimated to be amongst the five most significant sites in the Pilbara region, with information provided by archaeologists that the Juukan 2 rock shelter could be explained as the most important archeologically significant site in Australia. Regardless of this knowledge mining blasting proceeded, and this important information did not get considered.

Rio Tinto had won legal approval from the Western Australian government under an old Aboriginal Heritage Act. There had been strong objections from indigenous peoples from this area that were not listened to, and resultant distress and feelings of loss and lack of respect were experienced by Aboriginal people. Noted indigenous leader and anthropologist Marcia Langdon has described Tio Tinto’s actions as a form of ‘cultural vandalism’ of sacred sites (Alston, 2020), with resultant pollution occurring in the form of destruction and devastation of this sacred historical area (Figs 1 and 2).
What is considered the most valuable and sacred find from the Juukan Caves area was the plaited length of human hair found in an archeological expedition in 2013 and assessed as over 4,000 years old. This find was shown through DNA testing to be linked to ancestors of the Pinikura and Puutu Kunti Kurrama (PKKP) traditional owners. Archeologists have described this archeological find as the type of find that occurs ‘once in a lifetime’ (Wahlquist, 2020a).

However, Rio Tinto was able to proceed with the mine blasting as Australian State laws did not prevent this, indicative at the time of sacred Aboriginal sites not being a priority over the opportunity for more economic business progress and more jobs. This incident is not without precedent. There are other similar incidents such as ancient rock art located on the Burrup Peninsula in north-west Australia facing threats from a gas project, that a government enquiry found is under pollution threat from emissions from nearby industrial activity.

Since the devastating destruction of the Juukan Gorge caves, with ensuing pollution of both the cultural history site and the important cultural history legacy of this place, there has been much criticism of Rio Tinto’s actions by government officials. Apologies have followed from Rio Tinto, including resignation by the CEO of Rio Tinto. Regardless of apologies or ensuing new and better ways to act in a more sustainable way in the future when considering mining on indigenous land, some things cannot be put right or restored. Archeologists in their quest for researching Aboriginal cultural history and environmental changes
over time have had their dig sites polluted and changed. Aboriginal people have had their cultural history and sacred spaces seriously disturbed and destroyed. Aboriginal history is sustained through storytelling, this can still occur but not in the way of experiencing the sacred spaces as they were preserved for many thousands of years. Aboriginal people have protested and yet more mining destructive actions have continued (Fig.3.).

There has been some reaction from mining giant BHP (Borillo,2020) who after the massive negative response to what happened with Rio Tinto at Juukan caves, put on hold plans to implement destruction of forty sacred sites in WA that had received WA Aboriginal Affairs Minister approval to proceed with mining exploration.

Fig. 3. The destruction of the Juukan Gorge heritage site drew a public outcry against iron ore miner Rio Tinto. (ABC News: Hugh Sando)

This destruction of the culturally significant Juukan Gorge caves area was not illegal. The Federal level of Australian government has in place the Environment Protection and Biodiversity Conservation Act (1999) that provides a legal framework to protect areas of national heritage listing. However, there are many ancient Aboriginal sites that do not have national heritage protection. Australian State laws preside over decisions where there is no national heritage listing, and where there has not been an application for Australian Federal government application. In the Rio Tinto case, the Aboriginal Heritage Act of 1972 was being followed, but there was a discrepancy between Section 17 that makes it an offense to negatively impact on an Aboriginal site without ministerial consent, whereas Section 18 allows the owner of the land (and this may be the holder of the mining lease) to apply for permission to proceed with approval of a committee with a development. In this case the minister gave permission to Rio Tinto to proceed with their mining intentions in the Juukan George area. This decision occurred under a dated Act that had not kept pace with cultural inclusion and consultation, as there was not a statutory requirement that traditional owners be consulted.

As a response to the destruction of Juukan Gorge, there have been submissions to an inquiry on the destruction of Juukan Gorge by the Federal Parliamentary Joint Standing Committee on Northern Australia. It has been highlighted that there are ongoing challenges in the Australian Federal Parliament, and the northern Australia committee has recommended in the initial report on this incident that Rio Tinto compensate the PKKP people, to reconstruct and take efforts to rebuild the Juukan Gorge site and make a commitment to halt mining in that area in the future. There have also been recommendations of a more united Federal approach to this issue and the need to consider the many values attendant to Aboriginal heritage sites (Jarrett et al., 2020). The ‘Never Again’ Juukan Gorge inquiry has released its interim findings (2020) which were scathing in criticizing Rio Tinto’s role in this tragic pollution and destruction of this historically significant environmental and culturally significant landscape.

Preserving culture-based sacred natural sites has associated benefits of protecting biodiversity and associated ecosystems. These sites often have protective practices of conservation ensured through applying religious beliefs and sociocultural practices to ensure preservation and preventing pollution and destruction (Aniah & Yelfaanivbe, 2016, p.916). Ideally culture- based conservation of Aboriginal sites should require consultation with elders to ensuring
sustainable environmental and cultural spaces. However, consultation with Aboriginal people does not come associated with the power to stop economic ‘progress’.

The ongoing challenge remains: how to create bridges and work together between two quite different worldviews: local Aboriginal communities and Western commercially oriented values. Colding and Folke (2001) recommended that to ensure sustainability of community ecosystems and cultures it is important to acknowledge and consult with Aboriginal people, and to respect their traditional institutions and ways of doing thing. This consultation does occur today but cannot be claimed to be effective if destruction and pollution of sacred sites is occurring to the extent it has been. Anchoring protection of sacred spaces of cultural significance and significant environmental areas that have historical significance needs more than the promise of psychological contracts to act respectfully in the future. The World Heritage Committee is taking action, one example being to work towards instigating protection of rock engravings on the Buppu Peninsula in Western Australia. This process is not fast, and meanwhile acid emissions from industry on this Peninsular continue to erode, damage and cause discoloration to rock carvings (Wahlqhist, 2020b).

