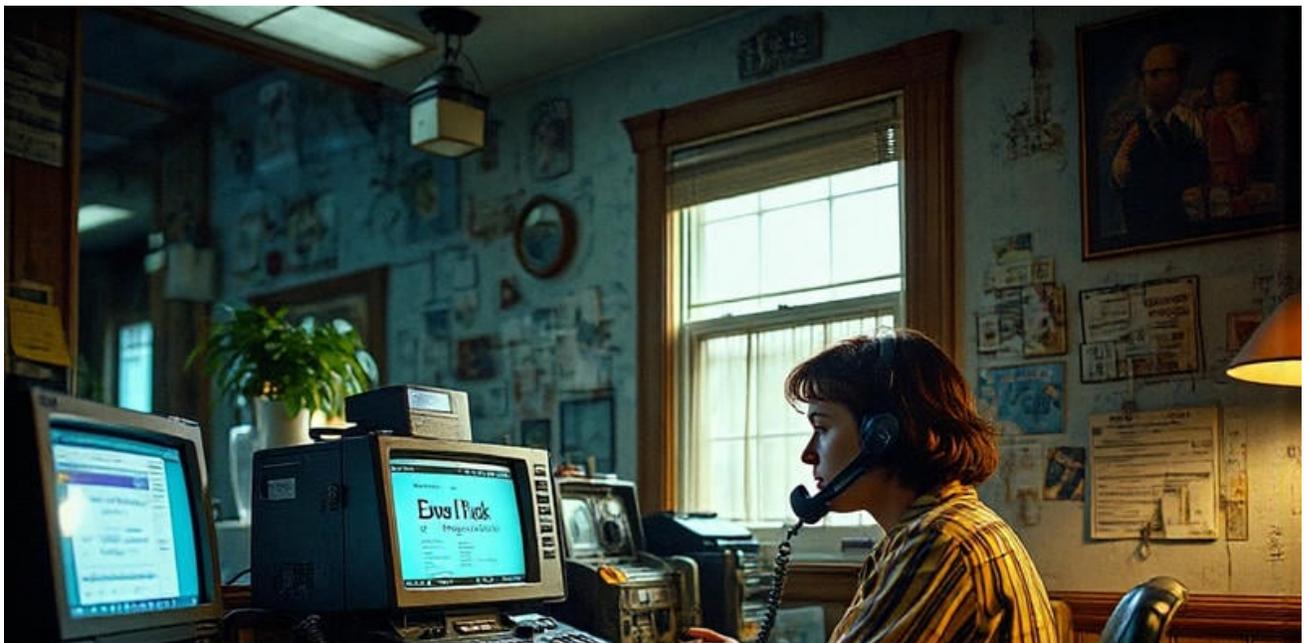


## Retrofit HVAC

- **Reviewing Key Safety Measures for Mobile Home HVAC Work**  
**Reviewing Key Safety Measures for Mobile Home HVAC Work Understanding PPE Guidelines for Mobile Home Furnace Repair Following OSHA Standards During Mobile Home AC Installations Noting Electrical Hazard Precautions in Mobile Home HVAC Projects Planning Lockout Procedures for Mobile Home Heating Maintenance Checking for Proper Ventilation in Mobile Home HVAC Crawl Spaces Confirming Compliance with HUD Requirements for Mobile Home Ducts Conducting On Site Safety Assessments Before Mobile Home AC Repairs Checking Gas Line Integrity in Mobile Home Heating Systems Identifying Combustion Clearance Issues in Mobile Home Furnaces Monitoring Air Quality Factors During Mobile Home HVAC Upkeep Coordinating Exit Strategies for Emergencies in Mobile Home HVAC Work**
- **Identifying Warning Signs of Outdated Components**  
**Identifying Warning Signs of Outdated Components Converting Older Units to High Efficiency Models Examining Duct Layout for Better Distribution Adjusting Equipment Size to Fit Modern Needs Evaluating Newer Options to Replace Electric Heaters Implementing Airflow Balancing Techniques Overcoming Physical Constraints in Legacy Structures Transitioning to Improved Refrigerants for Compliance Strengthening Insulation to Enhance Performance Matching Compatibility of Controls and Existing Wiring Coordinating Expert Consultations for Complex Projects Planning Timelines for Effective System Upgrades**
- **About Us**



## Importance of Safety in Mobile Home HVAC Work

When it comes to ensuring the comfort and safety of mobile homes, one crucial aspect that often goes overlooked is the proper ventilation of crawl spaces. These confined spaces beneath mobile homes are integral to maintaining a healthy living environment, yet they are prone to several common ventilation issues. Leaks in ductwork can lead to significant energy loss in mobile homes **mobile home hvac repair** compressor. Identifying and addressing these issues is essential for the overall efficiency of the home's HVAC system and for preventing potential damage caused by moisture buildup and poor air quality.

One of the most prevalent problems in mobile home crawl spaces is inadequate airflow. Due to limited space and sometimes suboptimal construction, these areas can become stagnant, trapping moisture and leading to mold growth. Poor airflow not only affects the structural integrity of the home but also impacts indoor air quality, potentially causing health issues for residents. Ensuring that vents are unobstructed and strategically placed can significantly improve circulation, allowing for proper ventilation.

Another common issue is excess moisture accumulation. Crawl spaces are notorious for being damp environments due to their proximity to the ground. Without proper ventilation, moisture can build up, resulting in wood rot, rusting of metal components, and even pest infestations. Installing vapor barriers on the ground surface and ensuring that there is adequate drainage around the mobile home are effective ways to combat this problem.

Additionally, improperly sealed ducts within crawl spaces can contribute to poor ventilation. Leaky ducts not only waste energy but also allow unconditioned air from outside or from within the crawl space itself into the HVAC system, reducing its efficiency. Regular inspections should be conducted to check for any ductwork leaks or disconnections that could compromise ventilation effectiveness.

Furthermore, seasonal changes can exacerbate these issues if not properly managed. In warmer months, higher humidity levels increase moisture risks in crawl spaces; conversely, colder weather may lead to frozen pipes if there isn't adequate airflow or insulation. Adjusting ventilation strategies according to seasonal demands ensures that these spaces remain dry and conducive for optimal HVAC performance year-round.

In conclusion, checking for proper ventilation in mobile home crawl spaces involves recognizing common issues such as inadequate airflow, moisture accumulation, leaky

ducts, and seasonal variations in climate conditions. By addressing these challenges through strategic placement of vents, installation of vapor barriers, regular maintenance checks on ductwork integrity, and adapting strategies based on weather changes- homeowners can safeguard their property against potential damages while enhancing overall indoor air quality. Taking proactive steps towards improving crawl space ventilation not only extends the life span of a mobile home's structure but also contributes significantly towards creating a healthier living environment inside it.

Inspecting HVAC crawl space ventilation in mobile homes is a crucial task that ensures the efficiency, safety, and longevity of the HVAC system. Proper ventilation prevents moisture buildup, mold growth, and structural damage, thus maintaining a healthy living environment. To carry out this inspection effectively, one must be equipped with the right tools and equipment. This essay will explore the essential tools needed for inspecting HVAC crawl space ventilation.

Firstly, personal protective equipment (PPE) is vital when entering and operating within crawl spaces. This includes a hard hat to protect against head injuries from low-hanging objects, gloves to safeguard hands from sharp edges or unsanitary surfaces, and coveralls to keep dirt and debris at bay. Respirators are also recommended due to potential exposure to dust or mold spores in confined areas.

Flashlights or headlamps are indispensable tools for navigating dark crawl spaces. They provide adequate lighting to inspect every nook and cranny without missing any critical details. A headlamp allows for hands-free operation, which can be particularly advantageous in cramped conditions.

Moisture meters are essential for detecting excess moisture levels within the crawl space environment. High moisture levels can indicate inadequate ventilation or leaks that need immediate attention. By identifying these issues early on with a moisture meter, one can take corrective action before significant damage occurs.

Another important tool is an infrared thermometer or thermal camera. These devices help identify temperature variations that may suggest improper airflow or insulation problems within the HVAC system. Spotting these irregularities early ensures that they can be addressed promptly to maintain optimal performance of the system.

A digital manometer might also be necessary if you suspect issues related to air pressure imbalances in the crawl space ventilation system. It measures air pressure differences between different areas of the home and helps confirm whether proper airflow is being maintained across all sections of the HVAC setup.

In addition to these electronic devices, having basic hand tools such as screwdrivers, pliers, and wrenches is essential for opening panels or tightening loose components during inspections.

Lastly, carrying a notepad or digital device for taking notes is useful for documenting findings during inspections. Recording observations allows inspectors to track changes over time and provides valuable information when discussing potential improvements or repairs with homeowners or contractors.

In conclusion, inspecting HVAC crawl space ventilation in mobile homes requires careful preparation with appropriate tools and equipment. From personal protective gear to advanced diagnostic devices like moisture meters and thermal cameras, each tool plays a pivotal role in ensuring thorough inspections that lead to effective maintenance solutions. Armed with these tools, professionals can confidently assess ventilation systems' health while safeguarding both property integrity and occupant well-being.

## **More About Us**

Mobile Home Air Conditioning Installation Services



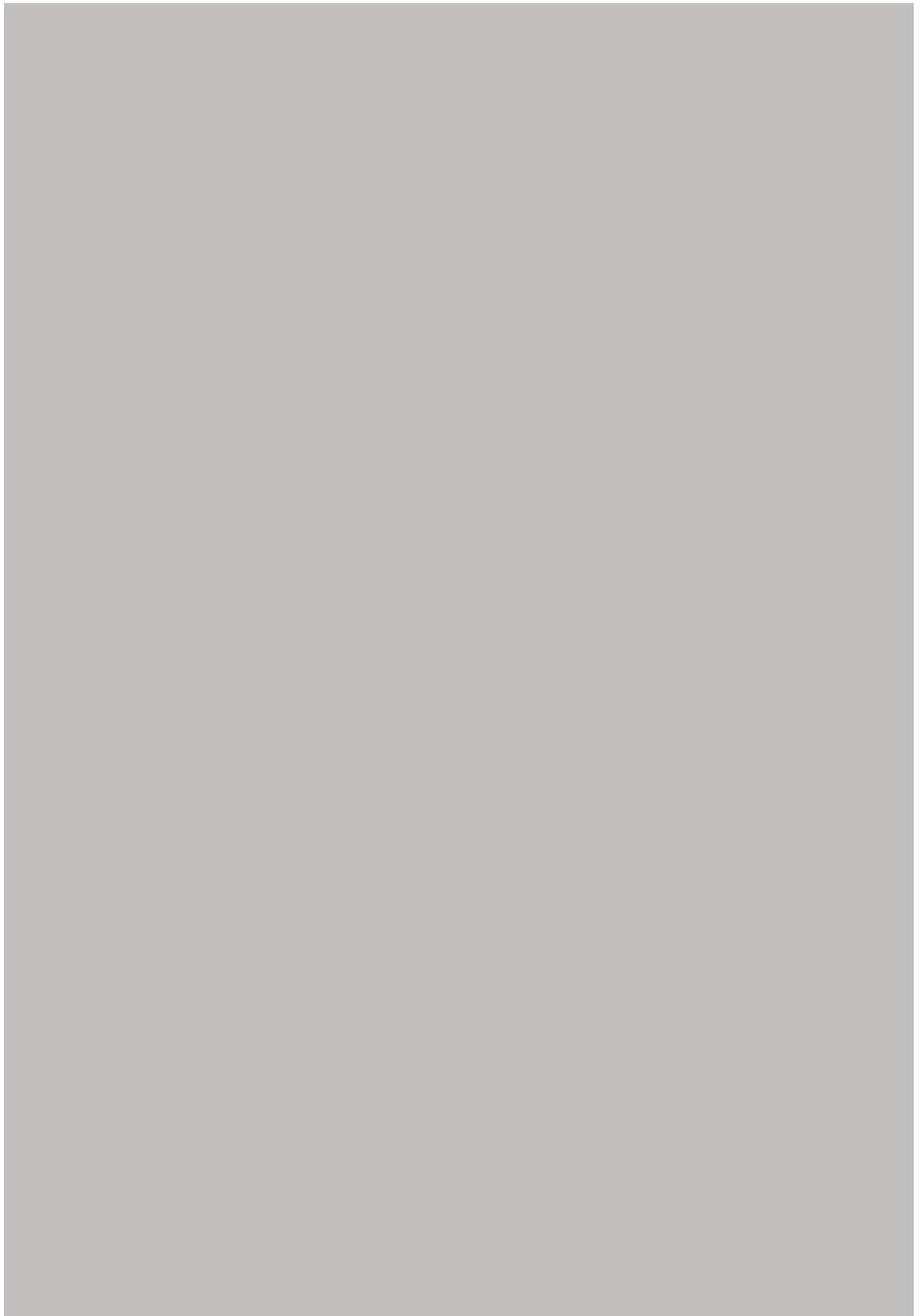
## **What Yelp Says About Us**

Mobile Home Hvac Service



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# Essential Safety Gear and Equipment for Technicians

Ensuring proper ventilation in the crawl spaces of mobile homes is essential for maintaining a healthy living environment. These often-overlooked areas can significantly impact air quality, energy efficiency, and the overall structural integrity of your home. In this step-by-step guide, we will explore how to check and improve ventilation in mobile home crawl spaces.

Firstly, it's crucial to understand why crawl space ventilation matters. Mobile homes are built with crawl spaces to elevate them from the ground, which helps protect against moisture intrusion and provides access to plumbing and electrical systems. However, without adequate ventilation, these spaces can become breeding grounds for mold, mildew, and pests due to trapped moisture and stagnant air.

Begin by conducting a visual inspection. Crawl under your mobile home with a flashlight in hand. Look for any signs of moisture accumulation or water pooling on the ground or foundation walls. Check for visible mold growth or musty odors that could indicate poor

ventilation.

Next, evaluate the existing ventilation system. Most mobile homes are equipped with vents along the perimeter of the crawl space walls. Ensure that these vents are unobstructed by debris such as leaves or dirt. They should be open year-round unless extreme weather conditions necessitate temporary closure.

Measure the total vent area relative to your crawl space size. A general rule of thumb is one square foot of vent area for every 150 square feet of crawl space floor area if there is no vapor barrier present, or one square foot per 1,500 square feet if there is a vapor barrier installed.

Consider installing additional vents if necessary to meet these guidelines. Alternatively, you might opt for mechanical ventilation solutions like exhaust fans or humidistats that automatically regulate airflow based on humidity levels.

Inspect insulation within the crawl space as well. Insulation plays a dual role: it prevents heat loss during winter months and helps manage humidity levels by reducing temperature fluctuations that contribute to condensation.

Finally, address any drainage issues around your mobile home that may exacerbate moisture problems in the crawl space. Ensure gutters are clean and functioning properly to direct rainwater away from the foundation.

In conclusion, maintaining proper ventilation in your mobile home's crawl space is vital for preserving its longevity and ensuring indoor air quality remains healthy. By following these steps-conducting inspections, evaluating current systems, adding vents if necessary-you can help prevent common problems associated with poor ventilation such as mold growth or pest infestations while also improving energy efficiency within your living environment.



# **Proper Procedures for Handling Refrigerants and Chemicals**

Proper ventilation in mobile home HVAC crawl spaces is crucial for maintaining a healthy living environment and ensuring the efficient functioning of heating, ventilation, and air conditioning systems. Inadequate ventilation can lead to a host of problems that affect both the structural integrity of the home and the performance of its HVAC system. Recognizing signs of poor ventilation and understanding their potential consequences are essential for homeowners who wish to maintain their residence effectively.

