UNEP - United Nations Environment Program

Air Pollution and Particulates

Overview

Since the Industrial Revolution, humans have begun to release more and more unnatural substances into the air around us, such as sulphur dioxide, nitrous oxides, particulate matter, greenhouse gases and others. Now however, we understand the harmful nature of many of these gaseous pollutants. Depending on the specific pollutant, they can have negative effects on health, wildlife, the environment and climate. Unfortunately, many of the airborne pollutants are byproducts of everyday industrial mechanisms, crucial to the industries of transport, agriculture, mining, power generation, and several others, the latter being the greatest polluter. These industries are all necessary for our society to function, and the processes that they rely on are difficult to circumvent.

The United Nations Environment Programme (UNEP) works to bring attention to and advocate for the protection of the global environment. The Programme was established in 1972[1], and today it is made up of one hundred and twenty-two member states, as well as several accredited observers who are barred from participating in votes.[2] Their mission is to "provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations."[3] As such, it is of the utmost importance to the UNEP that safe levels of air quality are maintained around the globe. Accordingly, the UNEP has implemented several initiatives and

resolutions in order to protect global air quality, such as a resolution (UNEA1/7) drafted in 2014 in order to "[encourage] governments to take action across sectors to improve air quality to protect human health and the environment, reduce negative impacts, including on the economy, and promote sustainable development."[4]

Two prevalent groups of hazardous air pollutants are sulfur dioxide (SO_2) and nitrous oxides (NO_x). These compounds are responsible for the phenomenon known as acid rain. SO_2 forms when sulfur—released from rocks during the refining process for coal, oil and several metals—binds to oxygen in our atmosphere. Conversely $NO_x$is formed when nitrogen contained in fuels, or in the air, bonds with oxygen during combustion reactions, such as those in car motors.[5] Both gases, once in the air, react with and dissolve into atmospheric water vapor creating, among other things, sulfuric acid (H_2SO_4) and Nitric Acid (HNO_3). These acids then fall as raindrops, otherwise known as acid rain. The acid rain then lowers the pH of the soil and water, harming, and in some cases, killing both plant and animal life alike.[6]

Another category of air pollutants is known as volatile organic compounds (VOC). This collection includes all sorts of gasses, some released by VOC containing products like varnish, and others synthesized as a by-product from processes like burning fuel or smoking tobacco. All VOCs are known to have negative health effects, but the specifics vary from gas to gas. Many of these compounds will also react with nitrous oxides to produce ground level ozone.[7] Ozone high up in the atmosphere protects the earth from the most powerful of UV rays. Surface level ozone, however, can have a series of negative consequences. Inhaling ozone on its own can

lead to respiratory complications, especially in those prone to asthmatic attacks. Ozone can also combine with particulates forming a thick smoke known as smog, which has been demonstrated to lead to respiratory and pulmonary problems.[8]

Another important air pollutant to consider is carbon monoxide (CO), which primarily affects respiratory processes. CO is primarily released through the tailpipes of vehicles. It binds with hemoglobin in the blood, inhibiting the body's ability to carry oxygen throughout the body.[9] This can lead to impeded brain functions and, in extreme cases, death.

Additionally, there are also airborne particulates. Particulate matter (PM) includes any solid mass small enough to hover in the air and is capable of being aspirated. They are separated into several categories by size. This is due to the fact that the size of the PM determines how far throughout the body it can penetrate. PM_{10}includes any matter smaller than ten micrometers (10μm). PM_{10} really only penetrates the respiratory tract whereas $PM_{2.5}$, being particles smaller than two point five micrometers (2.5μm), can penetrate deeper into the lungs and even into the alveoli. $PM_{0.1}$includes all airborne particles with a diameter smaller than zero point one micrometers (0.1μm). It is the least studied of the three but it is believed to be able to enter the bloodstream.[10] Unsurprisingly, airborne particulate matter has been shown to increase respiratory distress, especially in asthmatics, as well as promote lung cancer and cardiovascular disease.

Finally, there are greenhouse gases, such as carbon dioxide (CO_2) and methane (CH_4). These are gases that, when they amass in our atmosphere, allow sunlight to enter but trap the heat that then bounces off the earth's surface into space. Greenhouse gases, in the proper

quantity, are extremely important for life on earth. However, when too much is released into the air, they can drastically increase the temperature of the planet, assisting in a phenomenon known as climate change or global warming. A majority of the greenhouse gases emitted by human activity are caused by the burning of fossil fuels, such as coal, natural gas and oil, in order to produce heat or electricity.

