

Air Quality Concerns and Links to Wildfires

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Abstract

Air quality is classified by the degree of pollution present in the ambient air including but not limited to, carbon dioxide, aerosols and other airborne chemical compounds. Not only is it measured based off of the CO₂ emissions, but other anthropogenic factors contribute as well. Higher levels of air pollution are found in areas with larger population densities. Both natural and anthropogenic sources contribute to the air pollution. Low air quality can lead to adverse health effects on human health, visibility, and climate. There has been a recent development of concern for air quality and the effects of wildfires and their contribution to the AQI, specifically in Colorado. This literature review will highlight the primary areas where wildfires contribute to local air quality. After several years of recent climate analysis, a correlation can be found between anthropogenic emissions and the rise in air pollution. Despite multiple efforts, air quality is a developing concern and needs to be addressed in the next few years. Since the topic doesn't have long time periods of usable data, the issue has been difficult to put into perspective. However, with the rapid increase in emissions and anthropogenic sources, action needs to be taken sooner rather than later before the effects are irreversible.

Introduction

The topic of air quality has been a matter of discussion with the increase in population. Population increase has led to a rise in anthropogenic sources that have been a large contributor to air pollution. The presence of anthropogenic sources accelerates the concentrations of harmful emissions in the atmosphere and poses threats to the state of the environment. Air quality is measured with the use of the Air Quality Index (AQI) and is categorized based on the levels of pollutants, it ranges from values of 0-500; 0-50 is classified as good, 51-100 as moderate, 101-150 as unhealthy for sensitive groups, and 200+ as unhealthy to very hazardous [1]. The AQI is influenced by

aerosols and compound emissions being released into the atmosphere. AQI is used by the Environmental Protection Agency (EPA) to analyze the different contributors to air pollution in the atmosphere; these pollutants include ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide [1]. The air quality in population dense locations has been a prevalent issue. Before the EPA released the Clean Air Act in 1990 the government had little involvement with air quality. This act allowed air quality to gain recognition and a commitment to future research was disclaimed. When looking at what makes up air pollution, CO₂ has a large presence in the problem. Even though there are other

sources of carbon dioxide, wildfires are a large contributor to the Earth's CO₂ load [2]. When fires are burning, the flaming combustion converts the burning matter into carbon dioxide that is then released into the atmosphere. Not only does the carbon dioxide pose threats to the environment, but to human health as well.

Why is Air Quality a Growing Concern

The topic of climate change has always been controversial, climate scientists have had to present several arguments to validate the severity of the issue. However, with the recent shift in climate, air quality has shown to be positively correlated to the increase in climate change. Part of this contribution comes from people and their high demand for resources. Anthropogenic sources (including industrial and residential) have been releasing large amounts of greenhouse gases (GHG) into the atmosphere. Over time, production of emissions has increased exponentially at a concerning rate. The lifetime of greenhouse gases and air pollutants in the atmosphere determines the scale of their effects [6]. It has been predicted that by the year 2050, the world will be unable to reverse the effects that have already taken place. The increase in global temperature has led to longer periods of drought, higher annual temperature averages, and a large decrease in natural resources, and will continue to do so.

Air pollution has been increasing exponentially since the industrial revolution. Before the EPA was established emissions were at an all time high. Populations were

facing smog, low air quality, and polluted waters. However, once the Clean Air Act was introduced in 1990, a shift towards educating the public was made. At the time, the general population had little knowledge about the effects air quality had on human health. In modern day, it is more widely comprehended that air quality impacts must be placed into the larger context of land and environmental management [2]. Today, our world still faces these concerns, but at a higher accelerated rate.

Poor air quality can lead to severe health problems. For the most part people experience moderate symptoms, but in more severe cases (where an area is densely populated and has a higher AQI), people are more prone to more critical conditions. Areas with AQI of 151 or more pose the greatest threats to the human population and their health. Cases of asthma, cardiovascular episodes such as stroke, heart failure, and cardiac dysrhythmia, have all been reported [2]. With regulations on emissions enforced, starting from 2020 to 2100, society as a whole could prevent 153 +/- 43 million premature deaths [6]. Unfortunately, anthropogenic sources aren't the only issue that needs to be addressed, and there are several other factors that are harder to control. Natural systems of GHG, specifically carbon, are found in various forms around the world. These systems include examples such as forest fires, oceans, wetlands, permafrost, mud volcanoes, and earthquakes [7]. In recent months, there have been large outbreaks of forest fires all over the United States, affecting a large portion of the western

states. Colorado in particular, has been experiencing record breaking wildfires that have claimed hundreds of thousands of acres in a matter of a few months. This volume of fire activity has never been seen before and is posing danger to communities in the affected areas.