One of the primary signs of inadequate ventilation in crawl spaces is excessive moisture build-up. This can manifest as condensation on ductwork or standing water on the floor of the crawl space. When moisture levels rise, it creates an ideal environment for mold and mildew growth, which can compromise indoor air quality and present health risks to occupants by triggering allergies or respiratory issues. Furthermore, high moisture levels can cause wooden structures to rot over time, weakening the home's foundation.

Another indicator of insufficient ventilation is a musty odor emanating from the crawl space. This smell often indicates mold growth or decaying organic material due to humidity and lack of airflow. If left unaddressed, these odors can permeate living areas above the crawl space, making indoor environments unpleasant and unhealthy.

In addition to smells and moisture problems, pests like rodents or insects may also be more prevalent in poorly ventilated areas. These creatures are attracted to damp environments where they can find food sources or nest materials. Pests not only pose health hazards but can also damage insulation and wiring within HVAC systems, leading to costly repairs or replacements.

The consequences of neglecting proper ventilation extend beyond immediate health concerns; they also impact energy efficiency and operational costs. For instance, when an HVAC system works harder than necessary due to restricted airflow or clogged filters caused by dust accumulation from poor ventilation, it consumes more energy than needed-leading to higher utility bills. Over time, this increased strain on equipment reduces its lifespan, necessitating premature replacement.

To prevent these issues, homeowners should regularly inspect their mobile home's crawl space for any signs of inadequate ventilation such as moisture accumulation or unusual smells. Installing vents strategically around the perimeter can improve airflow substantially while keeping humidity levels in check. Additionally, using vapor barriers on floors may help reduce moisture intrusion from below-ground sources.

In conclusion, ensuring adequate ventilation within mobile home HVAC crawl spaces is vital for safeguarding both structural integrity and system efficiency. By being vigilant about recognizing signs like excess moisture or persistent odors early on-and taking corrective measures promptly-homeowners can avoid significant expenses down the line while promoting healthier living conditions indoors. Regular maintenance checks paired with appropriate upgrades will contribute greatly towards achieving optimal results concerning air quality management throughout one's dwelling space.

# Electrical Safety Protocols for Mobile Home HVAC Work

Crawl spaces in mobile homes often present unique challenges, particularly when it comes to ensuring proper ventilation. These confined areas are prone to moisture accumulation, which can lead to a host of issues such as mold growth, structural damage, and poor air quality. Therefore, implementing effective solutions and best practices for improving crawl space ventilation is essential for maintaining a healthy living environment.

One of the fundamental steps in ensuring proper ventilation in mobile home HVAC crawl spaces involves assessing the current state of airflow. A thorough inspection should be conducted to identify any existing blockages or restrictions that might impede air movement. This process typically includes checking for debris, insulation obstructions, or improperly sealed vents that may hinder the natural circulation of air.

Once any obstructions have been cleared, it is crucial to evaluate the adequacy of existing vent placements. Mobile homes generally require vents on all sides of the crawl space to promote cross-ventilation effectively. It's important that these vents remain unobstructed throughout the year; therefore, regular maintenance and cleaning are necessary to prevent leaves or other debris from clogging them.

In addition to physical inspections and maintenance, incorporating technological solutions can greatly enhance crawl space ventilation. Installing exhaust fans or mechanical ventilators

specifically designed for crawl spaces can significantly improve airflow. These devices help draw out moist air while introducing fresh air into the space, thus reducing humidity levels and preventing moisture-related problems.

Another effective solution involves using vapor barriers on the ground within the crawl space. By covering the soil with durable plastic sheeting, homeowners can prevent ground moisture from seeping into the space above. This measure not only helps control humidity but also aids in maintaining temperature stability within both the crawl space and living areas.

Moreover, integrating smart technology into home systems allows for continuous monitoring of conditions within a mobile home's crawl space. Devices such as humidity sensors and smart thermostats provide real-time data on environmental factors like temperature and humidity levels. Homeowners can use this information to make informed decisions about adjusting ventilation strategies according to current conditions.

Alongside these technical solutions, educational efforts play a pivotal role in improving crawl space ventilation in mobile homes. Homeowners should be encouraged to understand the importance of maintaining an optimal balance between indoor and outdoor air exchange rates while recognizing signs indicative of inadequate ventilation-such as musty odors or visible mold growth-in their HVAC systems' vicinity.

In conclusion, achieving proper ventilation in mobile home HVAC crawl spaces requires diligent attention combined with practical interventions tailored towards enhancing airflow efficiency while minimizing moisture intrusion risks over time. By embracing comprehensive strategies encompassing both traditional methods like vent placement optimization alongside modern technologies such as mechanical ventilators coupled with ongoing education initiatives targeting residents themselves-homeowners stand poised not only safeguard their properties against potential damages but also foster healthier indoor environments conducive towards overall wellbeing without compromising comfort levels enjoyed therein!

# Best Practices for Ensuring Structural Integrity During Installation and Maintenance

Ensuring optimal performance of mobile home HVAC systems involves regular maintenance, with one crucial aspect being the proper ventilation of crawl spaces. These spaces, often overlooked, play a vital role in maintaining the efficiency and longevity of your HVAC system. Proper ventilation within these areas helps prevent moisture buildup, which can lead to mold growth and structural damage, ultimately affecting the overall air quality and energy efficiency of your home.

First and foremost, it is essential to understand the purpose of ventilation in crawl spaces. These areas are typically located beneath mobile homes and serve as a buffer between the ground and the living space above. While they provide easy access to plumbing, electrical systems, and ductwork, their enclosed nature makes them susceptible to moisture accumulation. Without adequate ventilation, this moisture can lead to problems such as wood rot or rusting components that compromise your HVAC system's functionality.

To ensure proper ventilation in these crawl spaces, begin by conducting regular inspections. Look for signs of excess moisture like condensation on surfaces or a musty odor-these are indicators that you may have an issue with airflow. It's also wise to check for any obstructions around existing vents that might impede air circulation.

One effective way to improve ventilation is by installing vent screens or grilles at strategic locations around the perimeter of your mobile home. These installations facilitate passive airflow while keeping pests out. Ensure these vents remain unobstructed by debris like leaves or dirt that could hinder their function.

Additionally, consider using vapor barriers as part of your maintenance routine. A vapor barrier is a sheet material typically made from plastic that covers the ground in crawl spaces to reduce moisture infiltration from soil evaporation. This simple addition can significantly enhance the air quality by minimizing dampness levels.

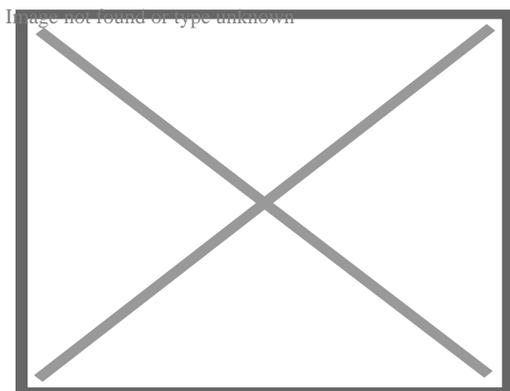
Moreover, mechanical solutions such as exhaust fans can be employed for more active management of humidity levels within crawl spaces. These fans help expel moist air directly outside rather than allowing it to linger beneath your flooring-a proactive measure particularly beneficial in humid climates.

Finally, remember that seasonal changes can affect how well-ventilated these areas are; therefore, adjustments may be required throughout the year to maintain equilibrium between temperature and humidity levels inside your home versus those outside it.

In conclusion, checking for proper ventilation in mobile home HVAC crawl spaces should be an integral part of any homeowner's maintenance checklist. Through regular inspections coupled with strategic installations like vent screens or vapor barriers-and potentially employing mechanical aids-you not only safeguard against potential hazards but also ensure optimal performance from your HVAC system over time. By prioritizing this often-neglected area underfoot today , you pave way for improved comfort , energy efficiency ,and peace-of-mind tomorrow .

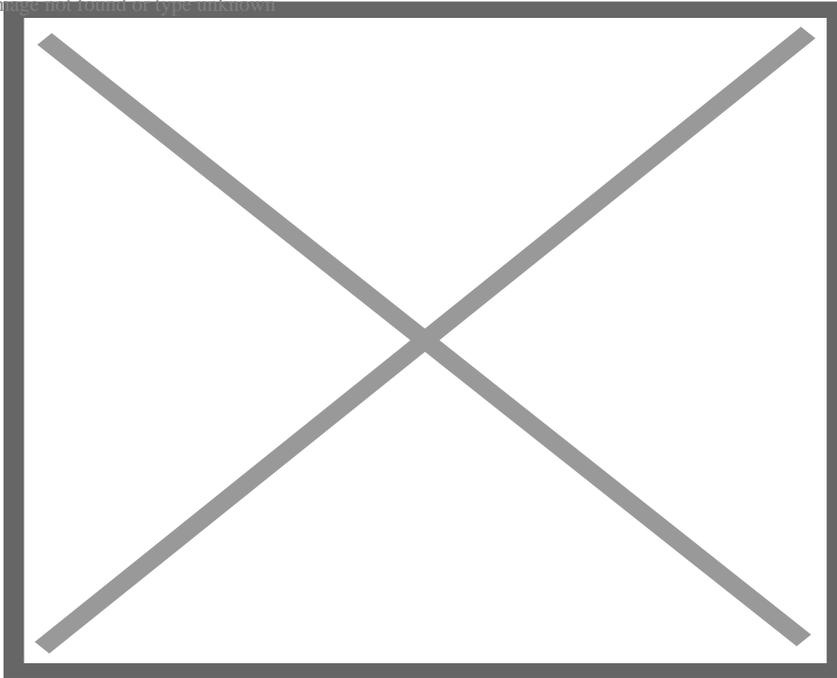
### **About Air pollution**

"Bad air quality" and "Air quality" redirect here. For the obsolete medical theory, see Miasma theory. For the measurement of air pollution, see Air quality index. For the qualities of air, see Atmosphere of Earth.



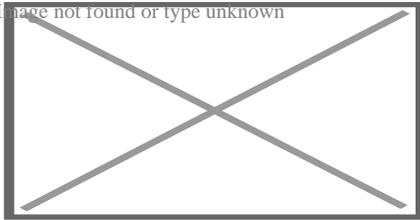
## Air pollution from a coking oven

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2016 Environmental Performance Index – darker colors indicate lower concentrations of fine particulate matter and nitrogen dioxide, as well as better indoor air quality.

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Deaths from air pollution per 100,000 inhabitants (IHME, 2019)

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Part of a series on

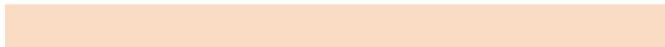
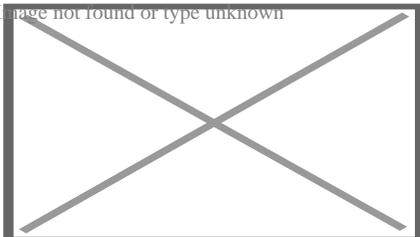


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Air pollution from a factory

## Air

- Acid rain
- Air quality index
- Atmospheric dispersion modeling
- Chlorofluorocarbon
- Combustion
- Exhaust gas
- Haze
- Global dimming
- Global distillation
- Indoor air quality
- Non-exhaust emissions
- Ozone depletion
- Particulates
- Persistent organic pollutant
- Smog
- Soot
- Volatile organic compound

## Biological

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- Genetic
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  - Invasive species

## Digital

- Information

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  - Ecological
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- Radium and radon in the environment
- Volcanic ash
- Wildfire

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- Noise barrier
- Noise control
- Soundproofing

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- Bioremediation
- Depleted uranium
- Nuclear fission
- Nuclear fallout
- Plutonium
- Poisoning
- Radioactivity
- Uranium
- Radioactive waste

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- Defecation
- Electrical resistance heating
- Illegal mining
- Soil guideline values
- Phytoremediation

## Solid waste

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- Biodegradable waste
- Brown waste
- Electronic waste
- Foam food container
- Food waste
- Green waste
- Hazardous waste
- Industrial waste
- Litter
- Mining
- Municipal solid waste
- Nanomaterials
- Plastic
- Packaging waste
- Post-consumer waste
- Waste management

## Space

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## Thermal

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## Visual

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- Advertising clutter
- Overhead power lines
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- Vandalism

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- Freshwater
- Groundwater
- Hypoxia
- Industrial wastewater
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- Nutrient
- Ocean acidification
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  - Heavy metals
  - Paint

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- Garbology
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- Most polluted cities
- Least polluted cities by PM2.5
- Treaties
- Most polluted rivers

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Part of a series on

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Tropical seasons

- Dry season
  - Harmattan
- Wet season

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  - Thundersnow
  - Dry thunderstorm
- Mesocyclone
  - Supercell
- Tornado
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- Cyclone
- Polar low
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  - Haboob
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  - Snow roller
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- Weather modification

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- Climate change
- Tornado terms
- Tropical cyclone terms

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Weather portal  
icon

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**Air pollution** is the contamination of air due to the presence of substances called pollutants in the atmosphere that are harmful to the health of humans and other living beings, or cause damage to the climate or to materials.<sup>[1]</sup> It is also the contamination of the indoor or outdoor environment either by chemical, physical, or biological agents that alters the natural features of the atmosphere.<sup>[1]</sup> There are many different types of air pollutants, such as gases (including ammonia, carbon monoxide, sulfur dioxide, nitrous oxides, methane and chlorofluorocarbons), particulates (both organic and inorganic) and biological molecules. Air pollution can cause diseases, allergies, and even death to humans; it can also cause harm to other living organisms such as animals and crops, and may damage the natural environment (for example, climate change, ozone depletion or habitat degradation) or built environment (for example, acid rain).<sup>[2]</sup> Air pollution can be caused by both human activities<sup>[3]</sup> and natural phenomena.<sup>[4]</sup>

Air quality is closely related to the Earth's climate and ecosystems globally. Many of the contributors of air pollution are also sources of greenhouse emission i.e., burning of fossil fuel.<sup>[1]</sup>

Air pollution is a significant risk factor for a number of pollution-related diseases, including respiratory infections, heart disease, chronic obstructive pulmonary disease (COPD), stroke, and lung cancer.<sup>[5]</sup> Growing evidence suggests that air pollution exposure may be associated with reduced IQ scores, impaired cognition,<sup>[6]</sup> increased risk for psychiatric disorders such as depression<sup>[7]</sup> and detrimental perinatal health.<sup>[8]</sup> The human health effects of poor air quality are far reaching, but principally affect the body's respiratory system and the cardiovascular system.<sup>[9]</sup><sup>[10]</sup> Individual reactions to air pollutants depend on the type of pollutant a person is exposed to,<sup>[11]</sup><sup>[12]</sup> the degree of exposure, and the individual's health status and genetics.<sup>[13]</sup>

Air pollution is the largest environmental risk factor for disease and premature death<sup>[5]</sup> <sup>[14]</sup> and the fourth largest risk factor overall for human health.<sup>[15]</sup> Air pollution causes the premature deaths of around 7 million people worldwide each year,<sup>[5]</sup> or a global mean loss of life expectancy (LLE) of 2.9 years,<sup>[16]</sup> and there has been no significant change in the number of deaths caused by all forms of pollution since at least 2015.<sup>[14]</sup><sup>[17]</sup><sup>[18]</sup> Outdoor air pollution attributable to fossil fuel use alone causes ~3.61

million deaths annually,<sup>[19]</sup> making it one of the top contributors to human death.<sup>[5]</sup> Anthropogenic ozone causes around 470,000 premature deaths a year and fine particulate (PM<sub>2.5</sub>) pollution around another 2.1 million.<sup>[20]</sup> The scope of the air pollution crisis is large: In 2018, WHO estimated that "9 out of 10 people breathe air containing high levels of pollutants."<sup>[21]</sup> Although the health consequences are extensive, the way the problem is handled is considered largely haphazard<sup>[22]</sup><sup>[21]</sup><sup>[23]</sup> or neglected.<sup>[14]</sup>

The World Bank has estimated that welfare losses (premature deaths) and productivity losses (lost labour) caused by air pollution cost the world economy \$5 trillion per year.<sup>[24]</sup><sup>[25]</sup><sup>[26]</sup> The costs of air pollution are generally an externality to the contemporary economic system and most human activity, although they are sometimes recovered through monitoring, legislation, and regulation.<sup>[27]</sup><sup>[28]</sup>

Many different technologies and strategies are available for reducing air pollution.<sup>[29]</sup> Although a majority of countries have air pollution laws, according to UNEP, 43 percent of countries lack a legal definition of air pollution, 31 percent lack outdoor air quality standards, 49 percent restrict their definition to outdoor pollution only, and just 31 percent have laws for tackling pollution originating from outside their borders.<sup>[30]</sup> National air quality laws have often been highly effective, notably the 1956 Clean Air Act in Britain and the US Clean Air Act, introduced in 1963.<sup>[31]</sup><sup>[32]</sup> Some of these efforts have been successful at the international level, such as the Montreal Protocol,<sup>[33]</sup> which reduced the release of harmful ozone depleting chemicals, and the 1985 Helsinki Protocol,<sup>[34]</sup> which reduced sulfur emissions,<sup>[35]</sup> while others, such as international action on climate change,<sup>[36]</sup><sup>[37]</sup><sup>[38]</sup> have been less successful.