The destruction continues, with cultural and environmental damage that pollutes sacred Aboriginal sites that cannot be reset to pre mining states. In WA, mining companies who intend to harm or destroy Aboriginal sites during their mining operations must apply to receive approval to proceed, under Section 18 of the Aboriginal Heritage Act. A social anthropologist, Dr Sarah Holcombe has stated that ‘Aboriginal people’s own knowledge and definition of a ‘site’ is barely part of the conversation (Dick, 2021). The Native Title Act has enabled Aboriginal people to negotiate about protecting sacred sites, but they do not have the power to in the final analysis either protect or stop mining operations. Over the last ten years there have been 463 applications for mining leases that would grant permission to either disturb or cause destruction to Aboriginal heritage sites, all of which have been approved (Dick, 2021). There are currently more than thirty large iron ore mines in the Pilbara region of WA (Fig 4).

Fig 4. The locations of major iron ore projects currently operating in Pilbara, relative to Aboriginal nations (Dick, 2021). Source: WA Department of Mines. Industry Regulation and Safety and the Australian Institute.

The WA Government is introducing the Aboriginal Heritage Bill (2020) for public consultation which would update the current Aboriginal Heritage Act (1972). Under this new proposed Act, if passed, there would be greater powers for Aboriginal people through the Aboriginal Cultural Heritage Council, a more transparent and thorough tiered assessment system, more continuous disclosure obligations; more Ministerial power to stop, prohibit or remedy activities that might harm Aboriginal cultural heritage; and offense judgements and penalties for harmful activities or false information. There has been criticism of this proposed Act (Kwaymullina, Kwaymullina, Butterfly, 2020) by Aboriginal people, including that proposed changes include that the Minister can consider but not necessarily have to follow recommendations from Aboriginal people (requesting that mining not proceed). Applicants for mining can appeal, but traditional owners cannot appeal. There is strong dissatisfaction that there is not enough voice for Aboriginal people to be consulted, and that it should be that Aboriginal involvement should be statutorily...
embedded as part of mining approval process (Kwaymullina, Kwaymullina and Butterfly, 2020). The United Nations Declaration on the Rights of Indigenous Peoples is not apparent in the language and recommendations being made around what happened at Juukan Gorge, yet it provides an international legal framework for how organisations can best engage in ways that respect, protect and promote the rights of Indigenous peoples (Jarrett et al., 2020). There has been concerted action at the community level with, for example, the Transparency International Australia (2020) recommending further examination of consent processes on how approval to mine was obtained, to have more transparent environmental impact assessments, and to ensure Aboriginal voices are heard.

There are questions to address: How many other potential environmental and Aboriginal cultural sacred spaces are at risk? Will these spaces be properly identified? Will there be appropriate consultation and agreement with traditional owners and between other stakeholders that are listened to? Will there be agreed to and actioned government protection for these spaces? Can national heritage protection for ancient Aboriginal sites of significance be put in place more effectively? Can potential Aboriginal cultural and land impact pollution impact of nearby mining ventures be correctly assessed (prior to mining ventures)? Will there be ramifications for mining companies that do not comply or listen to Aboriginal perspectives and wishes on these mining related issues?

Never again can we allow the destruction, the devastation and the vandalism of cultural sites as has occurred with the Juukan Gorge—never again! (Never Again Report, 2020, p.v)

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13. Trees are our past and our future: Lessons from pollution of forests in Australia

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“A nation that destroys its soils destroys itself. Forests are the lungs of our land, purifying the air and giving fresh strength to our people.”

-Franklin D. Roosevelt

Many species of trees are facing extinction, and the question needs to be asked of how can trees that have been part of history; that have experienced human civilisations that have come, gone, and changed; have lived so long; and yet, when they should be so valued as hallowed elders in the planetary ecosystem, they are now facing extinction by the impacts of human driven climate change and ecosystem damage? In Australia nearly half the forests have been destroyed over the last 200 years, and yet there are trees on earth such as an Australian eucalypt tree that have lived nearly 13,000 years (Fig 1). With an estimated age of over 80,000 years, Pando, a Quaking Aspen (Populus tremuloides) in the Fishlake National Forest, Utah, USA is claimed to be the oldest tree in the world as well as one of the oldest living organisms. In contrast, Homo sapiens evolved in East Africa around 200,000 years ago and first arrived in Australia some 60,000 years ago and North America about 20,000 years ago. We are somewhat insignificant in global long-term history but have had a greater impact than any other animals on the lands and seas and wildlife of the planet than any other species. How is it that we have had such an impact on the world’s forests? The case of Australia may indicate some answers.

Australian forests are around 134 million hectares in total, comprising 17 percent of Australian land area. Australia has around 3 percent of the world’s forests yet is ranked as the seventh largest forest area in the world. Of Australia’s forests, native forests comprise 98 percent, with the remainder being comprised of commercial forests and other forests (Abares, 2020). There are eight main types of forest tree in Australia (Fig.2), the main ones being eucalypts (78 percent) followed by Acacias (7 percent). Forests are a valued resource in Australia, so negative impacts such as pollution are closely monitored. Forests are valued for their ability to protect soil, are areas of clean water, provide social benefits such as tourism and recreational opportunities, are of value for research and education, and are (or should be) sites that can enable preservation of cultural and environmental heritage and sustainability. Indigenous forests comprise 52 percent of Australia’s forest area (Abares, 2020).
Land clearing of forests in Australia is proceeding at a disturbing rate. Projections were that by 2020 3m hectares of pristine forests would have been bulldozed in eastern Australia alone. This level has been described as equating to more than 1,500 football fields of native woodland and scrub, inclusive of forests, being cleared daily in Queensland alone on every day (Slezak, 2018).