Correlation between Air Quality and Wildfires

Colorado has historically exhibited issues with air quality including but not limited to, pollution, climate patterns, and wildfires. All of these factors together have proposed a detrimental concern to the state and continue to threaten everyone that lives there as they continue. The population of Colorado is approximately 5.6 million people, and 80% of the population lives within the Colorado Northern Front Range Metropolitan Area (NFRMA) [3]. This area encompasses cities of Denver, Boulder, Longmont, Greeley, and Fort Collins. The Denver population continues to grow and is expected to increase by nearly 50% by 2030. The infamous “Brown Cloud” in Denver, CO is a prime example of how the air pollution is dispersed. The large amounts of emissions from the city have created a visible brown smog that sits over the city. Additionally, Denver experiences highly complex flow patterns due to the unique meteorological situation. These complex weather patterns are driven by mountain-valley circulation effects from the Rocky Mountains, as well as variations in terrain and elevation [3]. The low temperature air from higher elevations, flows down towards the NFRMA and mixes with the arid, warmer temperatures in the

areas with lower elevations. Despite the concern of anthropogenic pollution and the effects on climate patterns, CO₂ emission from both the previous and current wildfires are contributing to the air pollution. The recent shift in climate, and the continuous trends of warmer annual temperatures have affected the fire regime through flammability, fuel availability, fire-season lengths, and ignitions [5]. This has increased the probability of wildfire occurring. Simultaneously, these effects are projected to escalate the annual area burned, number of lightning-ignited fires, and of course a warming climate. The Colorado fires have been a result of lack of precipitation; the annual average for this year (2020) is already lower than last year’s average. The smoke plums that tower hundreds of feet into the air, are filled with emissions enriched in hazardous air pollutants, CO, NO, PM, and many organic compounds [2]. In order to understand the dispersion of the compounds sourced from these plums, scientists and climatologists use the method of ventilation index. Ventilation index (VI) is an index that describes the potential for smoke and other pollutants to disperse from the source [4]. This evaluation allows a better understanding of how particles are dispersed in surrounding areas.

Future Work

In order to take action to help reduce AQI and emissions, society must first understand what needs to be addressed. Climate change projections are influenced by fluctuating factors such as projected population, patterns of carbon dioxide emissions, and

annual temperatures. Since the data being used to predict climate change is based on information from 1970-1980, it is difficult to gauge exactly where our world will be in the next upcoming decades. If society acknowledges the anthropogenic sources and the amount they contribute to the climate crisis, we can make commitments to better the future. One of the most common ideas that large industrial companies across the world have dedicated to is the “Commitment to Net Zero.” This is essentially a concept where industries will make extreme efforts to limit their carbon emissions to help improve air quality and dedicate their operations to flattening the curve. Global anthropogenic GHG emissions totaled at 362 Gt CO₂-eq in just 2016, and anthropogenic sources have contributed to 47.9%-66% of the total global emissions [7]. These percentages are projected even higher now, as we face the countdown to the essential tipping point. Even though this is a very large scale problem, individuals can take action on a smaller scale. Small actions like switching to more energy efficient appliances, reducing travel, and a change in diet are all examples of easy changes. Collectively, this could downscale the effect of climate change and could save the world from long term effects. Already, government action has been taken in many countries and has been clearly acknowledged through national commitments. Unfortunately, other countries have yet to take action. Part of this problem results from the fact that in order to achieve a fully sustainable society, energy resources must be altered, such as a switch from oil and gas resources to renewable

energy. A change this dramatic requires a large budget that world leaders are struggling with. If the United States were to commit to sustainability, perhaps through the Green New Deal, upwards of 900 billion dollars would need to be used from other funding. The scientific community has two significantly different points of view on climate change [7]. Some claim that projections will be lesser than what is currently being proposed. The Intergovernmental Panel on Climate Change (IPCC) publishes a series of reports on the issue of climate change to help provide scientific support for international climate change. Yet, there is still controversial discussion. After several studies using various methods, the scientific community has concluded that the projected climate models could reasonably stimulate average temperatures when the atmosphere is analyzed in terms of both natural systems and human activity.

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