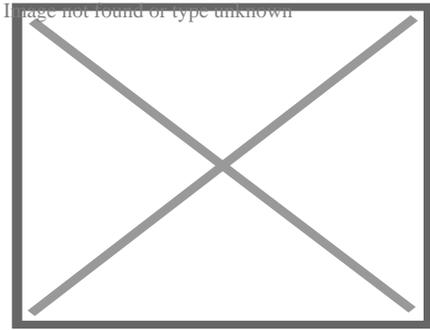
## Sources of air pollution

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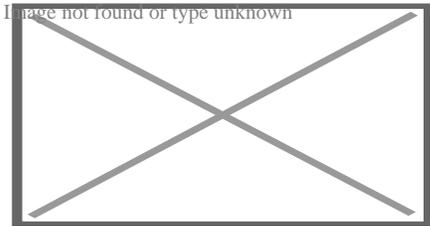
There are many different sources of air pollution. Some air pollutants (such as nitrogen oxides) originate mainly from human activities,<sup>[39]</sup> while some (notably radon gas) come mostly from natural sources.<sup>[40]</sup> However, many air pollutants (including dust and sulfur dioxide) come from a mixture of natural and human sources.<sup>[41]</sup>

## Anthropogenic (human-made) sources

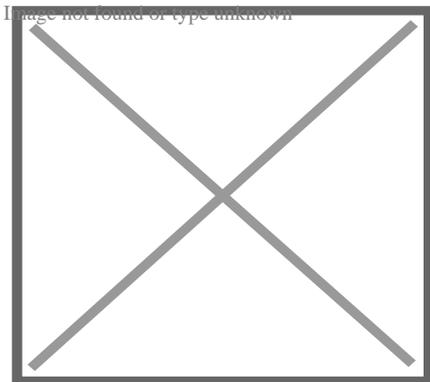
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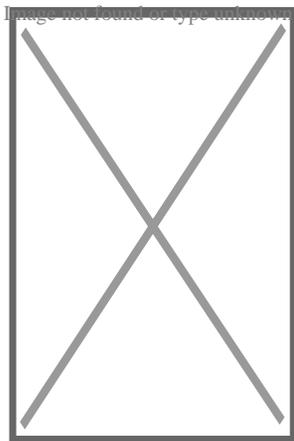
Demolition of the cooling towers of a power station, Athlone, Cape Town, South Africa, 2010



Controlled burning of a field outside of Statesboro, Georgia, US, in preparation for spring planting



Smoking of fish over an open fire in Ghana, 2018



Burning of joss paper in a Chinese temple in Hong Kong

- Stationary sources include:
  - fossil-fuel power plants and biomass power plants both have smoke stacks (see for example environmental impact of the coal industry)<sup>[42]</sup>
    - Oil and gas sites that have methane leaks<sup>[43][44][45][46]</sup>
  - burning of traditional biomass such as wood, crop waste and dung. (In developing and poor countries,<sup>[47]</sup> traditional biomass burning is the major source of air pollutants.<sup>[48][49]</sup> It is also the main source of particulate pollution in many developed areas including the UK & New South Wales.<sup>[50][51]</sup> Its pollutants include PAHs.<sup>[52]</sup>)
  - manufacturing facilities (factories)<sup>[53]</sup>
    - a 2014 study found that in China equipment-, machinery-, and devices-manufacturing and construction sectors contributed more than 50% of air pollutant emissions.<sup>[54]</sup><sup>[better source needed]</sup> This high emission is due to high emission intensity and high emission factors in its industrial structure.<sup>[55]</sup>
  - construction<sup>[56][57]</sup>
  - renovation<sup>[58]</sup>
  - waste incineration (incinerators as well as open and uncontrolled fires of mismanaged waste, making up about a fourth of municipal solid terrestrial waste)<sup>[59][60]</sup>
  - furnaces and other types of fuel-burning heating devices<sup>[61]</sup>
- Mobile sources include motor vehicles, trains (particularly diesel locomotives and DMUs), marine vessels and aircraft<sup>[62]</sup> as well as rockets and re-entry of components and debris.<sup>[63]</sup> The air pollution externality of cars enters the air from the exhaust gas and car tires (including microplastics<sup>[64]</sup>). Road vehicles make a significant amount of all air pollution (typically, for example, around a third to a half of all nitrogen dioxide emissions)<sup>[65][66][67]</sup> and are a major driver of climate change.<sup>[68][69]</sup>
- Agriculture and forest management strategies using controlled burns. Practices like slash-and-burn in forests like the Amazon cause large air pollution with the deforestation.<sup>[70]</sup> Controlled or prescribed burning is a practice used in forest management, agriculture, prairie restoration, and greenhouse gas reduction.<sup>[71]</sup> Foresters can use controlled fire as a tool because fire is a natural feature of both forest and grassland ecology.<sup>[72][73]</sup> Controlled burning encourages the sprouting of some desirable forest trees, resulting in a forest renewal.<sup>[74]</sup>

There are also sources from processes other than combustion:

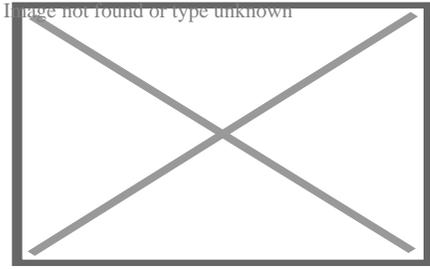
- Fumes from paint, hair spray, varnish, aerosol sprays and other solvents. These can be substantial; emissions from these sources was estimated to account for almost half of pollution from volatile organic compounds in the Los Angeles basin in the 2010s.<sup>[75]</sup>

- Waste deposition in landfills produces methane<sup>[76]</sup> and open burning of waste releases harmful substances.<sup>[77]</sup>
  - Nuclear weapons, toxic gases, germ warfare, and rocketry are examples of military resources.<sup>[78]</sup>
  - Agricultural emissions and emissions from meat production or livestock contribute substantially to air pollution<sup>[79]</sup><sup>[80]</sup>
    - Fertilized farmland may be a major source of nitrogen oxides.<sup>[81]</sup>
- Mean acidifying emissions (air pollution) of different foods per 100g of protein<sup>[82]</sup>

<b>Food Types</b>	<b>Acidifying Emissions (g SO<sub>2</sub>eq per 100g protein)</b>
<b>Beef</b>	343.6
<b>Cheese</b>	165.5
<b>Pork</b>	142.7
<b>Lamb and mutton</b>	139.0
<b>Farmed crustaceans</b>	133.1
<b>Poultry</b>	102.4
<b>Farmed fish</b>	65.9
<b>Eggs</b>	53.7
<b>Groundnuts</b>	22.6
<b>Peas</b>	8.5
<b>Tofu</b>	6.7

## Natural sources

[edit]



Dust storm approaching Stratford, Texas, in 1935

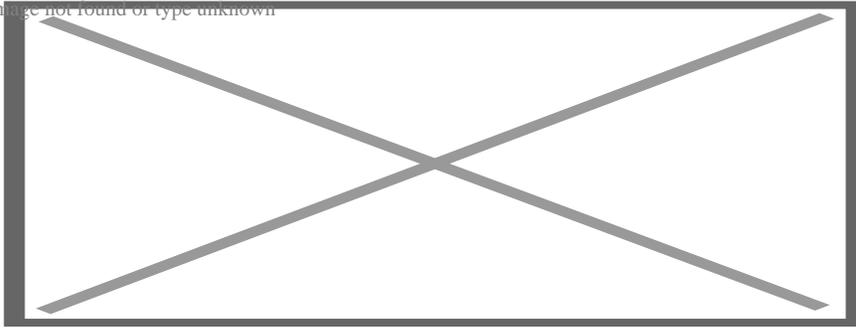
- Dust from natural sources, usually large areas of land with little or no vegetation.
- Methane, emitted by the digestion of food by animals, for example cattle.
- Radon gas from radioactive decay within the Earth's crust. Radon is a colorless, odorless, naturally occurring, radioactive noble gas that is formed from the decay of radium. It is considered to be a health hazard. Radon gas from natural sources can accumulate in buildings, especially in confined areas such as the basement and it is the second most frequent cause of lung cancer, after cigarette smoking.
- Smoke and carbon monoxide from wildfires. During periods of active wildfires, smoke from uncontrolled biomass combustion can make up almost 75% of all air pollution by concentration.<sup>[83]</sup>
- Vegetation, in some regions, emits environmentally significant amounts of volatile organic compounds (VOCs) on warmer days. These VOCs react with primary anthropogenic pollutants – specifically,  $\text{NO}_x$ ,  $\text{SO}_2$ , and anthropogenic organic carbon compounds – to produce a seasonal haze of secondary pollutants.<sup>[84]</sup> Black gum, poplar, oak and willow are some examples of vegetation that can produce abundant VOCs. The VOC production from these species result in ozone levels up to eight times higher than the low-impact tree species.<sup>[85]</sup>
- Volcanic activity, which produces sulfur, chlorine, and ash particulates.<sup>[86]</sup>

## Emission factors

[edit]

Main article: AP 42 Compilation of Air Pollutant Emission Factors

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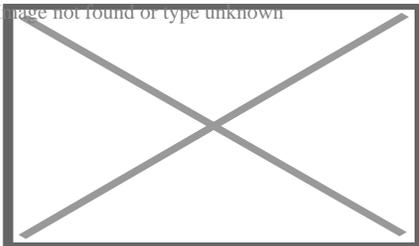


Beijing air in 2005 after rain (left) and a smoggy day (right)

Air pollutant emission factors are reported representative values that aim to link the quantity of a pollutant released into the ambient air to an activity connected with that pollutant's release.<sup>[2][87][88][89]</sup> The weight of the pollutant divided by a unit weight, volume, distance, or time of the activity generating the pollutant is how these factors are commonly stated (e.g., kilograms of particulate emitted per tonne of coal burned). These criteria make estimating emissions from diverse sources of pollution easier. Most of the time, these components are just averages of all available data of acceptable quality, and they are thought to be typical of long-term averages.

The Stockholm Convention on Persistent Organic Pollutants identified pesticides and other persistent organic pollutants of concern. These include dioxins and furans which are unintentionally created by combustion of organics, like open burning of plastics, and are endocrine disruptors and mutagens.

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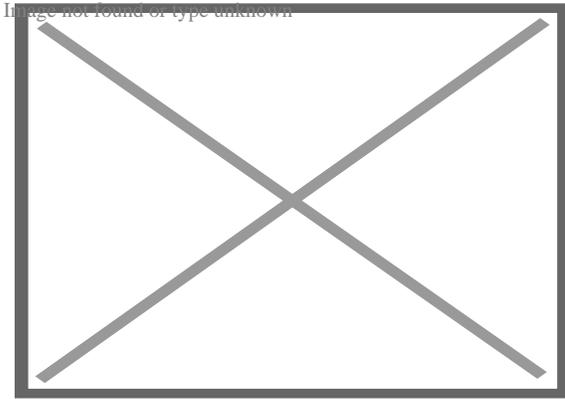
E-waste processing in Agbogbloshie, Ghana, using open-burning of electronics to access valuable metals like copper. Open burning of plastics is common in many parts of the world without the capacity for processing. Especially without proper protections, heavy metals and other contaminants can seep into the soil, and create water pollution and air pollution.

The United States Environmental Protection Agency has published a compilation of air pollutant emission factors for a wide range of industrial sources.<sup>[90]</sup> The United Kingdom, Australia, Canada, and many other countries have published similar compilations, as well as the European Environment Agency.<sup>[91][92][93][94]</sup>

## Pollutants

[edit]

Main articles: Pollutant and Greenhouse gas emissions



Schematic drawing, causes and effects of air pollution: (1) greenhouse effect, (2) particulate contamination, (3) increased UV radiation, (4) acid rain, (5) increased ground-level ozone concentration, (6) increased levels of nitrogen oxides

An air pollutant is a material in the air that can have many effects on humans and the ecosystem.<sup>[95]</sup> The substance can be solid particles, liquid droplets, or gases, and often takes the form of an aerosol (solid particles or liquid droplets dispersed and carried by a gas).<sup>[96]</sup> A pollutant can be of natural origin or man-made. Pollutants are classified as primary or secondary. Primary pollutants are usually produced by processes such as ash from a volcanic eruption.

Other examples include carbon monoxide gas from motor vehicle exhausts or sulfur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. Ground level ozone is a prominent example of a secondary pollutant. Some pollutants may be both primary and secondary: they are both emitted directly and formed from other primary pollutants.