Pollution can also be interpreted as an unnaturally occurring change of the landscape, such as has happened in the reduction of forest area in Queensland where there was an increase in environmental weed infestations, and an increase in the impact of feral animals that encroached into formerly forest areas (Gibson et al., 2013). The side impact of deforestation is that many tens of millions of native animals, many of which are threatened species, have experienced, or are facing, losing their habitats (Slezak, 2018). Modified landscapes results in a reduction over time in biodiversity, negative destruction and changing of ecosystems, and species loss (Cogger et al., 2003). A serious and ongoing negative impact from deforestation is the resultant change in soil composition, which impacts upon areas further downstream. For example, in Western Australia it has been estimated that around 7 percent of agricultural land is now being negatively impacted by increased salination because of deforestation.

Impact of threat from deforestation on species extinction and climate change acceleration through deforestation are well-researched and documented (Cogger et al., 2003; Laurance, 2010). However, there are other negative impacts that can affect spaces far from the original deforestation area. Negative impacts identified include impacts on marine and freshwater habitats caused by increases in erosion and sedimentation, and future pollution threats when land is used differently such as threats from nutrient runoff from agricultural lands and alluvial mining, which affect the ecological balance of wetlands and rivers (Ainsworth et al., 2016). Resulting pollution in water then continues its journey and trail of destruction by flowing into rivers that in turn drain on to the Great Barrier Reef (Commonwealth of Australia, 2014). Deforestation accompanied by native vegetation clearance impacts on ecological processes such as changing hydrological cycles, which in turn cause rise in water tables and mobilise salt in the soil, and as highlighted by Walker et al (1993) cause increased salinity.

Bushfires of increasing ferocity and shorter time between fires are becoming an increasing part of the Australian landscape. With global warming accelerating, soil and vegetation is becoming increasingly dry, which presents an ideal situation for wildfires to occur. Bushfires have increased in Australia and are now occurring in areas not previously ravaged by such fires, for example occurring in the Gondwanaland Rainforest (Fig 3) and in Lamington National Park in Queensland (Fig 4), and areas of Tasmania that lost 200,000 hectares of vegetation and forest (Baldwin and Ross, 2019).
Not only has devastation occurred to the ecological system because of these and other recent Australian fires, but associated soot, ash from the fires and burned vegetation have found their way to streams, to beaches, and to water reservoirs, with water becoming polluted, resulting in blooms of algae, and changing water quality. This by-product of forest fires has been found along shorelines; has choked the gills of fish; affects filter feeders such as mussels; washes into water reservoirs; and affects the quality of water that is often in short supply, resulting also in increased carbon dioxide emissions around the planet (Duncombe, 2020). Smoke from these Australian fires has had global impacts, with increased aerosols rising into the upper atmosphere, raising CO$_2$ levels.

Wildfires totally change the ecosystem services of forests. Instead of bringing benefits to humanity by absorbing carbon dioxide and some of the other pollutants from human generated activities, during bushfires they release these pollutants into the air with associated smoke and ash. Although Isley and Taylor (2020) estimated that these toxic trace elements (associated with leaded petrol not used since 2002), and the industrial emissions from fossil fuel burning, refineries, transport and power generation, are considered as pollutants, they remain within recommended health based suggested levels at this stage. However, this ‘just safe’ level of pollutants cannot be predicted for future fires.

This toxic release as a side impact of Australian forest fires into the atmosphere reminds us of what occurred in Ukraine and Belarus when radioactive materials from the Chernobyl disaster that occurred years earlier, were released into the atmosphere during recent bushfires. When fires release carbon in large quantities into the environment, this in turn can result in more extreme weather, which for Australian forests may mean more severe forest fires in future.

Although those involved in logging and land clearing are often the focus of concern about the resulting pollution that alters both ecosystems and landscapes, there is also considerable pollution stemming from tourism. Recreational trails, particularly when associated with motorised recreation can cause inroads into forest areas, resulting in fragmenting vegetation within the forest with attendant impact on flora and fauna, polluting these formerly pristine forest areas with rubbish and causing damage to ecosystems (Ballantyne, Gudes and Pickering, 2014). One example of this is the popular tourist destination of the Daintree Rainforest, the oldest rainforest in the world, estimated to be around 180 million years old. Tourists and their vehicles also cause pollution to forests, and this has occurred also in the Daintree Rainforest area (Fig 5) which is a World Heritage listed site and is valuable and noted for having the highest number of rare and threatened plant and animal species in the world. Pollution and damage to the Daintree Rainforest area includes litter from plastic, glass, wrappers, cans, and paper, but the more invisible but high impact concern is the ecological pollution of the area that has caused stress and displacement to Daintree Rainforest flora and fauna. Marine dumping of rubbish in the Daintree Rainforest and other forest areas accessible to tourists is a continually growing risk with increasing negative environmental impacts. Air pollution risks and impact are also occurring in the Daintree Rainforest area, as water particles collide with carbon dioxide forming a weak acid, which becomes acid rain which in turn falls and pollutes rivers and lakes and causes harm to aquatic life.
There is value in considering how we could do things differently in Australia and all countries, if we could reframe our perceptions of the human as being part of the earth ecological system rather than at the top of the ecological chain? Alan Watts (1989) presents an argument that can relate to destruction of trees or anything living on this Planet as humans being in a tendency to have an ‘I’ perspective which aligns with separateness and can lead to a sense of needing to be a conqueror of nature or in other parts of life also. This perspective of existence is egocentric and opposite to feeling a ‘we’ approach that would approach life with an awareness and respect for being part of a world ecosystem. Wohlleben (2016), drawing on scientific research, presents the analogy that trees parallel human families and communities, communicating and supporting and nurturing each other, even guarding each other against danger. If we reflect on this fact, there are lessons to learn from trees in living life as humans in the same way as trees, not destroying each other or other forms of life, protecting and respecting the planet, and viewing trees and forests as part of the bigger ecosystem of earth and viewing trees as valued elders.