Global Picture

When it comes to average concentration of $PM_{2.5}$, Saudi Arabia, Qatar, Kuwait and the United Arab Emirates are all within the top ten, due heavily to the prominence of the oil industry in these nations. China and India however, both suffer from more air pollution deaths per capita than four out of these five nations. This is a result of having very densely populated cities. Both Asian nations are home to some of the world's most polluted cities, as well as wide open, clean countryside Therefore both nations rank lower in nationwide average amounts of $PM_{2.5}$ per cubic meter of air. Saudi Arabia, on the other hand, does not reach such high concentrations in its cities, but has a more consistently high concentration across the whole nation. As a result of this, China and India have the highest number of citizens exposed to the world's highest $PM_{2.5}$ concentrations, whereas even citizens of rural Saudi Arabia are exposed to above average concentrations.[11]

As for carbon dioxide production, many of the aforementioned Middle Eastern nations with the world's most toxic air, are among the world's top ten carbon dioxide producers as well. However, some nations who rank in the top ten nations with the safest air, and the lowest $PM_{2.5}$

concentrations, namely the United States of America and Australia, are also in the top ten biggest CO_2 producers. This is in part because, while oil refining, which takes place largely in the middle east, produces a significant amount of airborne particulates, the finished product is often sold to other nations as fuel, which is the single greatest contributor to global CO_2 emissions. It is also important to note that while greenhouse gases are not directly harmful to people, and therefore do not constitute so called dirty air, they still have serious negative effects on climate, which can lead to, among other things, increased death tolls from natural disasters.

It is important to note that high concentrations of $PM_{2.5}$ disproportionately affect the world's least wealthy nations, due to the high emphasis on the export of products like oil, which influences the existence of an ultra-wealthy minority, despite a low average wealth. Conversely, concentrations of another pollutant, namely ozone, is much more consistent. National average $PM_{2.5}$ concentrations range from 5-108$\mu g/m^3$, whereas national average ozone concentrations, measured in parts per billion, only range from 20-72ppb.[12]

The Indian Government has recently enacted the National Clean Air Programme, which aims to reduce the concentration of $PM_{2.5}$ and PM_{10} by 20-30% over a five year period. If successful this could bring the Indian national average amount of microscopic airborne particles from 62 micrograms per cubic meter ($\mu g/m^3$) to 40-50$\mu g/m^3$, which is much closer to the WHO recommended 10$\mu g/m^3$. The Indian government has also opened an option to extend and expand the program at the end of the five years depending on its success.[13] The Programme identifies the cities that will require the most amount of work, as well as the industries that need to change,

however it places the emphasis on each city creating its own plan, and finding its own way to accomplish the goals it lays out for each of them.[14]

Consequences of Air Pollution

The World Health Organization acknowledges that at concentrations above 35μg/$m^3$the health risks are certain and recommends that nations maintain concentrations lower than 10μg/m^3. In 2017, they recorded that 92% of the world's population lived in areas above their recommendation and 82% lived in areas above their absolute limit. That is over seven billion people living in unsafe conditions. Additionally, while concentrations of $PM_{2.5}$ are declining, ground level ozone concentrations are rising and will pose a serious threat as nations develop.

Both $PM_{2.5}$ and ground level ozone have been conclusively linked with several health issues. The WHO, the US EPA, the International Agency for Research on Cancer and other agencies have concluded that "air pollution exposure is linked with increased hospitalizations, disability, and early death from respiratory diseases, heart disease, stroke, lung cancer, and diabetes, as well as communicable diseases like pneumonia." The World Health Organization has also determined that seven million people die every year as a result of exposure to air pollution. That's a little over 1 in 8 deaths occurring as a result of unclean air. This finding ranks unclean air as the world's number one health risk.[15]

Over the last one hundred years, human produced greenhouse gases have caused the average global temperature of the earth to increase by approximately 1.5°C. While this may not

seem like much, even a fraction of a degree can have monumental effects. Studies show that, following current trends, by the year 2100, sea levels will likely rise by over half a meter, with the possibility of rising as much as two meters. If the latter is to occur, some two hundred million people could be displaced.[16]

Not only will rising temperatures raise sea levels, they will also exacerbate some of the most extreme natural disasters. At present, experts agree that it is difficult to pin the entirety of extreme weather events on climate change, but it is possible to determine a rough estimate of the percentage of the damages it is responsible for.[17] For instance, a flood may occur regardless of global warming, but raised sea levels would cause it to extend further and with greater force than it otherwise would have. A forest fire may start by an abuse of fire regulations, but the hot and dry air would allow it to spread faster and make it more challenging to fight.