## Primary pollutants

[edit]



This section **is in list format but may read better as prose**. You can help by converting this section, if appropriate. Editing help is available. *(April 2023)*

Pollutants emitted into the atmosphere by human activity include:

- Ammonia: Emitted mainly by agricultural waste. Ammonia is a compound with the formula  $\text{NH}_3$ . It is normally encountered as a gas with a characteristic pungent odor. Ammonia contributes significantly to the nutritional needs of

terrestrial organisms by serving as a precursor to foodstuffs and fertilizers. Ammonia, either directly or indirectly, is also a building block for the synthesis of many pharmaceuticals. Although in wide use, ammonia is both caustic and hazardous.<sup>[97]</sup> In the atmosphere, ammonia reacts with oxides of nitrogen and sulfur to form secondary particles.<sup>[98]</sup>

- Carbon dioxide (CO<sub>2</sub>): Carbon dioxide is a natural component of the atmosphere, essential for plant life and given off by the human respiratory system.<sup>[99]</sup> It is potentially lethal at very high concentrations (typically 100 times "normal" atmospheric levels).<sup>[100][101]</sup> Although the World Health Organization recognizes CO<sub>2</sub> as a climate pollutant, it does not include the gas in its *Air Quality Guidelines* or set recommended targets for it.<sup>[102]</sup> Because of its role as a greenhouse gas, CO<sub>2</sub> has been described as "the worst climate pollutant".<sup>[103]</sup> Statements such as this refer to its long-term atmospheric effects rather than shorter-term effects on such things as human health, food crops, and buildings. This question of terminology has practical consequences, for example, in determining whether the U.S. Clean Air Act (which is designed to improve air quality) is deemed to regulate CO<sub>2</sub> emissions.<sup>[104]</sup> That issue was resolved in the United States by the Inflation Reduction Act of 2022, which specifically amended the Clean Air Act "to define the carbon dioxide produced by the burning of fossil fuels as an 'air pollutant.'"<sup>[105]</sup> CO<sub>2</sub> currently forms about 410 parts per million (ppm) of Earth's atmosphere, compared to about 280 ppm in pre-industrial times,<sup>[106]</sup> and billions of metric tons of CO<sub>2</sub> are emitted annually by burning of fossil fuels.<sup>[107]</sup> CO<sub>2</sub> increase in Earth's atmosphere has been accelerating.<sup>[108]</sup> CO<sub>2</sub> is an asphyxiant gas and not classified as toxic or harmful in general.<sup>[109]</sup> Workplace exposure limits exist in places like UK (5,000 ppm for long-term exposure and 15,000 ppm for short-term exposure).<sup>[101]</sup> Natural disasters like the limnic eruption at Lake Nyos can result in a sudden release of huge amount of CO<sub>2</sub> as well.<sup>[110]</sup>
- Carbon monoxide (CO): CO is a colorless, odorless, toxic gas.<sup>[111]</sup> It is a product of combustion of fuel such as natural gas, coal or wood. Vehicular exhaust contributes to the majority of carbon monoxide let into the atmosphere. It creates a smog type formation in the air that has been linked to many lung diseases and disruptions to the natural environment and animals.
- Chlorofluorocarbons (CFCs): Emitted from goods that are now prohibited from use; harmful to the ozone layer. These are gases emitted by air conditioners, freezers, aerosol sprays, and other similar devices. CFCs reach the stratosphere after being released into the atmosphere.<sup>[112]</sup> They interact with other gases here, causing harm to the ozone layer. UV rays are able to reach the Earth's surface as a result of this. This can result in skin cancer, eye problems, and even plant damage.<sup>[113]</sup>
- Nitrogen oxides (NO<sub>x</sub>): Nitrogen oxides, particularly nitrogen dioxide, are expelled from high temperature combustion, and are also produced during thunderstorms by electric discharge. They can be seen as a brown haze dome

above or a plume downwind of cities. Nitrogen dioxide is a chemical compound with the formula  $\text{NO}_2$ . It is one of several nitrogen oxides. One of the most prominent air pollutants, this reddish-brown toxic gas has a characteristic sharp, biting odor.

- Odors: Such as from garbage, sewage, and industrial processes.
- Particulate matter/particles (PM), also known as particulates, atmospheric particulate matter (APM), or fine particles, are microscopic solid or liquid particles suspended in a gas.<sup>[114]</sup> Aerosol is a mixture of particles and gas. Volcanoes, dust storms, forest and grassland fires, living plants, and sea spray are all sources of particles. Aerosols are produced by human activities such as the combustion of fossil fuels in automobiles, power plants, and numerous industrial processes.<sup>[115]</sup> Averaged worldwide, anthropogenic aerosols – those made by human activities – currently account for approximately 10% of the atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease,<sup>[116]</sup> altered lung function and lung cancer. Particulates are related to respiratory infections and can be particularly harmful to those with conditions like asthma.<sup>[117]</sup>
- Persistent organic pollutants, which can attach to particulates. Persistent organic pollutants are organic compounds that are resistant to environmental degradation due to chemical, biological, or photolytic processes (POPs). As a result, they've been discovered to survive in the environment, be capable of long-range transmission, bioaccumulate in human and animal tissue, biomagnify in food chains, and pose a major threat to human health and the ecosystem.<sup>[118]</sup>
- Persistent free radicals connected to airborne fine particles are linked to cardiopulmonary disease.<sup>[119][120]</sup>
- Polycyclic Aromatic Hydrocarbons (PAHs): a group of aromatic compounds formed from the incomplete combustion of organic compounds including coal and oil and tobacco.<sup>[121]</sup>
- Radioactive pollutants: Produced by nuclear explosions, nuclear events, war explosives, and natural processes such as the radioactive decay of radon.
- Sulfur oxides ( $\text{SO}_x$ ): particularly sulfur dioxide, a chemical compound with the formula  $\text{SO}_2$ .  $\text{SO}_2$  is produced by volcanoes and in various industrial processes. Coal and petroleum often contain sulfur compounds, and their combustion generates sulfur dioxide. Further oxidation of  $\text{SO}_2$ , usually in the presence of a catalyst such as  $\text{NO}_2$ , forms  $\text{H}_2\text{SO}_4$ , and thus acid rain is formed. This is one of the causes for concern over the environmental impact of the use of these fuels as power sources.
- Toxic metals, such as lead and mercury, especially their compounds.
- Volatile organic compounds (VOC): VOCs are both indoor and outdoor air pollutants.<sup>[122]</sup> They are categorized as either methane ( $\text{CH}_4$ ) or non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases because of their role in creating ozone and prolonging the life

of methane in the atmosphere. This effect varies depending on local air quality. The aromatic NMVOCs benzene, toluene and xylene are suspected carcinogens and may lead to leukemia with prolonged exposure. 1,3-butadiene is another dangerous compound often associated with industrial use.

## Secondary pollutants

[edit]

Secondary pollutants include:

- Ground level ozone ( $O_3$ ): Ozone is created when  $NO_x$  and VOCs mix. It is a significant part of the troposphere.<sup>[123]</sup> It's also an important part of the ozone layer, which can be found in different sections of the stratosphere. Photochemical and chemical reactions involving it fuel many of the chemical activities that occur in the atmosphere during the day and night. It is a pollutant and a component of smog that is produced in large quantities as a result of human activities (mostly the combustion of fossil fuels).<sup>[124]</sup>  $O_3$  is largely produced by chemical reactions involving  $NO_x$  gases (nitrogen oxides, especially from combustion) and volatile organic compounds in the presence of sunlight. Due to the influence of temperature and sunlight on this reaction, high ozone levels are most common on hot summer afternoons.<sup>[125]</sup>
- Peroxyacetyl nitrate ( $C_2H_3NO_5$ ): similarly formed from  $NO_x$  and VOCs.
- Photochemical smog: particles are formed from gaseous primary contaminants and chemicals.<sup>[126]</sup> Smog is a type of pollution that occurs in the atmosphere. Smog is caused by a huge volume of coal being burned in a certain region, resulting in a mixture of smoke and sulfur dioxide.<sup>[127]</sup> Modern smog is usually caused by automotive and industrial emissions, which are acted on in the atmosphere by UV light from the sun to produce secondary pollutants, which then combine with the primary emissions to generate photochemical smog.

## Other pollutants

[edit]

There are many other chemicals classed as hazardous air pollutants. Some of these are regulated in the USA under the Clean Air Act and in Europe under numerous directives (including the Air "Framework" Directive, 96/62/EC, on ambient air quality assessment and management, Directive 98/24/EC, on risks related to chemical agents at work, and Directive 2004/107/EC covering heavy metals and polycyclic

aromatic hydrocarbons in ambient air).<sup>[128][129]</sup>

"*[Illegible text]*

Hazardous air pollutants (4 C, 68 P)

Before flue-gas desulfurization was installed, the emissions from this power plant in New

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Before flue-gas desulfurization was installed, the emissions from this power plant in New Mexico contained excessive amounts of sulfur dioxide.

Thermal oxidisers are air pollution abatement options for hazardous air pollutants (HAPs

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Thermal oxidisers are air pollution abatement options for hazardous air pollutants (HAPs), volatile organic compounds (VOCs), and odorous emissions.

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This video provides an overview of a NASA study on the human fingerprint on global air quality.

## Exposure

[edit]

The risk of air pollution is determined by the pollutant's hazard and the amount of exposure to that pollutant. Air pollution exposure can be measured for a person, a group, such as a neighborhood or a country's children, or an entire population. For example, one would want to determine a geographic area's exposure to a dangerous air pollution, taking into account the various microenvironments and age groups. This can be calculated<sup>[130]</sup> as an inhalation exposure. This would account for daily exposure in various settings, e.g. different indoor micro-environments and outdoor locations. The exposure needs to include different ages and other demographic groups, especially infants, children, pregnant women, and other sensitive subpopulations.<sup>[130]</sup>

For each specific time that the subgroup is in the setting and engaged in particular activities, the exposure to an air pollutant must integrate the concentrations of the air pollutant with regard to the time spent in each setting and the respective inhalation rates for each subgroup, playing, cooking, reading, working, spending time in traffic, etc. A little child's inhaling rate, for example, will be lower than that of an adult. A young person engaging in strenuous exercise will have a faster rate of breathing than a child engaged in sedentary activity. The daily exposure must therefore include the amount of time spent in each micro-environmental setting as well as the kind of activities performed there. The air pollutant concentration in each microactivity/microenvironmental setting is summed to indicate the exposure.<sup>[130]</sup>

For some pollutants such as black carbon, traffic related exposures may dominate total exposure despite short exposure times since high concentrations coincide with proximity to major roads or participation in (motorized) traffic.<sup>[131]</sup> A large portion of

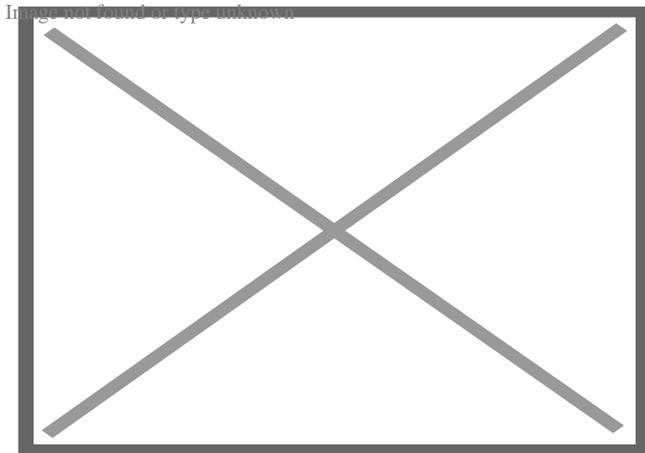
total daily exposure occurs as short peaks of high concentrations, but it remains unclear how to define peaks and determine their frequency and health impact.[<sup>132</sup>]

In 2021, the WHO halved its recommended guideline limit for tiny particles from burning fossil fuels. The new limit for nitrogen dioxide (NO<sub>2</sub>) is 75% lower.[<sup>133</sup>]  
Growing evidence that air pollution—even when experienced at very low levels—hurts human health, led the WHO to revise its guideline (from 10 µg/m<sup>3</sup> to 5 µg/m<sup>3</sup>) for what it considers a safe level of exposure of particulate pollution, bringing most of the world—97.3 percent of the global population—into the unsafe zone.[<sup>134</sup>]

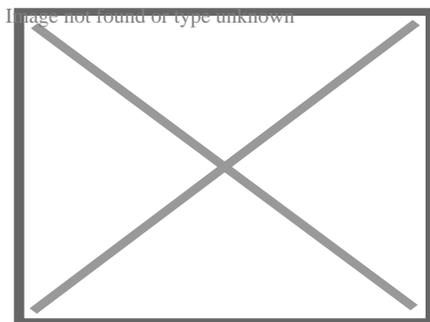
## Indoor air quality

[edit]

Main articles: Indoor air quality and Indoor air pollution in developing countries



The share of total deaths from indoor air pollution, 2017



Air quality monitoring, New Delhi, India

A lack of ventilation indoors concentrates air pollution where people often spend the majority of their time. Indoor air pollution can pose a significant health risk. According to EPA reports, the concentrations of many air pollutants can be two to five times higher in indoor air than in outdoor air. Indoor air pollutants can be up to 100 times higher in some cases than they are outside. People can spend up to 90% of their time

indoors, according to the American Lung Association; the US Consumer Product Safety Commission (CPSC) 2012; and the US Environmental Protection Agency 2012a.[<sup>135</sup>]

Indoor contaminants that can cause pollution include asbestos, biologic agents, building materials, radon, tobacco smoke, and wood stoves, gas ranges, or other heating systems.[<sup>135</sup>]

Radon (Rn) gas, a carcinogen, is exuded from the Earth in certain locations and trapped inside houses. Building materials including carpeting and plywood emit formaldehyde (H-CHO) gas. Paint and solvents give off volatile organic compounds (VOCs) as they dry. Lead paint can degenerate into dust and be inhaled.[<sup>136</sup>][<sup>137</sup>]

Intentional air pollution is introduced with the use of air fresheners, incense, and other scented items. Controlled wood fires in cook stoves and fireplaces can add significant amounts of harmful smoke particulates into the air, inside and out.[<sup>136</sup>][<sup>137</sup>] Indoor pollution fatalities may be caused by using pesticides and other chemical sprays indoors without proper ventilation. Also the kitchen in a modern produce harmful particles and gases, with equipment like toasters being one of the worst sources.[<sup>138</sup>]

Carbon monoxide poisoning and fatalities are often caused by faulty vents and chimneys, or by the burning of charcoal indoors or in a confined space, such as a tent. [<sup>139</sup>] Chronic carbon monoxide poisoning can result even from poorly-adjusted pilot lights. Traps are built into all domestic plumbing to keep sewer gas and hydrogen sulfide, out of interiors. Clothing emits tetrachloroethylene, or other dry cleaning fluids, for days after dry cleaning.

Though its use has now been banned in many countries, the extensive use of asbestos in industrial and domestic environments in the past has left a potentially very dangerous material in many localities. Asbestosis is a chronic inflammatory medical condition affecting the tissue of the lungs. It occurs after long-term, heavy exposure to asbestos from asbestos-containing materials in structures. Those with asbestosis have severe dyspnea (shortness of breath) and are at an increased risk regarding several different types of lung cancer. As clear explanations are not always stressed in non-technical literature, care should be taken to distinguish between several forms of relevant diseases. According to the World Health Organization,[<sup>140</sup>] these may be defined as asbestosis, lung cancer, and peritoneal mesothelioma (generally a very rare form of cancer, when more widespread it is almost always associated with prolonged exposure to asbestos).

Biological sources of air pollution are also found indoors, as gases and airborne particulates. Pets produce dander, people produce dust from minute skin flakes and decomposed hair, dust mites in bedding, carpeting and furniture produce enzymes

and micrometre-sized fecal droppings, inhabitants emit methane, mold forms on walls and generates mycotoxins and spores, air conditioning systems can incubate Legionnaires' disease and mold, and houseplants, soil and surrounding gardens can produce pollen, dust, and mold. Indoors, the lack of air circulation allows these airborne pollutants to accumulate more than they would otherwise occur in nature.

## Health effects

[edit]

Air pollution has both acute and chronic effects on human health, affecting a number of different systems and organs but principally affect the body's respiratory system and the cardiovascular system. Afflictions include minor to chronic upper respiratory irritation such as difficulty in breathing, wheezing, coughing, asthma<sup>[141]</sup> and heart disease, lung cancer, stroke, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung disease, or asthmatic attacks.