“If we want to use forests as a weapon in the fight against climate change, then we must allow them to grow old, which is exactly what large conservation groups are asking us to do.”
Peter Wohlleben (2016)

References
14. Which solution towards managing regional water pollution problems?

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Introduction
Pollution is a result of degrading the ecosystem of nature by human beings not knowing that future generations will need what was created by our Creator for creatures. The causes of water pollution include land degradation, deforestation, soil erosion, bad methods of fishing, siltation, poor garbage management, wetland degradation, building near buffer zone and gender disagreements to what to value, use and conserve.

Recognition of the need for action on gender mainstreaming regarding water pollution by United Nations programmes.
Water is essential to human beings and all forms of life. However, pollution and lack of access to clean water is proliferating the cycle of poverty, water-borne diseases, and gender inequities. More attention is needed to control pollution and to improve water quality and sanitation for the benefit of women who collect domestic water and to improve health. Over-exploitation of groundwater and growing pollution from leaching of fertilizers and pesticides compels women (and girls) to walk further to collect safe water for their domestic needs (Gender and Water Alliance, 2006).

Background: water pollution issues in Uganda
Water and sanitation remain strategic issues for the health of women and girls in Uganda, where 27 million of Uganda’s 43 million inhabitants lack access to improved sanitation (Access To Water Is Access To Education | Water.org (Accessed 02 March 2021)). Many schools in Uganda lack toilets on campus, making full-time attendance and course completion difficult for many girls. Wastewater treatment remain inadequate and has serious consequences for Lake Victoria, into which much of Uganda’s drainage waters flows.

The significance of Lake Victoria
The ecological health of Lake Victoria has been damaged by rapid population growth, especially through in-migration of plantation workers, and because of clearance of natural vegetation and pollution from industrial, urban and agricultural sources (Banaddas et al., 2009). In particular, Murchison Bay, the area that is effectively the estuary of the rivers draining the Kampala urban area, is both a source of freshwater for the city and the recipient of all the wastewater from the built-up area. The 60 km² by is central to the development and health of over 1.5 million people in its catchment area. Although it is a source of food, employment, transport and recreation, the bay is being used as a dumping ground for waste.

Fig.1 View of Murchison Bay. Lake Victoria, near Entebbe
Industrial pollution from the manufacturing zones within Kampala is releasing heavy metals into drainage waters. Many such discharges are uncontrolled. Many of the local streams that are used for irrigation downstream of built-up areas contain high concentrations of heavy metals, such as lead and copper, that could be taken up by food crops and so enter human blood streams. They could also enter the human food chain through fish in Lake Victoria (Walakira and Okot-Okumi, 2011).

Potentially more worrying is pollution by organic compounds, particularly those in cosmetics and health care products. Since 2019, high levels of non-prescription pharmaceutically active substances (PhACs) have been found in stream channels draining into Lake Victoria. At present the levels in Lake Victoria itself are not worrying, but the PhACs are not being removed by the processes at the wastewater treatment plant (Dalhme et al., 2020). Improvements to wastewater flows are necessary. One way of alleviating some pollution problems would be to use natural or artificial wetlands to remove contaminants. In Masaka municipality, southwest of Kampala, the wastewater treatment plant was inefficient, but the passage of wastewater through a wetland reduced pollutant loads significantly, by between 70 and 90 percent for suspended solids, biological oxygen demand, nitrogen and phosphorus. Nature based solutions, such as wetlands, can play a significant role in reducing pollutant loads in storm flow pulses and from intermittent releases for Ugandan municipalities with currently inadequate treatment facilities (Bategenya et al., 2015).

**Approaches**

Wider approaches beyond sanitary and civil engineering and green infrastructure are required. Consideration of water users and land and water managers is necessary. Above all, to meet the differing perspectives and needs of men and women, gender mainstreaming is necessary in the Lake Victoria Basin. Gender mainstreaming in the region of Eastern Africa through training of trainers and awareness programmes is one of the key answers to pollution. Another is to reduce soil erosion and the washing of agricultural chemicals into streams by covering the land by green vegetation to maintain and conserve, protect soil erosion to our waters.

The Community based Impact Assessment Network for Eastern Africa (CIANEA) gender mainstreaming in water resources development project has been working in this direction for many years. However, the project is being lagging because of the COVID 19, because now we cannot meet as we used to do, what we do is sharing through emails and WhatsApp, there is a bottle neck because of not reaching the project’s sites. We pray to our creator to forgive us and pass through Covid.

When applying gender mainstreaming to a given site in the Lake Victoria Basin, we must consider: implementation; stakeholder identification and responsibilities for specific activities: who does what? We need to assess the resources required: who has access, control, owns and makes decisions regarding the resources. In examining the benefits of a project, we ask what factors control access to benefits. Finally, we must look at participation in the project: how and when do men and women participate in realizing the benefits of which they may or may not have control?

**Fig. 2** Participatory decision-making in the field in Uganda.
Lessons learnt.

We have gained five key lessons from our projects:

- International relationships are extremely critical in obtaining major funding activities for the gender mainstreaming work.
- Participation of all relevant stakeholders is critical for the success of any dialogue. Ownership and appropriation of the process by all involved stakeholders are essential.
- Trust and understanding must be built from the beginning.
- Appropriate forums and platforms must be established for a dialogue to continue and be effective.
- Dialogues are most successful when they are integrated within existing institutions and processes.