Perspectives on this Issue

From an ecological perspective, air pollution can have a very damaging effect. Acid rain can lower the pH of the soil or water of a region beyond what is considered tolerable for the inhabiting species. Even if some animals have higher tolerances for acidity, their primary food supplies may not, leading to starvation. Acidic rain and fog can also strip minerals and nutrients from the ground and from tree leaves themselves, reducing their ability to absorb sunlight, ultimately killing the plant.[18] Climate change also intensifies periodic droughts, leading to even greater rates of species death and extinction.

Air pollution can also be looked at from a technological perspective. When it comes to energy generation, combustion of fossil fuels is by far the oldest method. However, as technology develops, more and more energy is generated from renewable methods, such as wind turbines, hydroelectric dams, solar panels and biofuels. “Renewables” made up 24 percent of global electricity generation in 2014. That’s expected to rise to 31% by 2040.”[19]

There are several complex aspects to the economic perspective of air pollution. The development of new, green technologies, such as 100% electric cars, is expensive and time consuming. This is likely the leading factor against change. It is very easy to quantify the cost to develop new innovations and replace old infrastructure. Contrarily, it is much harder to give an exact value for the property damage caused by climate change, or the loss in worker productivity due to premature death.

The human rights viewpoint on air pollution examines our intrinsic right to clean air. Article 25 of the Universal Declaration of Human Rights (UDHR) designates that “everyone has the right to a standard of living adequate for the health and well-being of himself and of his family.”[20] Everyone has the right to clean air, despite air pollution being a problem that disproportionately affects lower class citizens. The question must be raised, should foreign governments, as global citizens, be held responsible to help uphold the human rights of those overseas, and if so, to what degree?

Proposed Solutions

An example of a successful solution to air pollution is the Montreal Protocol. While ground level, or tropospheric ozone is a health hazard, the ozone layer in the stratosphere is crucial to life on earth. Without it, we would have no protection from the sun's harmful UV rays. The Montreal protocol was a treaty to reduce the use of chlorofluorocarbons (CFCs) in several industries, most notably refrigeration and air conditioning. which are chemicals that destroy ozone they come into contact with. These chemicals also act as super-greenhouse gases, thousands of times more potent than CO_2. Experts estimate that without the Montreal Protocol, the UV index would frequently hit 30, where anything above 11 is considered extreme and the globe would be at least 25% hotter. Recently, an amendment was made known as the Kigali Amendment. Under this amendment, hydrofluorocarbons (HFCs), which have acted as a cheap replacement for CFCs, would also be targeted. HFCs, while not dangerous to ozone are similarly powerful greenhouse gases to CFCs.[21]

The Paris agreement was enacted on November 4th, 2016. Its goal was to limit the rise in average global temperature by the year 2100 to below 2°C, and more ambitiously, below 1.5°C if possible. The main mechanism of this treaty was its requirement of all parties to put forward nationally determined contributions (NDCs). This allowed all participants to individually fit their contributions to their own budget, and not change their budget around their contributions. These funds were to be put to aiding various vulnerable nations to reduce their carbon emissions. The agreement also demanded that every five years, all participating nations bring forward a

summary of the progress made within their own borders in reducing greenhouse gas emissions.[22] On June 1st, 2017, the United States of America announced that it would cease all participation with the Paris Climate Agreement. In his statement, President Trump cited the "draconian financial and economic burdens the agreement imposes on [the] country."[23]

Questions to Consider

1. What are the main air pollutants produced in your country?
2. How is your country affected directly and indirectly by air pollution?
3. What legislation does your country already have in place regarding air pollution?
4. What are the main sources of energy in your country?
5. What other countries share your country's position?

Additional Resources

"UNEP – United Nations Environment Programme" UN Environment, www.unenvironment.org.

Climate Change Canada. "Government of Canada." Canada.ca, Government of Canada, 13 Apr. 2017, www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/

Gould, Skye, and Dave Mosher. "The Best - and Worst - Countries for Air Pollution and Electricity Use." World Economic Forum, www.weforum.org/agenda/2017/02/the-best-and-worst-countries-for-air-pollution-and-electricity-use.

"How Air Pollution Is Destroying Our Health." World Health Organization, World Health Organization,

www.who.int/air-pollution/news-and-events/how-air-pollution-is-destroying-our-health.

Central Intelligence Agency, Central Intelligence Agency, 1 Feb. 2018, https://www.cia.gov/library/publications/the-world-factbook/.