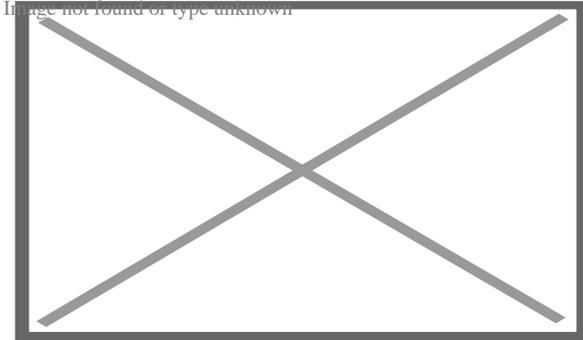
Short and long term exposures have been linked with premature mortality and reduced life expectancy<sup>[142]</sup> and can result in increased medication use, increased doctor or emergency department visits, more hospital admissions and premature death.<sup>[130]</sup><sup>[better source needed]</sup> Diseases that develop from persistent exposure to air pollution are environmental health diseases, which develop when a health environment is not maintained.<sup>[143]</sup>

Even at levels lower than those considered safe by United States regulators, exposure to three components of air pollution, fine particulate matter, nitrogen dioxide and ozone, correlates with cardiac and respiratory illness.<sup>[144]</sup> Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, and the individual's health status and genetics.<sup>[130]</sup> The most common sources of air pollution include particulates and ozone (often from burning fossil fuels),<sup>[145]</sup> nitrogen dioxide, and sulfur dioxide. Children aged less than five years who live in developing countries are the most vulnerable population to death attributable to indoor and outdoor air pollution.<sup>[146]</sup>

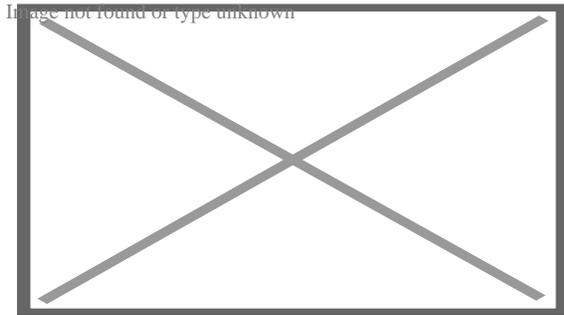
Under the Clean Air Act, U.S. EPA sets limits on certain air pollutants, including setting limits on how much can be in the air anywhere in the United States.<sup>[147]</sup> Mixed exposure to both carbon black and ozone could result in significantly greater health affects.<sup>[148]</sup>

# Mortality

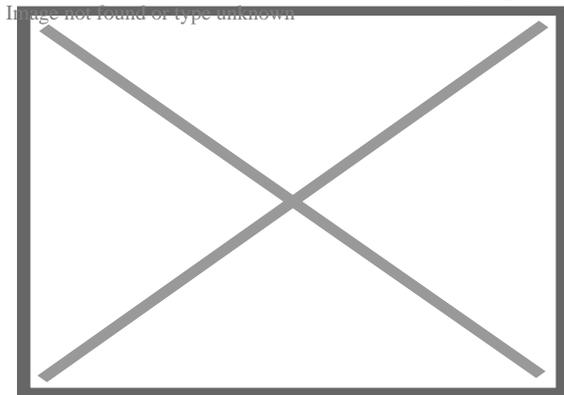
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Estimates of the death toll from air pollution vary across publications.



Deaths caused by accidents and air pollution from fossil fuel use in power plants exceed those caused by production of renewable energy.<sup>[149]</sup>



Estimated annual number of deaths attributed to air pollution in 2019. This includes three categories of air pollution: indoor household, outdoor particulate matter and ozone.

Estimates of deaths toll due to air pollution vary.<sup>[150]</sup> In 2014 the World Health Organization estimated that every year air pollution causes the premature death of 7 million people worldwide,<sup>[5]</sup> 1 in 8 deaths worldwide.<sup>[151]</sup> A study published in 2019 indicated that in 2015 the number may be closer to 8.8 million, with 5.5 million of these premature deaths due to air pollution from anthropogenic sources.<sup>[152][153]</sup> A 2022 review concluded that in 2019 air pollution was responsible for approximately 9 million premature deaths. It concluded that since 2015 little real progress against pollution has been made.<sup>[14][154]</sup> Causes of deaths include strokes, heart disease, COPD, lung cancer, and lung infections.<sup>[5]</sup> Children are particularly at risk.<sup>[155]</sup>

In 2021, the WHO reported that outdoor air pollution was estimated to cause 4.2 million premature deaths worldwide in 2019.<sup>[156]</sup>

The global mean loss of life expectancy (LLE; similar to YPLL) from air pollution in 2015 was 2.9 years, substantially more than, for example, 0.3 years from all forms of direct violence.<sup>[16]</sup> Communities with persons that live beyond 85 years have low ambient air pollution, suggesting a link between air pollution levels and longevity.<sup>[157]</sup>

## Primary mechanisms

[edit]

The WHO estimates that in 2016, ~58% of outdoor air pollution-related premature deaths were due to ischaemic heart disease and stroke.<sup>[156]</sup> The mechanisms linking air pollution to increased cardiovascular mortality are uncertain, but probably include pulmonary and systemic inflammation.<sup>[158]</sup>

## By region

[edit]

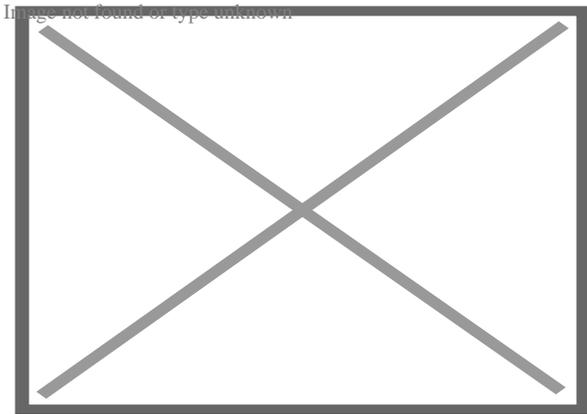
India and China have the highest death rate due to air pollution.<sup>[159][160]</sup> India also has more deaths from asthma than any other nation according to the World Health Organization. In 2019, 1.6 million deaths in India were caused by air pollution.<sup>[161]</sup> In 2013, air pollution was estimated to kill 500,000 people in China each year.<sup>[162]</sup> In 2012, 2.48% of China's total air pollution emissions were caused by exports due to US demand, causing an additional 27,963 deaths across 30 provinces.<sup>[163]</sup>

Annual premature European deaths caused by air pollution are estimated at 430,000<sup>[164]</sup> to 800,000.<sup>[153]</sup> An important cause of these deaths is nitrogen dioxide and other nitrogen oxides (NOx) emitted by road vehicles.<sup>[164]</sup> Across the European

Union, air pollution is estimated to reduce life expectancy by almost nine months.<sup>[165]</sup> In a 2015 consultation document the UK government disclosed that nitrogen dioxide is responsible for 23,500 premature UK deaths per annum.<sup>[166]</sup> There is a positive correlation between pneumonia-related deaths and air pollution from motor vehicle emissions in England.<sup>[167]</sup>

Eliminating energy-related fossil fuel emissions in the United States would prevent 46,900–59,400 premature deaths each year and provide \$537–\$678 billion in benefits from avoided PM<sub>2.5</sub>-related illness and death.<sup>[168]</sup>

A study published in 2023 in *Science* focused on sulfur dioxide emissions by coal power plants (coal PM<sub>2.5</sub>) and concluded that "exposure to coal PM<sub>2.5</sub> was associated with 2.1 times greater mortality risk than exposure to PM<sub>2.5</sub> from all sources."<sup>[169]</sup> From 1999 to 2020, a total of 460,000 deaths in the US were attributed to coal PM<sub>2.5</sub>.<sup>[169]</sup>

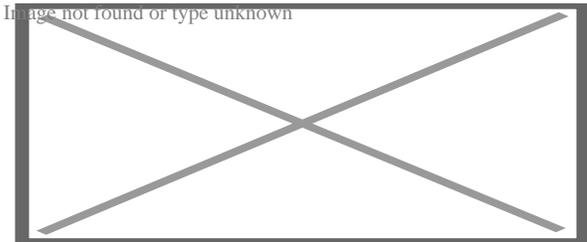


Air pollution deaths by nation due to fossil fuels

**Major causes**

[edit]

Further information: § Sources



A comparison of footprint-based and transboundary pollution-based relationships among G20 nations for the number of PM<sub>2.5</sub>-related premature deaths<sup>[170]</sup>

The largest cause of air pollution is fossil fuel combustion<sup>[171]</sup> – mostly the production and use of cars, electricity production, and heating.<sup>[172]</sup> There are estimated 4.5 million annual premature deaths worldwide due to pollutants released by high-emission power stations and vehicle exhausts.<sup>[173]</sup>

Diesel exhaust (DE) is a major contributor to combustion-derived particulate matter air pollution. In several human experimental studies, using a well-validated exposure chamber setup, DE has been linked to acute vascular dysfunction and increased thrombus formation.<sup>[174][175]</sup>

A study concluded that PM<sub>2.5</sub> air pollution induced by the contemporary free trade and consumption by the 19 G20 nations causes two million premature deaths annually, suggesting that the average lifetime consumption of about ~28 people in these countries causes at least one premature death (average age ~67) while developing countries "cannot be expected" to implement or be able to implement countermeasures without external support or internationally coordinated efforts.<sup>[176][170]</sup>

## Guidelines

[edit]

Main article: Air quality guideline

The US EPA has estimated that limiting ground-level ozone concentration to 65 parts per billion (ppb), would avert 1,700 to 5,100 premature deaths nationwide in 2020 compared with the 75 ppb standard. The agency projected the more protective standard would also prevent an additional 26,000 cases of aggravated asthma, and more than a million cases of missed work or school.<sup>[177][178]</sup> Following this assessment, the EPA acted to protect public health by lowering the National Ambient Air Quality Standards (NAAQS) for ground-level ozone to 70 ppb.<sup>[179]</sup>

A 2008 economic study of the health impacts and associated costs of air pollution in the Los Angeles Basin and San Joaquin Valley of Southern California shows that more than 3,800 people die prematurely (approximately 14 years earlier than normal) each year because air pollution levels violate federal standards. The number of annual premature deaths is considerably higher than the fatalities related to auto collisions in the same area, which average fewer than 2,000 per year.<sup>[180][181][182]</sup> A 2021 study found that outdoor air pollution is associated with substantially increased mortality "even at low pollution levels below the current European and North American standards and WHO guideline values" shortly before the WHO adjusted its guidelines.<sup>[183][184]</sup>

# Cardiovascular disease

[edit]

According to the Global Burden of Disease Study, air pollution is responsible for 19% of all cardiovascular deaths.<sup>[185][186]</sup> There is strong evidence linking both short- and long-term exposure to air pollution with cardiovascular disease mortality and morbidity, stroke, blood pressure, and ischemic heart diseases (IHD).<sup>[186]</sup>

Air pollution is a leading risk factor for stroke, particularly in developing countries where pollutant levels are highest.<sup>[187]</sup> A systematic analysis of 17 different risk factors in 188 countries found air pollution is associated with nearly one in three strokes (29%) worldwide (33.7% of strokes in developing countries versus 10.2% in developed countries).<sup>[187][188]</sup> In women, air pollution is not associated with hemorrhagic but with ischemic stroke.<sup>[189]</sup> Air pollution was found to be associated with increased incidence and mortality from coronary stroke.<sup>[190]</sup> Associations are believed to be causal and effects may be mediated by vasoconstriction, low-grade inflammation and atherosclerosis.<sup>[191]</sup> Other mechanisms such as autonomic nervous system imbalance have also been suggested.<sup>[192][193]</sup>

# Lung disease

[edit]

Research has demonstrated increased risk of developing asthma<sup>[194]</sup> and chronic obstructive pulmonary disease (COPD)<sup>[195]</sup> from increased exposure to traffic-related air pollution. Air pollution has been associated with increased hospitalization and mortality from asthma and COPD.<sup>[196][197]</sup>

COPD comprises a spectrum of clinical disorders that include emphysema, bronchiectasis, and chronic bronchitis.<sup>[198]</sup> COPD risk factors are both genetic and environmental. Elevated particle pollution contributes to the exacerbation of this disease and likely its pathogenesis.<sup>[199]</sup>

The risk of lung disease from air pollution is greatest for infants and young children, whose normal breathing is faster than that of older children and adults; the elderly; those who work outside or spend a lot of time outside; and those who have heart or lung disease comorbidities.<sup>[200]</sup>

A study conducted in 1960–1961 in the wake of the Great Smog of 1952 compared 293 London residents with 477 residents of Gloucester, Peterborough, and Norwich, three towns with low reported death rates from chronic bronchitis. All subjects were male postal truck drivers aged 40 to 59. Compared to the subjects from the outlying towns, the London subjects exhibited more severe respiratory symptoms (including cough, phlegm, and dyspnea), reduced lung function (FEV<sub>1</sub> and peak flow rate), and increased sputum production and purulence. The differences were more pronounced for subjects aged 50 to 59. The study controlled for age and smoking habits, so concluded that air pollution was the most likely cause of the observed differences.<sup>[201]</sup> More studies have shown that air pollution exposure from traffic reduces lung function development in children<sup>[202]</sup> and lung function may be compromised by air pollution even at low concentrations.<sup>[203]</sup>

It is believed that, much like cystic fibrosis, serious health hazards become more apparent when living in a more urban environment. Studies have shown that in urban areas people experience mucus hypersecretion, lower levels of lung function, and more self-diagnosis of chronic bronchitis and emphysema.<sup>[204]</sup>

## Cancer

[edit]

Dark factory clouds obscure the Clark Avenue Bridge in Cleveland, Ohio, July 1973.

Image not found or type unknown

Dark factory-emitted clouds obscuring the Clark Avenue Bridge in Cleveland, Ohio in July 1973

Around 300,000 lung cancer deaths were attributed globally in 2019 to exposure to fine particulate matter, PM<sub>2.5</sub>, suspended in the air.<sup>[205]</sup> PM<sub>2.5</sub> exposure, such as from car exhausts, activates dormant mutations in lung cells, causing them to become

cancerous.<sup>[206]</sup><sup>[205]</sup> Unprotected exposure to PM<sub>2.5</sub> air pollution can be equivalent to smoking multiple cigarettes per day,<sup>[207]</sup><sup>[*dead link* ]</sup> potentially increasing the risk of cancer, which is mainly the result of environmental factors.<sup>[208]</sup>

Long-term exposure to PM<sub>2.5</sub> (fine particulates) increases the overall risk of non-accidental mortality by 6% per 10 µg/m<sup>3</sup> increase. Exposure to PM<sub>2.5</sub> is also associated with an increased risk of mortality from lung cancer (range: 15–21% per 10 µg/m<sup>3</sup> increase) and total cardiovascular mortality (range: 12–14% per 10 µg/m<sup>3</sup> increase).<sup>[209]</sup>

The review further noted that living close to busy traffic appears to be associated with elevated risks of these three outcomes – increase in lung cancer deaths, cardiovascular deaths, and overall non-accidental deaths. The reviewers also found suggestive evidence that exposure to PM<sub>2.5</sub> is positively associated with mortality from coronary heart diseases and exposure to SO<sub>2</sub> increases mortality from lung cancer, but the data was insufficient to provide solid conclusions.<sup>[209]</sup> Another investigation showed that higher activity level increases deposition fraction of aerosol particles in human lung and recommended avoiding heavy activities like running in outdoor space at polluted areas.<sup>[210]</sup>

In 2011, a large Danish epidemiological study found an increased risk of lung cancer for people who lived in areas with high nitrogen oxide concentrations.<sup>[211]</sup> Another Danish study, likewise noted evidence of possible associations between air pollution and other forms of cancer, including cervical cancer and brain cancer.<sup>[212]</sup>

## Kidney disease

[edit]

A study of 163,197 Taiwanese residents over the period of 2001–2016 estimated that every 5 µg/m<sup>3</sup> decrease (from an approximate peak of 30µg/m<sup>3</sup>) in the ambient concentration of PM<sub>2.5</sub> was associated with a 25% reduced risk of chronic kidney disease development.<sup>[213]</sup> According to a cohort study involving 10,997 atherosclerosis patients, higher PM 2.5 exposure is associated with increased albuminuria.<sup>[214]</sup>

## Fertility

[edit]

## Nitrogen dioxide (NO<sub>2</sub>)

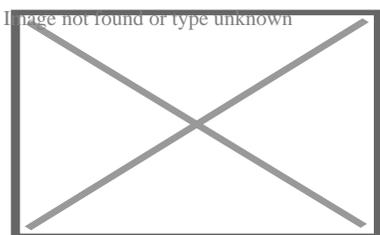
[edit]

An increase in NO<sub>2</sub> is significantly associated with a lower live birth rate in women undergoing IVF treatment.<sup>[215]</sup> In the general population, there is a significant increase in miscarriage rate in women exposed to NO<sub>2</sub> compared to those not exposed.<sup>[215]</sup>

## Carbon monoxide (CO)

[edit]

CO exposure is significantly associated with stillbirth in the second and third trimester.<sup>[215]</sup>



Standard line-angle structure of benzo-a-pyrene (BaP)

## Polycyclic aromatic hydrocarbons

[edit]

Polycyclic aromatic hydrocarbons (PAHs) have been associated with reduced fertility. Benzo(a)pyrene (BaP) is a well-known PAH and carcinogen which is often found in exhaust fumes and cigarette smoke.<sup>[216]</sup> PAHs have been reported to administer their toxic effects through oxidative stress by increasing the production of Reactive Oxygen Species (ROS) which can result in inflammation and cell death. More long-term exposure to PAHs can result in DNA damage and reduced repair.<sup>[217]</sup>

Exposure to BaP has been reported to reduce sperm motility and increasing the exposure worsens this effect. Research has demonstrated that more BaPs were found in men with reported fertility issues compared to men without.<sup>[218]</sup>

Studies have shown that BaPs can affect folliculogenesis and ovarian development by reducing the number of ovarian germ cells via triggering cell death pathways and inducing inflammation which can lead to ovarian damage.[<sup>219</sup>]

## Particulate matter

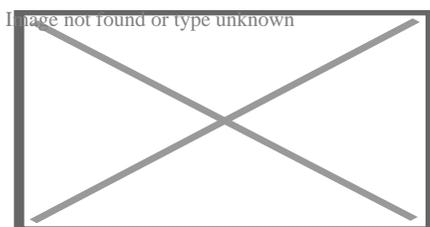
[edit]

Particulate matter (PM) refers to the collection of solids and liquids suspended in the air. These can be harmful to humans, and more research has shown that these effects may be more extensive than first thought; particularly on male fertility. PM can be different sizes, such as PM<sub>2.5</sub> which are tiny particles of 2.5 microns in width or smaller, compared with PM<sub>10</sub> which are classified as 10 microns in diameter or less.

