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Smoke and Fog: Smog Impacts on Wildlife

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SUMMARY

Beginning with a thorough understanding of smog's origins, the review reveals the complicated interplay of pollutants that combine to generate this atmospheric issue. By distinguishing between traditional London-type smog and Los Angeles smog, readers gain insight into the various exhibitions of this environmental problem. As the review progresses, the emphasis changes to the wildlife health consequences of smog, revealing a startling array of respiratory and cardiovascular problems linked to chronic exposure. Smog has a severe impact on wildlife's respiratory health, reducing their ability to breathe. Pollutant inhalation and ground-level ozone exposure cause inflammation and damage to the respiratory systems of wild animals. These irritants impair lung function, reduce lung capacity, and can lead to persistent respiratory difficulties or even death in severe situations. For example, tiny particles can penetrate deep into the respiratory system, causing tissue damage and decreasing oxygen intake. In conclusion pollution is extremely dangerous to wildlife, particularly to the habitats and species in the impacted areas.

Keywords: Smog, Wildlife, Pollution, Fog, Health

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INTRODUCTION

The term "smog" initially appeared in 1905 in London, England, to denote smoky fog (Allaby, 2014). Smog is often used as a representation of air pollution. It not only shares characteristics with common air pollutants but also possesses unique traits due to its specific chemical composition and geographical distribution. Its impact on human society is evident in two significant events. The first was the Great London Smog of 1952, which reportedly claimed over 10,000 lives within two months and caused long-term health issues. The second event took place in Los Angeles during the 1960s, when photochemical smog a secondary pollutant formed from emissions from vehicles and industrial sources emerged (Boffey, 1968; Li et al., 2021).

In the presence of particulate matter, water droplets can enhance fog formation by increasing the number of condensation nuclei and chemically reacting with fog droplets. Smog results from the combination of pollutants from sources such as burning, recirculated dust, and industrial activities, particularly under humid conditions (Tao et al., 2014; Ali et al., 2019). Winter smog is mostly composed of gaseous pollutants such as nitrogen oxides (NO_x), sulfur dioxide (SO_2), and ozone

(O_3). The rise in cardiovascular and respiratory disorders has been related to the gaseous components of winter smog (Pérez-Díaz et al., 2017; Zeng et al., 2019).

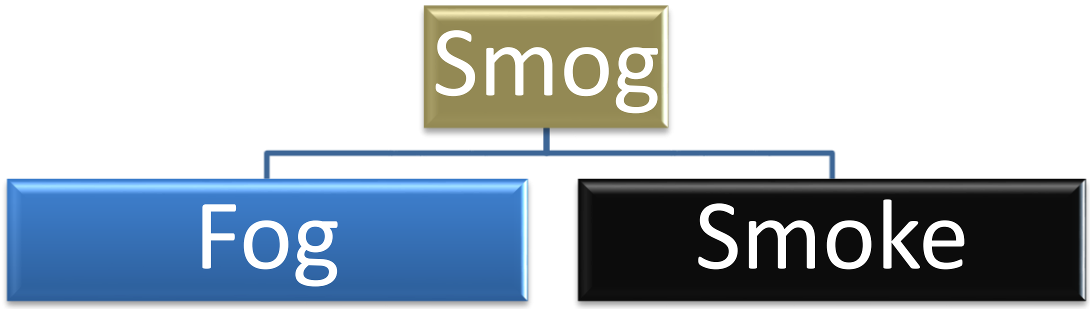

Figure 1: What is smog?

Generally, there have been two types of smog based on their origin (Figure 1), known as London and Los Angeles (Figure 2). ***London smog***, also known as sulfurous smog, includes a high level of sulfur dioxide. Notably, in 1952, a severe bout of London smog lasted a week and claimed between 4,000 and 10,000 lives. At the time, the UK standard for sulfur dioxide was 0.04 ppm, while the daily average for PM10 was 50 µg/m3. During the 1952 occurrence, the greatest reported smoke concentration was 4.46 mg/m3, with sulfur dioxide levels reaching 1.34 ppm (Whittaker et al., 2004). In contrast, ***Los Angeles smog*** is caused by the interaction of nitrogen oxides and reactive hydrocarbon molecules. This type of smog is distinguished by high levels of oxidants, which are dependent on intense sun radiation and contribute to the generation of secondary pollutants such as ozone and trace gases (Gaffney et al., 2009). Furthermore, smog has a direct impact on the greenhouse effect since it modifies the land's topography (Isha et al., 2024).

Figure 2: Types of smog.