Conclusion

In gender mainstreaming for water pollution reduction and management, stakeholder identification, partnership and participation bring transparency, access, control, decision-making and ownership. Collective decision-making is the way to achieve sustainable development goals and environmental health world-wide.

References


15. Combatting river pollution: the continuing battle in the River Mersey catchment, England

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Introduction

Water pollution in urban areas is a global problem that requires constant vigilance and action. Often called the cradle of the industrial revolution, mid-nineteenth century Manchester and its surrounding towns suffered from the rapid in-migration for rural areas, inadequate housing and poor public health services, that still beset many major cities elsewhere in the twenty-first century. The record of continuing public works to improve urban drainage and river water quality over almost two centuries summarised in this article gives an indication the dealing pollution is a continuing struggle which must have permanent and adequate government backing and community support.

Manchester, the industrial revolution and accelerating pollution

In the mid-nineteenth century Manchester contained overcrowded housing surrounded by factories, mills, railway lines and viaducts, much of which was liable to flooding from polluted rivers. Typical of this situation was one area at the foot of sloping ground, which was suffering accumulations of effluent from higher upslope, and flooding from the River Irk, a Mersey River tributary, polluted by the dumping of personal and industrial waste. In 1837, a nearby factory owner was fined because he dumped naphtha into the stream which caused “which large quantities of obnoxious and unwholesome smell, stenches and effluvia (to) issue from said River into and upon the dwelling houses of divers of His Majesty’s liege subjects” (Douglas et al., 2002). Under these conditions, diseases such as typhoid were widespread.

Although sewage collection systems were available at that time, waterborne sewage disposal and treatment did not become available until 1890. The major achievement was the construction of the City of Manchester’s large works at Davyhulme in 1896. This expansion set up a new form of organic waste: sewage sludge. This was originally taken by barge down the Manchester Ship Canal to be dumped in a defined area of the Irish Sea. When this ceased in 1998, Greater Manchester’s people were producing about 77,500 tonnes of dry sewage per annum, of which 45,600 tonnes required disposal.

Removing stormwater and waste domestic and industrial water required drains, which were developed in phases: (i) culverting of water courses and street drains to 1820, (ii) local sewerage systems 1792–1880 and (iii) intercepting sewers in two stages 1886–1898 (including the Davyhulme works). During the 19th century, the drainage system received ever increasing amounts of varied, and uncontrolled, discharges; including liquids containing many dissolved substances and much solid waste including ashes and cinders from houses and factories. The consequences of this are evocatively described by the 1870 Rivers Pollution Commission Report, a direct response to local and national concerns about the foul rivers: “When taking samples at Throstlenest Weir, below Manchester, at 05:00 h on July 21, 1869, we saw the whole water of the River Irwell, there 46 yards wide, caked over with a thick scum of dirty froth, looking like a solid, sooty crusted surface. Through this scum, here and there, at intervals of six and eight yards, heavy bursts of bubbles were continually breaking evidently rising from the bottom; and wherever a yard or two of the scum was cleared away, the whole surface was seen simmering and sparkling with a continual effervescence of smaller bubbles rising from various depths throughout the water, showing that the whole river was fermenting and generating gas. The air was filled with the stench of this gaseous emanation many yards away. The temperature of the water was 76°F, and that of the air 54°F.”

The Port of Manchester and its Ship Canal

In the meantime, the growth of international trade had led to Manchester developing its own inland international port and constructing a ship canal to the sea. Opened in 1894, the canal relied on water fed into to it from the diverted River Irwell. Not only did the water come, but all the solid and dissolved, inorganic and organic pollutants came as well. Thus, the Manchester Ship Canal became polluted virtually as soon as it was completed, both from the Irwell and from the 519 out-falls of sewage and industrial effluent which feed into it. As early as 1896, complaints of pollution during summer droughts led to the creation of a Port Sanitary Authority. By1912, the Eighth Report of the Royal Commission on Sewage Disposal had
defined the standards for sewage works effluents as 20 mg l\(^{-1}\) of BOD and 30 mg l\(^{-1}\) suspended solids. Meeting the BOD (biological oxygen demand) standard, which indicates whether there is sufficient oxygen in the water to support fish life remains a constant challenge because of the continuing risk of sewage spillage into the river and the canal.

As Greater Manchester has grown and people have used more water, increased water discharges to sewers meant more overflows from combined sewers, which carry both waste water and rainfall runoff from roofs and streets, during storm events. In addition, increasing farm effluent, especially from pig farms where effluent from one pig is equivalent to that from five humans, has led to many small streams being heavily polluted. In 1985 Manchester had 97 combined stormwater sewage overflows discharging into the Medlock, a Mersey tributary flowing through the heart of the city, which means that even in small rainfall events untreated sewerage entered the river.
After 1985, the UK urban pollution management programme set out to intercept most of these overflow sources and to create large new storm water storage tanks from which the effluent during overflows is far less oxygen demanding than from the original outfalls. With much financial investment, much of the 19th century sewage system has been rebuilt; treatment plants have been upgraded; and most small sewage treatment plants have been eliminated, with interceptor sewers taking wastes to major stations such as the Davyhulme treatment works. River water quality had improved considerably in the last decade of the 20th century and local fishermen were catching edible trout out of the River Mersey on the south of the City of Manchester.

Now one of the biggest wastewater treatment works in the UK, the Davyhulme Treatment Plant receives wastewater from the entire western side of Manchester, serving 1.2 million people and dealing with wastewater from Trafford Park, the largest industrial park in Europe. The site operates 24-hours-a-day, every day - and in heavy rain. Flows of more than 30,000 litres per second are treated at the works...that is like emptying 90 road tankers every minute! To keep this magnificent process going, £200m was invested in the plant in the decade to 2020.