A study in California found that increased exposure to PM<sub>2.5</sub> led to decreased sperm motility and increased abnormal morphology. Similarly, in Poland exposure to PM<sub>2.5</sub> and PM<sub>10</sub> led to an increase in the percentage of cells with immature chromatin (DNA that has not fully developed or has developed abnormally).[<sup>220</sup>]

In Turkey, a study examined the fertility of men who work as toll collectors and are therefore exposed to high levels of traffic pollutants daily. Traffic pollution often has high levels of PM<sub>10</sub> alongside carbon monoxide and nitrogen oxides.[<sup>220</sup>] There were significant differences in sperm count and motility in this study group compared to a control group with limited air pollution exposure.

In women, while overall effects on fertility do not appear significant there is an association between increased exposure to PM<sub>10</sub> and early miscarriage. Exposure to smaller particulate matter, PM<sub>2.5</sub>, appears to have an effect on conception rates in women undergoing IVF but does not affect live birth rates.[<sup>215</sup>]



Ozone structure showing three oxygen atoms

## Ground-level ozone pollution

[edit]

Ground-level ozone ( $O_3$ ), when in high concentrations, is regarded as an air pollutant and is often found in smog in industrial areas.

There is limited research about the effect that ozone pollution has on fertility.<sup>[215]</sup> At present, there is no evidence to suggest that ozone exposure poses a deleterious effect on spontaneous fertility in either females or males. However, there have been studies which suggest that high levels of ozone pollution, often a problem in the summer months, exert an effect on in vitro fertilisation (IVF) outcomes. Within an IVF population,  $NO_x$  and ozone pollutants were linked with reduced rates of live birth.<sup>[215]</sup>

While most research on this topic is focused on the direct human exposure of air pollution, other studies have analysed the impact of air pollution on gametes and embryos within IVF laboratories. Multiple studies have reported a marked improvement in embryo quality, implantation and pregnancy rates after IVF laboratories have implemented air filters in a concerted effort to reduce levels of air pollution.<sup>[221]</sup> Therefore, ozone pollution is considered to have a negative impact on the success of assisted reproductive technologies (ART) when occurring at high levels.

Ozone is thought to act in a biphasic manner where a positive effect on live birth is observed when ozone exposure is limited to before IVF embryo implantation. Conversely, a negative effect is demonstrated upon exposure to ozone after embryo implantation. However, after adjusting for  $NO_2$ , the association between  $O_3$  and IVF live birth rate was no longer significant.<sup>[222][223]</sup>

In terms of male fertility, ozone is reported to cause a significant decrease in the concentration and count of sperm in semen after exposure.<sup>[224]</sup> Similarly, sperm vitality, the proportion of live spermatozoa in a sample, was demonstrated to be diminished as a result of exposure to air pollution.<sup>[223]</sup> However, findings on the effect of ozone exposure on male fertility are somewhat discordant, highlighting the need for further research.<sup>[223]</sup>

## Children

[edit]

Children and infants are among the most vulnerable to air pollution. Polluted air leads to the poisoning of millions of children under the age of 15, resulting in the death of some 600,000 children annually (543,000 under 5 years of age and 52,000 aged 5-15 years).<sup>[225]</sup> Children in low or middle income countries are exposed to higher levels of fine particulate matter than those in high income countries.<sup>[225]</sup>

Health effects of air pollution on children include asthma, pneumonia and lower respiratory tract infections and low birth weight.<sup>[226]</sup> A study in Europe found that exposure to ultrafine particles can increase blood pressure in children.<sup>[227]</sup>

## **Prenatal exposure**

[edit]

Prenatal exposure to polluted air has been linked to a variety of neurodevelopmental disorders in children. For example, exposure to polycyclic aromatic hydrocarbons (PAH) was associated with reduced IQ scores and symptoms of anxiety and depression.<sup>[228]</sup> They can also lead to detrimental perinatal health outcomes that are often fatal in developing countries.<sup>[8]</sup> A 2014 study found that PAHs might play a role in the development of childhood attention deficit hyperactivity disorder (ADHD).<sup>[229]</sup>

Researchers have found a correlation between air pollution and risk of autism spectrum disorder (ASD) diagnosis, although definitive causality has not yet been established. In Los Angeles, children living in areas with high levels of traffic-related air pollution were more likely to be diagnosed with autism between three–five years of age.<sup>[230]</sup> A cohort study in Southern California linked in-utero exposure to near-roadway air pollution to an increased risk of ASD diagnosis<sup>[231]</sup> and a study in Sweden concluded that exposure to PM<sub>2.5</sub> during pregnancy was associated with ASD.<sup>[232]</sup> A Danish study linked exposure to air pollution during infancy, but not during pregnancy, to an increased risk of ASD diagnosis.<sup>[233]</sup>

The connection between air pollution and neurodevelopmental disorders in children is thought to be related to epigenetic dysregulation of the primordial germ cells, embryo, and fetus during a critical period. Some PAHs are considered endocrine disruptors and are lipid soluble. When they build up in adipose tissue they can be transferred across the placenta can exert a genotoxic effect, causing DNA damage and mutations.<sup>[234]</sup> Air pollution has been associated with the prevalence of preterm births.<sup>[235]</sup>

## **Infants**

[edit]

Ambient levels of air pollution have been associated with preterm birth and low birth weight. A 2014 WHO worldwide survey on maternal and perinatal health found a statistically significant association between low birth weights (LBW) and increased levels of exposure to PM<sub>2.5</sub>. Women in regions with greater than average PM<sub>2.5</sub>

levels had statistically significant higher odds of pregnancy resulting in a low-birth weight infant even when adjusted for country-related variables.<sup>[236]</sup> The effect is thought to be from stimulating inflammation and increasing oxidative stress.

A study found that in 2010 exposure to PM<sub>2.5</sub> was strongly associated with 18% of preterm births globally, which was approximately 2.7 million premature births. The countries with the highest air pollution associated preterm births were in South and East Asia, the Middle East, North Africa, and West sub-Saharan Africa.<sup>[237]</sup> In 2019, ambient particulate matter pollution in Africa resulted in at least 383,000 early deaths, according to new estimates of the cost of air pollution in the continent. This increased from 3.6% in 1990 to around 7.4% of all premature deaths in the area.<sup>[238][239][240]</sup>

The source of PM<sub>2.5</sub> differs greatly by region. In South and East Asia, pregnant women are frequently exposed to indoor air pollution because of wood and other biomass fuels being used for cooking, which are responsible for more than 80% of regional pollution. In the Middle East, North Africa and West sub-Saharan Africa, fine PM comes from natural sources, such as dust storms.<sup>[237]</sup> The United States had an estimated 50,000 preterm births associated with exposure to PM<sub>2.5</sub> in 2010.<sup>[237]</sup>

A study between 1988 and 1991 found a correlation between sulfur dioxide (SO<sub>2</sub>) and total suspended particulates (TSP) and preterm births and low birth weights in Beijing. A group of 74,671 pregnant women, in four separate regions of Beijing, were monitored from early pregnancy to delivery along with daily air pollution levels of SO<sub>2</sub> and TSP (along with other particulates). The estimated reduction in birth weight was 7.3 g for every 100 µg/m<sup>3</sup> increase in SO<sub>2</sub> and 6.9 g for each 100 µg/m<sup>3</sup> increase in TSP. These associations were statistically significant in both summer and winter, although summer was greater. The proportion of low birth weight attributable to air pollution, was 13%. This is the largest attributable risk ever reported for the known risk factors of low birth weight.<sup>[241]</sup> Coal stoves, which are in 97% of homes, are a major source of air pollution in this area.

Brauer et al. studied the relationship between air pollution and proximity to a highway with pregnancy outcomes in a Vancouver cohort of pregnant women using addresses to estimate exposure during pregnancy. Exposure to NO, NO<sub>2</sub>, CO, PM<sub>10</sub> and PM<sub>2.5</sub> were associated with infants born small for gestational age (SGA). Women living less than 50 meters away from an expressway or highway were 26% more likely to give birth to a SGA infant.<sup>[242]</sup>

## Central nervous system

[edit]

See also: Brain health and pollution and neuroplastic effects of pollution

Data is accumulating that air pollution exposure also affects the central nervous system.<sup>[243]</sup>

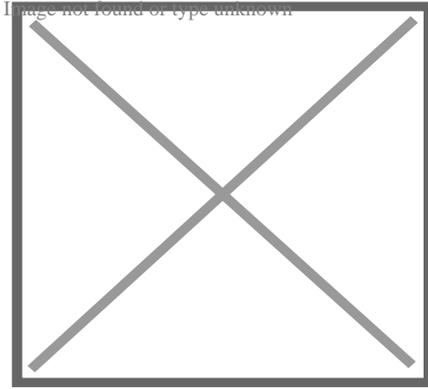
Air pollution increases the risk of dementia in people over 50 years old.<sup>[244]</sup> Indoor air pollution exposure during childhood may negatively affect cognitive function and neurodevelopment.<sup>[245][246]</sup> Prenatal exposure may also affect neurodevelopment.<sup>[247][248]</sup> Studies show that air pollution is associated with a variety of developmental disabilities, oxidative stress, and neuro-inflammation and that it may contribute to Alzheimer's disease and Parkinson's disease.<sup>[246]</sup>

Researchers found that early exposure to air pollution causes the same changes in the brain as autism and schizophrenia in mice. It also showed that air pollution also affected short-term memory, learning ability, and impulsivity. In this study, air pollution had a larger negative impact on male mice than on females.<sup>[249][250]</sup> Lead researcher on the study, Deborah Cory-Slechta, said that:<sup>[251]</sup>

When we looked closely at the ventricles, we could see that the white matter that normally surrounds them hadn't fully developed. It appears that inflammation had damaged those brain cells and prevented that region of the brain from developing, and the ventricles simply expanded to fill the space. Our findings add to the growing body of evidence that air pollution may play a role in autism, as well as in other neurodevelopmental disorders.

Exposure to fine particulate matter can increase levels of cytokines - neurotransmitters produced in response to infection and inflammation that are also associated with depression and suicide. Pollution has been associated with inflammation of the brain, which may disrupt mood regulation. Heightened PM<sub>2.5</sub> levels are linked to more self-reported depressive symptoms, and increases in daily suicide rates.<sup>[252][253]</sup>

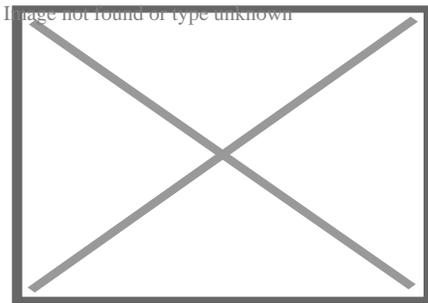
In 2015, experimental studies reported the detection of significant episodic (situational) cognitive impairment from impurities in indoor air breathed by test subjects who were not informed about changes in the air quality. Significant deficits were observed in the performance scores achieved in increasing concentrations of either volatile organic compounds (VOCs) or carbon dioxide, while keeping other factors constant. The highest impurity levels reached are not uncommon in some classroom or office environments.<sup>[254][255]</sup> Higher PM<sub>2.5</sub> and CO<sub>2</sub> concentrations were shown to be associated with slower response times and reduced accuracy in tests.<sup>[256]</sup>



PM2.5 Levels Across the World's 5 Most Populated Nations in 2019

## "Clean" areas

[edit]



Share of the population exposed to air pollution levels above WHO guidelines, 2017

Even in areas with relatively low levels of air pollution, public health effects can be significant and costly, since a large number of people breathe in such pollutants. A study found that even in areas of the U.S. where ozone and PM<sub>2.5</sub> meet federal standards, Medicare recipients who are exposed to more air pollution have higher mortality rates.<sup>[257]</sup>

Rural populations in India, like those in urban areas, are also exposed to high levels of air pollution.<sup>[258]</sup> In 2020, scientists found that the boundary layer air over the Southern Ocean around Antarctica is 'unpolluted' by humans.<sup>[259]</sup>

## Agricultural effects

[edit]

Various studies have estimated the impacts of air pollution on agriculture, especially ozone. A 2020 study showed that ozone pollution in California may reduce yields of certain perennial crops such as table grapes by as much as 22% per year, translating into economic damages of more than \$1 billion per year.<sup>[260]</sup> After air pollutants enter the agricultural environment, they not only directly affect agricultural production and quality, but also enter agricultural waters and soil.<sup>[261]</sup> The COVID-19 induced lockdown served as a natural experiment to expose the close links between air quality and surface greenness. In India, the lockdown induced improvement in air quality, enhanced surface greenness and photosynthetic activity, with the positive response of vegetation to reduce air pollution was dominant in croplands.<sup>[262]</sup> On the other hand, agriculture in its traditional form is one of the primary contributors to the emission of trace gases like atmospheric ammonia.<sup>[263]</sup>

## **Economic effects**

[edit]

Air pollution costs the world economy \$5 trillion per year as a result of productivity losses and degraded quality of life.<sup>[24][25][26]</sup> These productivity losses are caused by deaths due to diseases caused by air pollution. One out of ten deaths in 2013 was caused by diseases associated with air pollution and the problem is getting worse.

A small improvement in air quality (1% reduction of ambient PM<sub>2.5</sub> and ozone concentrations) would produce \$29 million in annual savings in the lower Fraser Valley region in 2010.<sup>[264]</sup> This finding is based on health valuation of lethal (death) and sub-lethal (illness) affects.