Smog has a significant negative impact on wild animals, affecting both their health and behavior. Exposure to pollutants such as particulate matter (PM), nitrogen oxides (NO_x), and ground-level ozone can lead to respiratory issues, including breathing difficulties, lung damage, and increased susceptibility to infections. These pollutants also weaken the immune systems of wildlife, making them more vulnerable to diseases and environmental stresses. Additionally, smog can alter animal behavior by affecting sensory perception, navigation, and feeding patterns. For instance, reduced visibility caused by smog can impair the hunting abilities of predators, while prey species may struggle to detect threats. Furthermore, smog can disrupt reproductive cycles, leading to lower birth rates and changed migration patterns, ultimately threatening the survival of species in polluted habitats. The combined physiological and behavioral effects of smog pose a serious risk to wildlife communities, particularly in areas with high levels of air pollution.

The Air Quality Index (AQI) measures the quality of air in a given area and is calculated by the United States Environmental Protection Agency (EPA). It takes into account five key air pollutants: tropospheric ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides. Air, Earth, and Particle Pollution is a monitoring system that uses sensors to detect particulate matter in the atmosphere. This system can enhance air quality in real time and collect data for future analysis. It is applicable for monitoring air quality in residential, commercial, and industrial settings. A higher AQI indicates a greater risk to health.

Air Quality Index (AQI)	Condition
0 to 50	Good
51 to 100	Moderate
101 to 200	Unhealthy for sensitive groups
201 to 300	Unhealthy for all
301 to 400	Very unhealthy

Figure 3: The Air Quality Index (AQI) by the United States Environmental Protection Agency.

AQI values range from 0 to 500. When the AQI is between 0 and 50, it falls within the good (green) range of air quality. If the AQI is between 51 and 100, it indicates moderate (yellow) air quality, which is generally acceptable, but some pollutants may pose health risks to certain individuals. People with respiratory conditions, such as asthma, may experience difficulty breathing, and others are advised to limit their outdoor activities. An AQI of 101 to 150 is considered harmful to sensitive groups (orange) (Figure 3). Individuals in these sensitive categories may experience adverse health effects, while the general population is unlikely to be affected. The most vulnerable groups include the mature, premature, and animals with lung disease, heart disease, or other chronic respiratory conditions. Those with asthma should follow their asthma action plans and consult their healthcare providers if they experience lung issues or other breathing difficulties. Individuals with heart or circulatory disorders should be vigilant for symptoms such as palpitations, shortness of breath, or unusual fatigue and should report these to their healthcare physician (Qin et al., 2020; Khan et al., 2024).

Objectives of study

The research is focused on smog impact on wildlife health and behavior in particular: how smog, an air pollutant, and affects different kinds of species in their natural habitats or homes. Research methods is adopted, how these pollutants affect wild animal health. This study is also look into changes in wild animal behavior brought about by smog. This includes differences in feeding patterns, migrations, and reproduction resulting from the stressors that follow pollution. Finally, this study provides a understanding of the consequences of smog on wildlife populations, so contributing to the larger fields of environmental conservation.

MECHANISMS OF SMOG FORMATION

Smog is a natural meteorological phenomenon composed of aerosols and photochemical smoke. The smog weather that the public has witnessed is a major meteorological disaster. In most circumstances, smoke and fog coexist, and smog cannot form and evolve without the right meteorological conditions (Cao et al., 2013; Mu and Zhang, 2014). Dust smog, as defined in the ground meteorological observation specification, is a phenomenon in which a large number of ultra-fine particles are evenly distributed in the air, making the air generally turbid with a horizontal visibility of less than 10 km (Administration, 2003).

Ultra-fine particulates are tiny dry particles from aerosols that originate mainly from natural sources and human activities. Smog can give distant bright objects a yellowish or reddish hue, while darker objects may appear slightly blue. According to the Industry Specification of Meteorology, smog is defined as a situation where visibility is less than 10 km, excluding obstructions caused by rain, sandstorms, blowing sand, floating dust, and other weather phenomena, with a relative humidity of less than 80%. Under specific meteorological conditions, smog and fog may occasionally transition in response to changes in relative humidity. The thickness of haze can range from 1 to 3 kilometers with little daily change. Smog particles are equally dispersed, whereas dust particles range in size from 1 to 10 microns, with an average diameter of 1 to 2 micron. During smog episodes, fine particle concentrations rise, reducing visibility and decreasing air quality. These tiny particles can be ingested and reach the bloodstream, posing substantial health hazards (Zhou et al., 2015). The prevalence of smog in central and eastern China has increased significantly in 2013. Because of the complex composition of smog aerosols, scientists, government officials, and the general public have paid close attention to the environmental and climatic repercussions of aerosol radioactive forcing (Wu, 2011).