However, in the years to 2027, new work to deal with high oxygen demand in the Irwell and the canal will be continuing. Works higher in the Irwell catchment at Bury, at Bolton on the Croal tributary, and on the canal at the Salford wastewater treatment plant are designed to increase oxygen levels in the Irwell and the canal and the minimise the adverse impacts of storm water overflows. The real issue is that at the old dock area at the Manchester end of the canal there is a large basin, where to ocean-going ships used to turn round. Over the decades, water flowing from the River Irwell into the large basin has met relatively slow-moving water and has itself reduced its velocity and dropped some of its suspended pollutant load. The muck and debris have accumulated on the floor of the basin. Now, particularly with climate change, there is a danger that in hot weather noxious hydrogen sulphide gases will be released from the bed of the basin. Also, this slow-moving water in the turning basin leads to a risk of low concentrations of dissolved oxygen that natural, flowing rivers enjoy. The low level of dissolved oxygen is a barrier to a thriving fish population and limits the migration of fish in the rivers in the upstream areas of Greater Manchester.

The Ship Canal and Salford Quays

However, other problems have had to be tackled in the former port area, now known as Salford Quays. The former docks were closed off from the canal and housing and offices were built around them. However, the water quality in the now isolated dock blue spaces was poor and its improvement was the essential first step in the development which has saw approximately 2,000 homes being built and the arrival of 900 businesses employing over 35,000 people. Although the water in the Quays was cleansed of organic pollutants within weeks of being isolated from the Ship Canal, stagnation caused by thermal stratification remained a significant problem. Thermal stratification, or layering of the waterbody, is a common occurrence in similarly shaped waterbodies, such as docks, reservoirs and canals, and is exacerbated by the quayside vertical walls and depth of the basins (up to 7 m). The result can be significant oxygen depletion of bottom waters from the biological activity of the microscopic plankton in the water column itself, and from the oxygen demand of the sediment, leading to unsightly bubbling and anaerobic conditions. Some form of artificial mixing (aeration) was therefore required to overcome this stratification and improve the water quality of the basins.

To solve this problem several artificial aeration systems (Helixors) were therefore installed into the Quays between 1987 and 1988. By completely turning over the water in the Quays Basins (typically taking around 4-6 hours to achieve) water column oxygen levels could be replenished from the atmosphere. The Helixor mixing system has proven highly effective at maintaining a well-mixed water column. The figure below clearly indicates how the oxygen differential recorded in 1986 was overcome by the installation and effective operation of the aeration system (see the 1989 profile in Fig.1.).
In addition, artificial reefs, floating islands, spawning habitats and lily stands have been introduced into the Quays to improve the diversity of the habitat. These efforts to increase heterogeneity were necessary at a time when natural colonisation by macrophytes was not considered a possibility, principally due to the basin depths. The Quays were also stocked with 12,000 coarse fish in 1989, following a trial in the preceding year. There is now a thriving fishery present. Indeed, the Quays have supported one of the fastest growing fish populations in the UK.

The Quays have been transformed since isolation into their current condition with Blue Flag water quality status and 100 per cent compliance with the mandatory standards of the Bathing Waters Directive in 2015. This has enabled them to host several major swimming events including the Commonwealth Games triathlon swimming stage in 2002 and the Great Salford Swim in 20109 and 2012.
Work has also been undertaken in the turning basin. Five oxygen injection units were installed into the Turning Basin in 2001. These could inject up to 15 tonnes of oxygen per day and the system performed well, maintaining the oxygen concentration required throughout the Turning Basin. It was operated throughout the months of May to September. The oxygenation system came to the end of its design life in 2011. With improvements in the water quality of the canal it was identified that use of liquid oxygen was no longer necessary. Instead, some form of water column mixing was now feasible, allowing atmospheric gases to replace oxygen. In 2012, 30 mixers were installed in the Turning Basin to maintain target oxygen concentration throughout the water column. This work is part of a continuing programme to manage pollution and achieve good quality freshwater throughout full upper 33km of the canal from the Irwell to Latchford Locks.

Conclusion

The Irwell catchment and the Ship Canal are constantly changing, both through local urban change and through global warming and the associated changes in weather systems that have altered storm magnitudes and frequencies. Although Greater Manchester has few of the old polluting industries left, it still has combined sewers and if big storms are more frequent, overflows of sewage laden urban storm water could become more frequent. Hotter, and possibly drier, summers could accentuate oxygen depletion in barely moving waters in the turning basin at Salford Quays and affect the recovering fish movements and the safety of engaging in water sports. The battle against pollution is continuing in Manchester 200 years after the worst circumstances of the early industrial revolution. It is a lesson we all must learn, but particularly governments: there is no once-for-all fix for pollution: it requires continuing action by all of us, individuals, communities, businesses and governments.

Further information

**General Background on health and environment:**

**The Industrial Revolution in Manchester and origins of the Ship Canal:**

**Water quality and storm sewer overflows:**

16. **Pollution and the impact on foreign fishing Industry on Sardinella in West Africa**

**CanJarri McKinley and Badara N Bajo**  
*Gunjur Environment Group GEPADG/CHEC Gambia*

The coastal waters of West Africa are home to many species of animals such as sea turtles, dolphins and seals which occupy the upper trophic levels of the food web. These high trophic level animals depend on the animals within the lower trophic levels for survival. Small pelagic fish serve as an intermediate level between the lower and higher trophic levels and one such species is *Sardinella aurita*, Round sardinella, which inhabit the waters around West Africa. Round sardinella are a major source of food for many animals and humans due to their abundance. However, in recent years the bountiful nature of this fish has been impacted by commercial use by foreign entities.