The problem is even more acute in the developing world. "Children under age 5 in lower-income countries are more than 60 times as likely to die from exposure to air pollution as children in high-income countries."<sup>[24][25]</sup> The report states that additional economic losses caused by air pollution, including health costs<sup>[265]</sup> and the adverse effect on agricultural and other productivity were not calculated in the report, and thus the actual costs to the world economy are far higher than \$5 trillion.

A study published in 2022 found "a strong and significant connection between air pollution and construction site accidents" and that "a 10-ppb increase in NO<sub>2</sub> levels increases the likelihood of an accident by as much as 25%".<sup>[266]</sup>

## **Other effects**

[edit]

Artificial air pollution may be detectable on Earth from distant vantage points such as other planetary systems via atmospheric SETI – including NO<sub>2</sub> pollution levels and with telescopic technology close to today. It may also be possible to detect extraterrestrial civilizations this way.<sup>[267][268][269]</sup>

## Historical disasters

[edit]

The world's worst short-term civilian pollution crisis was the 1984 Bhopal Disaster in India.<sup>[270]</sup> Leaked industrial vapours from the Union Carbide factory, belonging to Union Carbide, Inc., U.S.A. (later bought by Dow Chemical Company), killed at least 3787 people and injured from 150,000 to 600,000. The United Kingdom suffered its worst air pollution event when the 4 December Great Smog of 1952 formed over London. In six days more than 4,000 died and more recent estimates put the figure at nearer 12,000.<sup>[271]</sup>

An accidental leak of anthrax spores from a biological warfare laboratory in the former USSR in 1979 near Yekaterinburg (formerly Sverdlovsk) is believed to have caused at least 64 deaths.<sup>[272]</sup> The worst single incident of air pollution to occur in the US occurred in Donora, Pennsylvania, in late October 1948, when 20 people died and over 7,000 were injured.<sup>[273]</sup>

## Reduction and regulation

[edit]

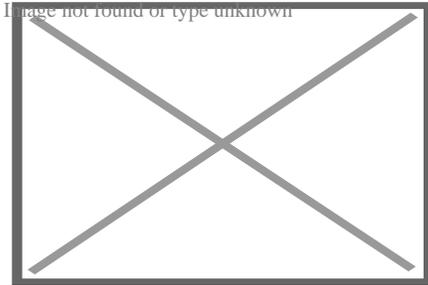
Global depletion of the surrounding air pollution will require valiant leadership, a surplus of combined resources from the international community, and extensive societal changes.<sup>[274]</sup> Pollution prevention seeks to prevent pollution such as air pollution and could include adjustments to industrial and business activities such as designing sustainable manufacturing processes (and the products' designs)<sup>[275]</sup> and related legal regulations as well as efforts towards renewable energy transitions.<sup>[276][277]</sup>

Efforts to reduce particulate matter in the air may result in better health.<sup>[278]</sup>

The 9-Euro-Ticket scheme in Germany which allowed people to buy a monthly pass allowing use on all local and regional transport (trains, trams and busses) for 9 euro (€) for one month of unlimited travel saved 1.8 million tons of CO<sub>2</sub> emissions during its three-month implementation from June to August 2022.<sup>[279]</sup>

# Pollution control

[edit]



Burning of items polluting Jamestown environment in Accra, Ghana

Various pollution control technologies and strategies are available to reduce air pollution.<sup>[280]</sup><sup>[281]</sup> At its most basic level, land-use planning is likely to involve zoning and transport infrastructure planning. In most developed countries, land-use planning is an important part of social policy, ensuring that land is used efficiently for the benefit of the wider economy and population, as well as to protect the environment.<sup>[282]</sup> Stringent environmental regulations, effective control technologies and shift towards the renewable source of energy also helping countries like China and India to reduce their sulfur dioxide pollution.<sup>[283]</sup>

Titanium dioxide has been researched for its ability to reduce air pollution. Ultraviolet light will release free electrons from material, thereby creating free radicals, which break up VOCs and

NOx gases. One form is superhydrophilic.<sup>[284]</sup>

Pollution-eating nanoparticles placed near a busy road were shown to absorb toxic emission from around 20 cars each day.<sup>[285]</sup>

# Energy transition

[edit]

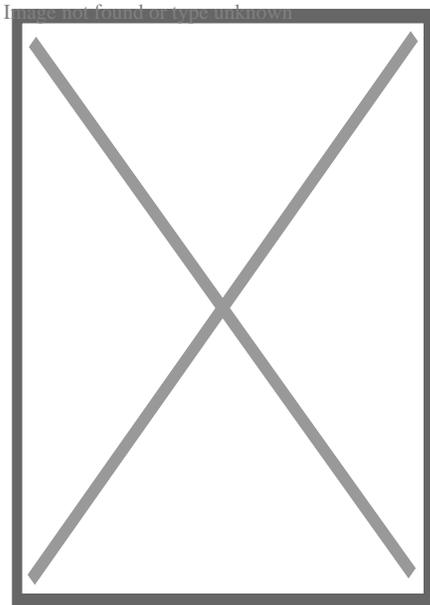
Since a large share of air pollution is caused by combustion of fossil fuels such as coal and oil, the reduction of these fuels can reduce air pollution drastically. Most effective is the switch to clean power sources such as wind power, solar power, hydro

power which do not cause air pollution.<sup>[286]</sup> Efforts to reduce pollution from mobile sources includes expanding regulation to new sources (such as cruise and transport ships, farm equipment, and small gas-powered equipment such as string trimmers, chainsaws, and snowmobiles), increased fuel efficiency (such as through the use of hybrid vehicles), conversion to cleaner fuels, and conversion to electric vehicles. For example, buses in New Delhi, India, have run on compressed natural gas since 2000, to help eliminate the city's "pea-soup" smog.<sup>[226][287]</sup>

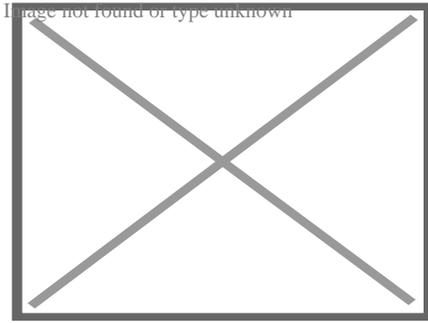
A very effective means to reduce air pollution is the transition to renewable energy. According to a study published in Energy and Environmental Science in 2015 the switch to 100% renewable energy in the United States would eliminate about 62,000 premature mortalities per year and about 42,000 in 2050, if no biomass were used. This would save about \$600 billion in health costs a year due to reduced air pollution in 2050, or about 3.6% of the 2014 U.S. gross domestic product.<sup>[286]</sup> Air quality improvement is a near-term benefit among the many societal benefits from climate change mitigation.

## Alternatives to pollution

[edit]



Support for a ban on high-emission vehicles in city centres in Europe, China and the US from respondents to the European Investment Bank Climate Survey



Support, use and infrastructure-expansion of forms of public transport that do not cause air pollution may be a critical key alternative to pollution.

There are now practical alternatives to the principal causes of air pollution:

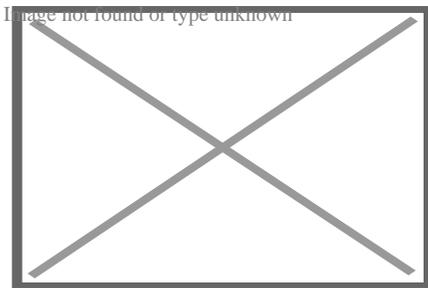
- Strategic substitution of air pollution sources in transport with lower-emission or, during the lifecycle, emission-free forms of public transport<sup>[288][289]</sup> and bicycle use and infrastructure (as well as with remote work, reductions of work, relocations, and localizations)
  - Phase-out of fossil fuel vehicles is a critical component of a shift to sustainable transport; however, similar infrastructure and design decisions like electric vehicles may be associated with similar pollution for production as well as mining and resource exploitation for large numbers of needed batteries as well as the energy for their recharging<sup>[290][291]</sup>
- Areas downwind (over 20 miles) of major airports have more than double *total particulate emissions in air* than other areas, even when factoring in areas with frequent ship calls, and heavy freeway and city traffic like Los Angeles.<sup>[292]</sup> Aviation biofuel mixed in with jetfuel at a 50/50 ratio can reduce jet derived cruise altitude particulate emissions by 50–70%, according to a NASA led 2017 study (however, this should imply ground level benefits to urban air pollution as well).<sup>[293]</sup>
- Ship propulsion and idling can be switched to much cleaner fuels like natural gas. (Ideally a renewable source but not practical yet)
- Combustion of fossil fuels for space heating can be replaced by using ground source heat pumps and seasonal thermal energy storage.<sup>[294]</sup>
- Electricity generated from the combustion of fossil fuels can be replaced by nuclear and renewable energy. Heating and home stoves, which contribute significantly to regional air pollution, can be replaced with a much cleaner fossil fuel, such as natural gas, or, preferably, renewables, in poor countries.<sup>[295][296]</sup>
- Motor vehicles driven by fossil fuels, a key factor in urban air pollution, can be replaced by electric vehicles. Though lithium supply and cost is a limitation, there are alternatives. Herding more people into clean public transit such as electric trains can also help. Nevertheless, even in emission-free electric vehicles, rubber tires produce significant amounts of air pollution themselves, ranking as 13th worst pollutant in Los Angeles.<sup>[297]</sup>

- Reducing travel in vehicles can curb pollution. After Stockholm reduced vehicle traffic in the central city with a congestion tax, nitrogen dioxide and PM<sub>10</sub> pollution declined, as did acute pediatric asthma attacks.<sup>[298]</sup>
- Biodigesters can be utilized in poor nations where slash and burn is prevalent, turning a useless commodity into a source of income. The plants can be gathered and sold to a central authority that will break them down in a large modern biodigester, producing much needed energy to use.<sup>[299]</sup>
- Induced humidity and ventilation both can greatly dampen air pollution in enclosed spaces, which was found to be relatively high inside subway lines due to braking and friction and relatively less ironically inside transit buses than lower sitting passenger automobiles or subways.<sup>[300]</sup>

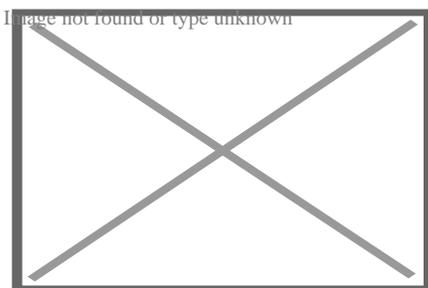
Further information: § Sources

## Control devices

[edit]



Tarps and netting are often used to reduce the amount of dust released from construction sites.



Air pollution from a car

The following items are commonly used as pollution control devices in industry and transportation. They can either destroy contaminants or remove them from an exhaust stream before it is emitted into the atmosphere.

- **Particulate control**
  - Mechanical collectors (dust cyclones, multicyclones)

- Electrostatic precipitators: An electrostatic precipitator (ESP), or electrostatic air cleaner, is a particulate collection device that removes particles from a flowing gas (such as air), using the force of an induced electrostatic charge. Electrostatic precipitators are highly efficient filtration devices that minimally impede the flow of gases through the device, and can easily remove fine particulates such as dust and smoke from the air stream.
- Baghouses: Designed to handle heavy dust loads, a dust collector consists of a blower, dust filter, a filter-cleaning system, and a dust receptacle or dust removal system (distinguished from air cleaners which utilize disposable filters to remove the dust).
- Particulate scrubbers: A wet scrubber is a form of pollution control technology. The term describes a variety of devices that use pollutants from a furnace flue gas or from other gas streams. In a wet scrubber, the polluted gas stream is brought into contact with the scrubbing liquid, by spraying it with the liquid, by forcing it through a pool of liquid, or by some other contact method, so as to remove the pollutants.
- **Scrubbers**
  - Baffle spray scrubber
  - Cyclonic spray scrubber
  - Ejector venturi scrubber
  - Mechanically aided scrubber
  - Spray tower
  - Wet scrubber
- **NO<sub>x</sub> control**
  - LO-NO<sub>x</sub> burners
  - Selective catalytic reduction (SCR)
  - Selective non-catalytic reduction (SNCR)
  - NO<sub>x</sub> scrubbers
  - Exhaust gas recirculation
  - Catalytic converter (also for VOC control)
- **VOC abatement**
  - Adsorption systems, using activated carbon, such as Fluidized Bed Concentrator
  - Flares
  - Thermal oxidizers
  - Catalytic converters
  - Biofilters
  - Absorption (scrubbing)
  - Cryogenic condensers
  - Vapor recovery systems
- **Acid gas/SO<sub>2</sub> control**
  - Wet scrubbers

- Dry scrubbers
- Flue-gas desulfurization
- **Mercury control**
  - Sorbent injection technology
  - Electro-catalytic oxidation (ECO)
  - K-Fuel
- **Dioxin and furan control**
- **Miscellaneous associated equipment**
  - Source capturing systems
  - Continuous emissions monitoring systems (CEMS)

## Monitoring

[edit]

See also: Smart city

Further information: Air pollution measurement and Environmental monitoring

Spatiotemporal monitoring of air quality may be necessary for improving air quality, and thereby the health and safety of the public, and assessing impacts of interventions.<sup>[301]</sup> Such monitoring is done to different extents with different regulatory requirements with discrepant regional coverage by a variety of organizations and governance entities such as using a variety of technologies for use of the data and sensing such mobile IoT sensors,<sup>[302][303]</sup> satellites,<sup>[304][305][306]</sup> and monitoring stations.<sup>[307][308]</sup> Some websites attempt to map air pollution levels using available data.<sup>[309][310][311]</sup>

## Air quality modeling

[edit]

Main article: Air quality modeling

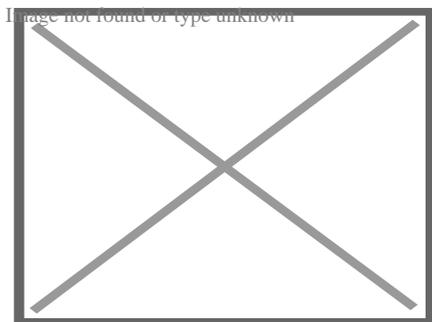
Numerical models either on a global scale using tools such as GCMs (general circulation models coupled with a pollution module) or CTMs (Chemical transport model) can be used to simulate the levels of different pollutants in the atmosphere. These tools can have several types (Atmospheric model) and different uses. These models can be used in forecast mode which can help policy makers to decide on appropriate actions when an air pollution episode is detected. They can also be used for climate modeling including evolution of air quality in the future, for example the IPCC (Intergovernmental Panel on Climate Change) provides climate simulations

including air quality assessments in their reports (latest report accessible through their site).

## Regulations

[edit]

Main article: Air quality law



Smog in Cairo

In general, there are two types of air quality standards. The first class of standards (such as the U.S. National Ambient Air Quality Standards and E.U. Air Quality Directive<sup>[312]</sup>) set maximum atmospheric concentrations for specific pollutants. Environmental agencies enact regulations which are intended to result in attainment of these target levels. The second class (such as the North American air quality index) take the form of a scale with various thresholds, which is used to communicate to the public the relative risk of outdoor activity. The scale may or may not distinguish between different pollutants.

### Canada

[edit]

In Canada, air pollution and associated health risks are measured with the Air Quality Health Index (AQHI).<sup>[313]</sup> It is a health protection tool used to make decisions to reduce short-term exposure to air pollution by adjusting activity levels during increased levels of air pollution.

The AQHI is a federal program jointly coordinated by Health Canada and Environment Canada. However, the AQHI program would not be possible without the commitment and support of the provinces, municipalities and NGOs. From air quality monitoring to health risk communication and community engagement, local partners are responsible

for the vast majority of work related to AQHI implementation. The AQHI provides a number from 1 to 10+ to indicate the level of health risk associated with local air quality. Occasionally, when the amount of air pollution is abnormally high, the number may exceed 10. The AQHI provides a local air quality current value as well as a local air quality maximums forecast for today, tonight and tomorrow and provides associated health advice.