Works Cited

[1] "Funds, Programmes, Specialized Agencies and Others." United Nations, United Nations, https://www.un.org/en/sections/about-un/funds-programmes-specialized-agencies-and-others/index.html.

[2] "Member States Directory." UNEP, https://www.unenvironment.org/cpr/member-states-directory.

[3] "Why Does UN Environment Matter?" UN Environment, www.unenvironment.org/about-un-environment/why-does-un-environment-matter.

[4]Environment Assembly resolution 1/7, Strengthening the role of the United Nations Environment Programme in promoting air quality, 27 June 2014, http://web.unep.org/environmentassembly/resolutions-and-decisions-unea-1.

[5]Climate Change Canada. "Government of Canada." Canada.ca, Government of Canada, 13 Apr. 2017, www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/

[6]Environmental Research Group, and King's College. "Air Quality by Local Authority." London Air Quality Network - King's College London, www.londonair.org.uk/.

[7] "Technical Overview of Volatile Organic Compounds." EPA, Environmental Protection Agency, 12 Apr. 2017, www.epa.gov/indoor-air-quality-iaq/technical-overview-volatile-organic-compounds.

[8]Environmental Research Group, and King's College. "Air Quality by Local Authority." London Air Quality Network - King's College London, www.londonair.org.uk/.

[9] Danel, Vincent. "Airborne Particulate Matter and Their Health Effects." Encyclopédie De L'environnement, 23 Apr. 2019, www.encyclopedie-environnement.org/en/health/airborne-particulate-health-effects/.

[10] Gould, Skye, and Dave Mosher. “The Best - and Worst - Countries for Air Pollution and Electricity Use.” World Economic Forum, www.weforum.org/agenda/2017/02/the-best-and-worst-countries-for-air-pollution-and-electricity-use.
[11] “Read the Report.” State of Global Air, www.stateofglobalair.org/report.

[12] Sharma, Nidhi. “Government Launches National Clean Air Programme.” The India Times, https://economictimes.indiatimes.com/news/politics-and-nation/government-launches-national-clean-air-programme/articleshow/67474160.cms.

[13] Vitre, Zarir De. “Air Pollution: We Aren't Doing Enough.” India Development Review, Https://Idronline.org India Development Review, 11 June 2019, https://idronline.org/air-pollution-we-arent-doing-enough/?gclid=CjwKCAjw8NfrBRA7EiwAfiVJpdl9oV6mks8JT7nbQMeDC9Lzj_f4XccpPYQqXEjRu9FPnjRSKV-BURoCp24QAvD_BwE.

[14] “Ambient and Household Air Pollution and Health.” World Health Organization, World Health Organization, 16 Feb. 2017, https://www.who.int/phe/health_topics/outdoorair/databases/en/.

[15]Bamber, Jonathan, and Michael Oppenheimer. “Climate Change: Sea Level Rise Could Displace Millions of People within Two Generations.” The Conversation, 6 Aug. 2019, www.theconversation.com/climate-change-sea-level-rise-could-displace-millions-of-people-within-two-generations-116753.

[16] Harvey, Chelsea. “Scientists Can Now Blame Individual Natural Disasters on Climate Change.” Scientific American, 2 Jan. 2018, www.scientificamerican.com/article/scientists-can-now-blame-individual-natural-disasters-on-climate-change/.

[17] “Effects of Acid Rain.” EPA, Environmental Protection Agency, 1 June 2017, www.epa.gov/acidrain/effects-acid-rain.

[18]Langlois, Bertrand. “Without the Ozone Treaty You'd Get Sunburned in 5 Minutes.” 30 Years Old, the Montreal Protocol Saved the Ozone Layer, But Its Work Is Unfinished, 25 Sept. 2017, www.nationalgeographic.com/news/2017/09/montreal-protocol-ozone-treaty-30-climate-change hcfs-hfcs/.

[19] “Universal Declaration of Human Rights.” United Nations, United Nations,

www.un.org/en/universal-declaration-human-rights/index.html.

[20]Langlois, Bertrand. “Without the Ozone Treaty You'd Get Sunburned in 5 Minutes.” 30 Years Old, the Montreal Protocol Saved the Ozone Layer, But Its Work Is Unfinished, 25 Sept. 2017, www.nationalgeographic.com/news/2017/09/montreal-protocol-ozone-treaty-30-climate-change hcfs-hfcs/.

[21] “The Paris Agreement.” UNFCCC, http://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

[22] “Statement by President Trump on the Paris Climate Accord.” The White House, The United States Government, https://www.whitehouse.gov/briefings-statements/statement-president-trump-paris-climate-accord/.