Increased presence of foreign fishmeal factories in West Africa has created pressure on the food system as overfishing of small pelagic fish such as the round sardinella has led to fish population decline. Trawling fleets, of which a significant portion originate in China, use bottom trawling methods to catch large amounts of small pelagic fish that are then taken ashore to fishmeal factories where they are processed and sold for fish food in aquaculture.

![Fig. 1. National and international journalists observing the pollution from the Chinese Golden Lead Fish Meal Factory at the Gunjur Bolonfenyo Lagoon 2017 Photo: Mr. Badara N Bajo](image)

The presence and operation of foreign bottom trawling fleets and their accompanying fish meal factories has contributed to the decline of round sardinella within West African waters, as well as causing pollution around the areas in which they operate. Without a significant change in the fisheries management plan and laws regulating sustainable operations, serious detriment to species numbers is on the horizon as well as the collapse of the marine food web.

Many issues are related to the decline of the population of round sardinella since 2010. Overfishing lead to an 80 percent decline between the 1996 and 2016, according to the Food and Agriculture Organization (Godfrey 2020). Throughout the region of West Africa including some of the northernmost countries the catch load for sardinella has increased with report stating that in Mauritania, catches of small pelagics landed for fishmeal increased from 50,000 t in 2011 to 240,000 t in 2014 (Corten 2016). These large catches of sardinella are taken to the fish meal factories that line the coasts of West Africa, with new ones being built every year, where the fish are boiled, minced, and dried. According to the Coalition for Fair Fisheries Arrangements, the fishmeal is used in farmed fishing operations where 5kg of fresh fish are needed to make 1kg of fishmeal. Fishmeal is one use of these unsustainably caught sardine, however other less lucrative avenues lie ahead for the fish.

Although most of the fishmeal factories sardinella supply comes from the many trawling fleets that surround the coast, a portion of the supply comes from local fisherman. To generate income, the local fisherman will try to sell their catch to the fishmeal factories, however, due to the large fish size, the load is rejected. Without another source able to purchase and use these large-sized catches, the fish are simply discarded back into the ocean or onto the beaches. This is one example of pollution created by the fishmeal factories; however, another system of pollution threatens juvenile sardinella. During the early stages of life, sardinella inhabit the brackish waters of lagoons and estuaries before migrating into the ocean to continue to mature. With the increased presence of fishmeal factories along the coast, the homes of the juvenile sardinella have become polluted whenever waste effluent has been emptied into a protected lagoon in the Gambia. In 2017, toxic waste from the Golden Lead factory in Gunjur, Gambia polluted Bolong Fenyo, a wildlife reserve established in 2008, leading to dead birds and crabs being found on the shores (Figs 1, 2 and 3) (Summers 2019). Direct threats to sardinella by way of overfishing and pollution of juvenile habitats are the largest contributors to the decline in population. However, there is evidence that shifting fishing practices also threaten juvenile sardinella. As a result of population decline in the species, the future of the marine food system is now at risk. There are also impacts on the human population (Fig.4).
Small pelagic fish such as the sardinella serve an important intermediate role between trophic levels and the population decline has been noted to have an impact on the food system. The practice of “fishing down food webs (that is, at lower trophic levels) leads at first to increasing catches, then to a phase transition associated with stagnating or declining catches” (Pauly 1998). This practice is unsustainable and eventually leads to instability in the food system as top predators must shift their dietary habits because of the loss of a key species however shifting diets is not always an option for some animals and leads to die-offs. Overfishing in West Africa for fishmeal factories supplies has heavily impacted sardinella but new findings are seeing impacts in the higher trophic levels. A sustainable proposal of science-based fisheries management is necessary to help recover sardinella populations and protect the future of animals within the higher tropic levels.

In 2021, the unsustainable fishing practices of foreign fishmeal factories are not only impacting the environment in a detrimental way but are also creating tension between various West African residents. In Ghana, a trawler was apprehended that was “manned by Chinese and Ghanaian crew with an estimated 13.9 metric tons of illegal small pelagic fish caught in a single day” (Oirere 2019). The fishing down of the food web has caused trawlers to engage in illegal fishing methods that involve catching juvenile sardinella and selling them through back-way traders. In March 2021 in the Gambia, the Gold Lead Fishmeal factory clashed with residents when the factory illegally acquired land adjacent to the compound. This clash between foreign businesses and residents will become a common scene if unsustainable methods continue to undermine the security of the food web as well as local food sources. Other impacts of the factory on local communities, such as pollution of lagoons (Fig. 5) add to their concerns.
Sensitization programs that aim to inform both citizens and subsidies about marine ecosystems, the impact of overfishing and the importance of sustainability would serve to not only educate but guide the understanding of laws and regulations surrounding those practices. Through the approach of involving local environmental groups, the community is strengthened through members actively participating and guiding the regulation of company practices that ultimately have the greatest impact on them. This approach also serves to eliminate barriers between different groups and curb the instances of environmental racism where foreign entities exercise their will over disenfranchised and underrepresented populations. Another benefit of this proposal would also help to generate awareness about the other environmental issues a community is facing, as well as increasing the manpower needed for restoration projects that might be needed because of previous unsustainable methods. Involvement of all parties that will potentially be impacted by any actions is the best approach and can serve to strength a community’s trust of their governmental agencies as they are directly involved in the legislative process. Organized implementation of this management proposal should be used for future assessment of sardinella fishing in West Africa to protect the species and all other species including humans that are potential impacted by unsustainable practices.