SMOG OR POLLUTANTS IMPACTS ON WILDLIFE

Smog significantly impacts the respiratory health of wildlife, impairing their ability to breathe and maintain overall well-being (Figure 4). Inhalation of pollutants and exposure to ground-level ozone lead to inflammation and damage within wild animals' respiratory systems (Relić and Đukić-Stojčić, 2023). These irritants compromise lung function, decrease lung capacity, and can result in chronic respiratory issues or even death in severe cases (Manisalidis et al., 2020). For instance, fine particles can penetrate deep into the respiratory tract, causing tissue damage and reducing oxygen intake. Additionally, smog weakens the immune system, making animals more susceptible to respiratory infections and illnesses (Kotwal et al., 2005). Prolonged exposure can hinder wildlife's ability to feed, move, or evade predators, ultimately threatening their survival in contaminated habitats (Guerrero Cruz, 2018; Relić and Đukić-Stojčić, 2023).

In their study, the authors claimed that strains associated with exposure to air pollutants such as heavy metals, particulate matter i.e. PM and volatile organic compounds i.e. VOCs delay reproductive functioning in animals besides causing hormonal dysfunctions and low fertility rates (Saleem et al., 2024). These pollutants disrupt endocrine systems by binding to sex hormones that are vital in successful mating besides breeding. Contaminants can negatively affect eggs, sperm or embryo in a way that reduces the number of hatchlings or increases developmental problems among the young (Harrison and Hester, 1999). In addition, stress due to exposure to smog and respiratory diseases resulting from the emissions reduce the energy that animals possess hence reducing the chances of performing courtship among animals or sustaining pregnancies among animals. Populations that are on the move are among the most affected, due to smog's impairing their sense of direction and time, resulting in the inability to breed. Of all the cumulative impacts with respect to susceptibility, smog has the most profound impact on an individual's reproductive health (Marco and Ortiz-Santaliestra, 2009; Camill, 2010; Saleem et al., 2024).

Polluted air hinders wildlife's feeding and foraging behavior in terms of seeking and capturing food rates (Liang et al., 2020; Barton et al., 2023). Smog has the effect of obscuring vision; investors that control crops or livestock may experience difficulty seeing their prey or recognizing vegetation that is adequate for feeding. Some actual pollutants, such as ground-level ozone and particulate matter, also have an impact on plant life, thereby depriving herbivores of their feed stocks. Moreover, physical contact with hazardous pollutants brings about stress, leading to less food intake, and animals experience stress through the inhalation of these pollutants (Pinto et al., 2010; Relić and Đukić-Stojčić, 2023). In marine environments alone, smog-caused acid rain hampers water quality, restricting access to fish and other animals on which most species depend (Prabhakar et al., 2012).

Smog impacts wildlife movement and navigation, impeding behaviors critical for species survival. Several map-reading mechanisms rely on vision, starlight, and physical environmental factors, such as those used by migratory animals, like birds, bats, and butterflies (Voigt et al., 2018; Wicht, 2024). However, high concentrations of pollution delay these species' the ability to see significant points and star constellations for navigation (Warnke, 2009). Additionally, heavy metals and nitrogen oxides, components of smog, can impair the sensitivity of their sense organs, limiting their ability to perceive magnetic fields or scents that guide migration (Balmori, 2022). Environmental pollution may also harm the strength and endurance of migratory animals, which need to cover large distances (Wicht, 2024).

HABITAT DEGRADATION DUE TO SMOG DEPOSITION

Deposition of smog in habitats is an increasing threat to vegetation, particularly in urban industrial areas. Smog is a combination of various air constituents that interact in a complex chemical manner (Arbaugh et al., 2003). It is harmful when it settles on plants, soil, and water bodies (Wright et al., 2018). This adversely affects vulnerable plant species; particulate matter not only limits light but also emits toxic chemicals that can destroy foliage, hinder growth, and weaken resistance to diseases. These cumulative effects threaten ecosystem integrity and species conservation, as both plant and animal organisms struggle to survive in contaminated environments (Lovett, 1994).

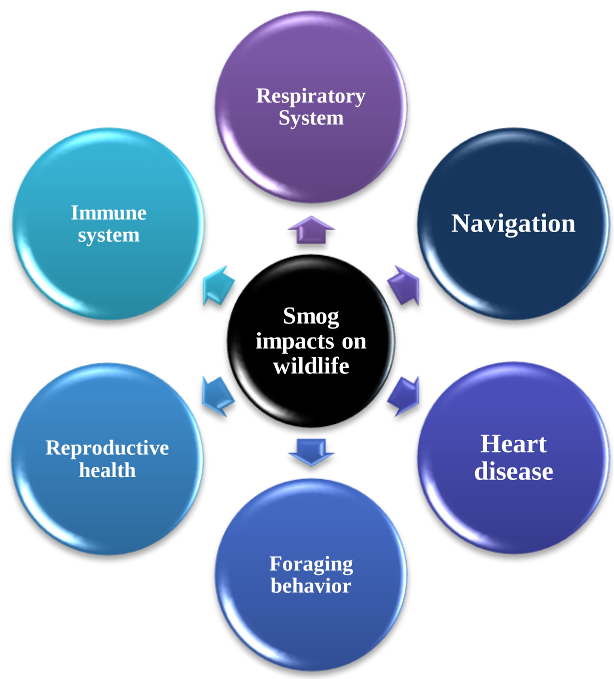

Figure 4: Smog or pollutants impacts on wildlife health.

MITIGATION STRATEGIES FOR SMOG

Addressing and controlling smog necessitates a comprehensive strategy that addresses the different pollutants and sources that contribute to its development. Here are certain ways for reducing and regulating smog (Rosenfeld et al., 1998; Rani et al., 2011; Arif and Hassan, 2023; Usman et al., 2023):

- Crop residue management is essential for controlling smog, especially in agrarian areas where burning crop remains gives to air contamination. Decreasing emissions of volatile composites from manures can also help improve air quality.
- Stack gas control measures are essential for reducing smog levels. These measures aim to limit the emissions of air pollutants, particularly those that contribute to photochemical smog. Industries utilize various technologies, such as dry and wet scrubbers and filters, to contain pollutants and support smog control efforts. Scrubbers are advanced treatment systems designed to eliminate and selectively remove different types of pollutants from industrial emissions before they reach the air. They mainly target nitrogen oxides, sulfur dioxide, as well as particulate matter.

Air filtration methods, are specially designed to capture or filter out particulate matter emissions from the air. Incorporating filters and scrubbers into a factory emission regulator plan represents a proactive method to managing smog sources. Additionally, transitioning to cleaner fuels is a significant strategy in the fight against smog. The goal of using cleaner fuels is to reduce pollutants released during combustion, thereby resulting in less haze and smog creation. The introduction of cleaner-burning fuels and certified renewables in factory processes is one of the most effective strategies for achieving this goal.

- Automobiles can be among the main sources of volatile natural greenhouse gas emissions, therefore annual evaluation and modification of standards for them is required. Additionally, developing infrastructure that promotes walking and cycling as alternatives to motorized transport is multifaceted and requires urban planning, policies, and design. Furthermore, increasing mass transportation is directly relevant in the fight against smog because it reduces the number of one-passenger car journeys and encourages cleaner modes of transportation.
- Skill development is an efficient technique to direct firms and people who are prepared to put in more effort to move towards better and cleaner machinery and procedures.
- Pollution prevention science incorporates extensive research and development into its efforts by adopting new achievements and methods or formulas for combating pollution. These activities provide the necessary weaponry to combat pollution. Science and technology provide innovative solutions, knowledge to support and create policies dealing with the vices connected with pollution and smog, and the information required to address the effects of pollution on ecological systems and human health.
- Effective urban development processes are critical for establishing and maintaining sustainable, functional, and livable communities. Urban planning is concerned with social, environmental, economic, and even cultural aspects of city life. Increasing green spaces in metropolitan areas is a functional method for improving air quality and fostering natural air purification. Integrating mixed residential and commercial properties into urban planning is an efficient way to reduce pollution from excessive transportation while also encouraging resource efficiency and sustainable development. Strategically situating urban trees through thoughtful design can reduce fog and pollution, improve air quality, eliminate heat islands, and increase ecological diversity.
- It is critical to remember the following concerning pollution: public education is extremely important for a variety of reasons. It helps individuals, stakeholders, and communities obtain insights into smog, participate in pollution management, and promote the development of a cleaner environment.

CONCLUSION

This form of pollution is extremely harmful to life, particularly to the habitats and animal species in the impacted areas. Smog contains contaminants that affect animals' respiratory systems, productivity, and immunological function, making it difficult to locate endangered species with diminishing populations. Smog also affects plant germination rates, which give food and shelter to a variety of species. These negative consequences of smog pollution underline the critical need for a serious environmental and wildlife conservation campaign, as well as successful preservation measures for specific species and habitats in the future.

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