Through the combined work with global organizations such as the Food and Agricultural Organizations, local and foreign governments and environmental groups that work on behalf of citizens, an effective management strategy could be implemented. One such proposal would include: mandatory detailed catch records from foreign trawlers, records for catches received at fish meal factories, clearly delegated areas, and time periods for fishing as well as intermediate management from informed residents and environmental groups. By not only monitoring the amount and type of fish caught as well as using information about sardinella migratory patterns and how the coincide with upwelling periods, but sustainable fishing practices can also be achieved. Understanding the science behind sardinella population fluctuations and what factors have the largest impact is an important step in preventing further population decline. This viewpoint is supported throughout the scientific community with one paper stating:

“Because stock collapses have been made more frequent by fishing and are caused by overly high fishing rates when abundance and productivity are low, simple measures that protect stocks when they are most susceptible to collapse would provide a positive step toward an ecosystem-based management strategy that can reduce the frequency and magnitude of collapses, protecting forage fish and the food webs and fisheries that depend on them.”

This specific type of pollution must be set in the context of other local sources of environmental contamination. Other pollution is caused by trash or waste burning by locals which normally occurs in the late evening or at night, around 7 to 8 pm Gambian time. Some residents burn their wastes in their backyards or at the street corners as there is no proper waste/trash management mechanism and no recycling plant in the country which is one of the major problems in this country. Heaps of mixed garbage contain all kinds of solid waste and plastics. When burnt the heaps take several hours to be completely burnt or die down. The flames and fumes emitted from the trash fires cause discomfort to certain residents and pedestrians in some localities and are believed to cause chest infections. An urgent, lasting solution is needed.

References
Projects conducted by the Marine Life Conservation Society to combat pollution in the Marmara Sea

Volkan Narci and Aysenur Semiz

Marine Life Conservation Society

Marine Life Conservation Society is a Non-Profit Organization based in Istanbul, Turkey. The Society’s main objectives are the protection of Turkey’s seas and natural assets. It started operations on the 9th of September 2015 in Heybeliada. Along with this aim the Society is carrying out various sustainability projects. Some of the projects are related to the Sea of Marmara which has faced heavy pollution since the 1980s. The main sources of pollution are heavy industrial facilities in the Gulf of Izmit near Istanbul (Fig.1) and waste from densely populated cities including Istanbul and Izmit. In 2017, 0.3 million m$^3$ of industrial waste and 2.1 million m$^3$ of domestic waste were being produced daily (Ozyigit et al., 2017). However, the pollution of the Marmara Sea is not only related to the urban life and industrial activities immediately around it, but it is also heavily impacted by the pollution loads coming from the Black Sea, which is fed by major rivers such as the Danube and Dnieper, which carry huge water flows and many contaminants into the Sea.

The pollutants in the Sea of Marmara include diverse heavy metals that have impacts on living organisms, including foraminifera whose shells become modified by these metals. In Erdek Bay in the western part of the sea and in nearby Bandirma Bay (Fig.1.) the observed changes in shell shapes were thought to be due to heavy metals in sea floor sediments that originated from discharge of industrial wastes, bilge water, and agricultural activities (spraying and fertilizing) in the surrounding area; (Yümün, 2017).

One of the Marine Life Conservation Society Projects aiming to counteract pollution impacts is centred around coral transplantation. Along with rainforests, coral reefs represent a large amount of biological diverse environments on earth.

The waters of the Marmara Sea are inhabited by organisms from both the Black Sea and the Mediterranean and are home to more than 24 coral (Fig.2) species. But their existence is threatened by the onslaught of nearby property construction.
Ghost nets, commercial fishing nets that have been lost, abandoned, or discarded at sea, are another major problem in the Marmara Sea, as well as all over the world. Every year ghost nets are responsible for trapping and killing millions of marine animals (Fig.3) including sharks, rays, bony fish, turtles, dolphins, whales, crustaceans and birds. The Marine Life Conservation Society team members (Fig.4) primarily clear the seabed of ghost nets abandoned by industrial fishing boats. They have removed (Fig.5) 27,000 square meters of ghost nets from sea bed.
They work with specific partners to ensure that the recycling of the ghost nets is done so by sustainable methods. They also support educational and art projects (Fig.6 and Fig.7) using the ghost nets they recover. Marine Life Conservation Society began the sensitive process of transplanting the corals to a better and safer location (Neandros, Rabbit Island (Fig.8)), working closely with marine biologists. Since 2017 they have transplanted 280 corals (Fig.9 and Fig.10) to the shores of Neandros (Tavşan Island) and achieved an impressive 90% success rate in 2017 when transplanting the first 90 corals, and 60% in 2019 for the remaining 190. Now, they are continuing coral transplantation periodically and they plan to transplant 200 more corals in next year.
The Marmara Sea is the easterly terminus point of the Mediterranean waters. The area is significant because it has so many different species. Because of this the Marine Life Conservation Society team started a Biodiversity Research Project in this area. Their purpose is to identify, record and promote the underwater natural wealth of this area. With a project that the Adalar Marine Life and Sports Club Association are working on, they are trying to create a nationally recognised marine protected area in Neandros. It is a bit like the story of Noah’s ark. It’s similar to the legend because, if they are able to preserve the diverse but small numbers of individuals of these species living in the Marmara Sea, they will be protected and increase in this area again.

The Marine Life Conservation Society team members are working with local communities, universities, corporate partners and the government on the Princes Islands, including Tavşan Island, to raise awareness about magnificent habitats, sustainability and political ecology, and to introduce people to the diverse marine life around the islands.

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Web pages of interest:

World Air Quality Index (AQI) Ranking | AirVisual (iqair.com)
Lists cities by the severity of air pollution using the US Air Quality Index mentioned in several of the papers in this issue.

Urban pollution levels across the Commonwealth - The Commonwealth
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Clear the Air for Children! - The Health Hub (thecommonwealth-healthhub.net)
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WHO | Air pollution and health: Summary
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Global E-Waste - Statistics & Facts | Statista
Access to data on the amounts of eWaste by country

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