**Risk: Low (1–3) Moderate (4–6) High (7–10) Very high (above 10)**

As it is now known that even low levels of air pollution can trigger discomfort for the sensitive population, the index has been developed as a continuum: The higher the number, the greater the health risk and need to take precautions. The index describes the level of health risk associated with this number as 'low', 'moderate', 'high' or 'very high', and suggests steps that can be taken to reduce exposure.<sup>[314]</sup>

Health risk	Air Quality Health Index	Health messages <sup>[315]</sup>	
		At risk population	General population
Low	1–3	<b>Enjoy</b> your usual outdoor activities.	<b>Ideal</b> air quality for outdoor activities
Moderate	4–6	<b>Consider reducing</b> or rescheduling strenuous activities outdoors if you are experiencing symptoms.	<b>No need to modify</b> your usual outdoor activities unless you experience symptoms such as coughing and throat irritation.
High	7–10	<b>Reduce</b> or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	<b>Consider reducing</b> or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very high	Above 10	<b>Avoid</b> strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion and should stay indoors.	<b>Reduce</b> or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

The measurement is based on the observed relationship of nitrogen dioxide (NO<sub>2</sub>), ground-level ozone (O<sub>3</sub>) and particulates (PM<sub>2.5</sub>) with mortality, from an analysis of several Canadian cities. Significantly, all three of these pollutants can pose health

risks, even at low levels of exposure, especially among those with pre-existing health problems.

When developing the AQHI, Health Canada's original analysis of health effects included five major air pollutants: particulates, ozone, and nitrogen dioxide (NO<sub>2</sub>), as well as sulfur dioxide (SO<sub>2</sub>), and carbon monoxide (CO). The latter two pollutants provided little information in predicting health effects and were removed from the AQHI formulation.

The AQHI does not measure the effects of odour, pollen, dust, heat or humidity.

## Germany

[edit]

TA Luft is the German air quality regulation.[<sup>316</sup>]

## Governing urban air pollution

[edit]

Further information: Phase-out of fossil fuel vehicles § Cities and territories

In Europe, Council Directive 96/62/EC on ambient air quality assessment and management provides a common strategy against which member states can "set objectives for ambient air quality in order to avoid, prevent or reduce harmful effects on human health and the environment ... and improve air quality where it is unsatisfactory".[<sup>317</sup>]

In July 2008, in the case *Dieter Janecek v. Freistaat Bayern*, the European Court of Justice ruled that under this directive[<sup>317</sup>] citizens have the right to require national authorities to implement a short term action plan that aims to maintain or achieve compliance to air quality limit values.[<sup>318</sup>][<sup>319</sup>]

This important case law appears to confirm the role of the EC as centralised regulator to European nation-states as regards air pollution control. It places a supranational legal obligation on the UK to protect its citizens from dangerous levels of air pollution, furthermore superseding national interests with those of the citizen.

In 2010, the European Commission (EC) threatened the UK with legal action against the successive breaching of PM<sub>10</sub> limit values.[<sup>320</sup>] The UK government has

identified that if fines are imposed, they could cost the nation upwards of £300 million per year.<sup>[321]</sup>

In March 2011, the Greater London Built-up Area remained the only UK region in breach of the EC's limit values, and was given three months to implement an emergency action plan aimed at meeting the EU Air Quality Directive.<sup>[322]</sup> The City of London has dangerous levels of PM<sub>10</sub> concentrations, estimated to cause 3000 deaths per year within the city.<sup>[323]</sup> As well as the threat of EU fines, in 2010 it was threatened with legal action for scrapping the western congestion charge zone, which is claimed to have led to an increase in air pollution levels.<sup>[324]</sup>

In response to these charges, mayor of London Boris Johnson has criticised the current need for European cities to communicate with Europe through their nation state's central government, arguing that in future "A great city like London" should be permitted to bypass its government and deal directly with the European Commission regarding its air quality action plan.<sup>[322]</sup>

This can be interpreted as recognition that cities can transcend the traditional national government organisational hierarchy and develop solutions to air pollution using global governance networks, for example through transnational relations. Transnational relations include but are not exclusive to national governments and intergovernmental organisations,<sup>[325]</sup> allowing sub-national actors including cities and regions to partake in air pollution control as independent actors.

Global city partnerships can be built into networks, for example the C40 Cities Climate Leadership Group, of which London is a member. The C40 is a public 'non-state' network of the world's leading cities that aims to curb their greenhouse emissions.<sup>[326]</sup> ] The C40 has been identified as 'governance from the middle' and is an alternative to intergovernmental policy.<sup>[327]</sup> It has the potential to improve urban air quality as participating cities "exchange information, learn from best practices and consequently mitigate carbon dioxide emissions independently from national government decisions".<sup>[326]</sup> A criticism of the C40 network is that its exclusive nature limits influence to participating cities and risks drawing resources away from less powerful city and regional actors.

## Indigenous people

[edit]

Because Indigenous people<sup>[328]</sup> frequently experience a disproportionate share of the effects of environmental degradation and climate change, even while they have

made very little contribution to the processes causing these changes, environmental justice is especially important to them. Indigenous peoples have been marginalized and their lands and resources have been exploited as a result of historical and continuing colonization, institutional injustices, and inequality.

Indigenous groups frequently lack the political and financial clout to influence policy decisions that impact their lands and means of subsistence or to lessen the effects of climate change. This makes the already-existing inequalities in these communities' social, economic, and health conditions worse. Furthermore, traditional ecological knowledge and Indigenous knowledge systems provide insightful information about sustainable resource management and climate change adaptation techniques. To promote persistence and environmental justice, Indigenous viewpoints must be acknowledged and integrated into efforts to mitigate the effects of climate change and adapt to them.

Combating climate change necessitates an all-encompassing strategy that recognizes the interdependence of social, economic, and environmental elements. This entails defending treaty rights, advancing Indigenous sovereignty and self-determination, and aiding Indigenous-led projects for sustainable development and environmental preservation.

## Hotspots

[edit]

Main article: Toxic hotspot

See also: Cancer alley and Superfund

Air pollution hotspots are areas where air pollution emissions expose individuals to increased negative health effects.<sup>[329]</sup> They are particularly common in highly populated, urban areas, where there may be a combination of stationary sources (e.g. industrial facilities) and mobile sources (e.g. cars and trucks) of pollution. Emissions from these sources can cause respiratory disease, childhood asthma,<sup>[141]</sup> cancer, and other health problems. Fine particulate matter such as diesel soot, which contributes to more than 3.2 million premature deaths around the world each year, is a significant problem. It is very small and can lodge itself within the lungs and enter the bloodstream. Diesel soot is concentrated in densely populated areas, and one in six people in the U.S. live near a diesel pollution hot spot.<sup>[330]</sup>

While air pollution hotspots affect a variety of populations, some groups are more likely to be located in hotspots. Previous studies have shown disparities in exposure to pollution by race and/or

## External videos

 [Air Visual Earth](#) —  
realtime map of global wind  
and air pollution<sup>[331]</sup>

income. Hazardous land uses (toxic storage and disposal facilities, manufacturing facilities, major roadways) tend to be located where property values and income levels are low. Low socioeconomic status can be a proxy for other kinds of social vulnerability, including race, a lack of ability to influence regulation and a lack of ability to move to neighborhoods with less environmental pollution. These communities bear a disproportionate burden of environmental pollution and are more likely to face health risks such as cancer or asthma.<sup>[332]</sup>

Studies show that patterns in race and income disparities not only indicate a higher exposure to pollution but also higher risk of adverse health outcomes.<sup>[333]</sup>

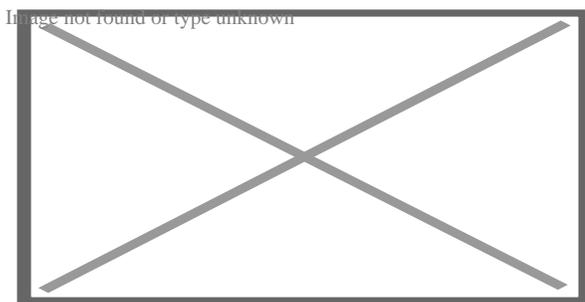
Communities characterized by low socioeconomic status and racial minorities can be more vulnerable to cumulative adverse health impacts resulting from elevated exposure to pollutants than more privileged communities.<sup>[333]</sup> Blacks and Latinos generally face more pollution than Whites and Asians, and low-income communities bear a higher burden of risk than affluent ones.<sup>[332]</sup> Racial discrepancies are particularly distinct in suburban areas of the Southern United States and metropolitan areas of the Midwestern and Western United States.<sup>[334]</sup> Residents in public housing, who are generally low-income and cannot move to healthier neighborhoods, are highly affected by nearby refineries and chemical plants.<sup>[335]</sup>

## Cities

[edit]

See also: List of most polluted cities in the world by particulate matter concentration

Further information: List of least polluted cities by particulate matter concentration



Nitrogen dioxide concentrations as measured from satellite 2002–2004

Air pollution is usually concentrated in densely populated metropolitan areas, especially in developing countries where cities are experiencing rapid growth and environmental regulations are relatively lax or nonexistent. Urbanization leads to a rapid rise in premature mortality due to anthropogenic air pollution in fast-growing tropical cities.<sup>[336]</sup> However, even populated areas in developed countries attain unhealthy levels of pollution, with Los Angeles and Rome being two examples.<sup>[337]</sup> Between 2002 and 2011 the incidence of lung cancer in Beijing near doubled. While

smoking remains the leading cause of lung cancer in China, the number of smokers is falling while lung cancer rates are rising .<sup>[338]</sup>

<sup>[339]</sup>

### World's Most Polluted Cities 2020 Average 2019 Average

Hotan, China	110.2	110.1
Ghaziabad, India	106.6	110.2
Bulandshahr, India	98.4	89.4
Bisrakh Jalalpur, India	96.0	-
Bhiwadi, India	95.5	83.4

Tehran was declared the most polluted city in the world on May 24, 2022.<sup>[340]</sup>

### Projections

[edit]

In a 2019 projection, by 2030 half of the world's pollution emissions could be generated by Africa.<sup>[341]</sup> Potential contributors to such an outcome include increased burning activities (such as the burning of open waste), traffic, agri-food and chemical industries, sand dust from the Sahara, and overall population growth.

In a 2012 study, by 2050 outdoor air pollution (particulate matter and ground-level ozone) is projected to become the top cause of environmentally related deaths worldwide.<sup>[342]</sup>

### See also

[edit]

-  [Global warming portal](#)
-  [Plants portal](#)
-  [Trees portal](#)

### Source

- [Beehive burner](#)
- [Bottom ash](#)
- [Concrete#Concrete – health and safety](#)
- [Diwali-related air pollution](#)
- [Flue-gas emissions from fossil-fuel combustion](#)
- [Health impacts of sawdust](#)

- Joss paper
- Metal working
- Mining
- Non-exhaust emissions
- Power tool
- Rubber pollution
- Slag
- Smelting
- Tire fire
- Welding
- Wood ash

## **Measurement**

- Air pollutant concentrations
- Air pollution measurement
- Organic molecular tracers
- Intake fraction
- Particulate matter sampler

## **Others**

- Air stagnation
- ASEAN Agreement on Transboundary Haze Pollution
- Asian brown cloud
- Atmospheric chemistry
- BenMAP
- Best Available Control Technology
- Critical load
- Emission standard
- Emissions & Generation Resource Integrated Database
- Environmental agreement
- Environmental racism
- Exposome
- Global Atmosphere Watch
- Global dimming
- Great Smog of London
- Haze
- Health Effects Institute (HEI)
- Indicator value
- International Agency for Research on Cancer
- International Day of Clean Air for Blue Skies
- Kyoto Protocol
- Light water reactor sustainability

- List of smogs by death toll
- Lowest Achievable Emissions Rate
- NASA Clean Air Study
- NIEHS
- Phytoremediation
- Polluter pays principle
- Regulation of greenhouse gases under the Clean Air Act
- Silicosis#Prevention

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## Further reading

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Library resources about

## Air pollution

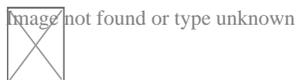
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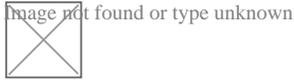
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## External links

[edit]



Wikimedia Commons has media related to ***Air pollution***.



Wikivoyage has travel information for ***Air pollution***.

- WHO fact sheet on outdoor air pollution
  - Air Pollution: Everything You Need to Know Guide by the Natural Resources Defense Council (NRDC)
  - Global real-time air quality index map
  - Air Quality Index (AQI) Basics
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Pollution

History

**Air**

- Acid rain
- Air quality index
- Atmospheric dispersion modeling
- Chlorofluorocarbon
- Combustion
  - Biofuel
  - Biomass
  - Joss paper
  - Open burning of waste
- Construction
  - Renovation
- Demolition
- Exhaust gas
  - Diesel exhaust
- Haze
  - Smoke
- Indoor air quality
- Internal combustion engine
- Global dimming
- Global distillation
- Mining
- Ozone depletion
- Particulates
  - Asbestos
  - Metal working
  - Oil refining
  - Wood dust
  - Welding
- Persistent organic pollutant
- Smelting
- Smog
- Soot
  - Black carbon
- Volatile organic compound
- Waste
- Biological hazard
- Genetic pollution
- Introduced species
  - Invasive species
- Information pollution

**Biological**

**Digital**

## Electromagnetic

### Natural

### Noise

### Radiation

### Soil

- Light
  - Ecological light pollution
  - Overillumination
- Radio spectrum pollution
- Ozone
- Radium and radon in the environment
- Volcanic ash
- Wildfire
- Transportation
  - Land
  - Water
  - Air
  - Rail
  - Sustainable transport
- Urban
- Sonar
  - Marine mammals and sonar
- Industrial
- Military
- Abstract
- Noise control
- Actinides
- Bioremediation
- Nuclear fission
- Nuclear fallout
- Plutonium
- Poisoning
- Radioactivity
- Uranium
- Electromagnetic radiation and health
- Radioactive waste
- Agricultural pollution
  - Herbicides
  - Manure waste
  - Pesticides
- Land degradation
- Bioremediation
- Open defecation
- Electrical resistance heating
- Soil guideline values
- Phytoremediation

## **Solid waste**

- Advertising mail
- Biodegradable waste
- Brown waste
- Electronic waste
  - Battery recycling
- Foam food container
- Food waste
- Green waste
- Hazardous waste
  - Biomedical waste
  - Chemical waste
  - Construction waste
  - Lead poisoning
  - Mercury poisoning
  - Toxic waste
- Industrial waste
  - Lead smelting
- Litter
- Mining
  - Coal mining
  - Gold mining
  - Surface mining
  - Deep sea mining
  - Mining waste
  - Uranium mining
- Municipal solid waste
  - Garbage
- Nanomaterials
- Plastic pollution
  - Microplastics
- Packaging waste
- Post-consumer waste
- Waste management
  - Landfill
  - Thermal treatment

## **Space**

- Satellite
- Air travel
- Clutter (advertising)
- Traffic signs
- Overhead power lines
- Vandalism

## **Visual**

## War

- Chemical warfare
- Herbicidal warfare (Agent Orange)
- Nuclear holocaust (Nuclear fallout - nuclear famine - nuclear winter)
- Scorched earth
- Unexploded ordnance
- War and environmental law
- Agricultural wastewater
- Biological pollution
- Diseases
- Eutrophication
- Firewater
- Freshwater
- Groundwater
- Hypoxia
- Industrial wastewater
- Marine
  - debris
- Monitoring
- Nonpoint source pollution
- Nutrient pollution
- Ocean acidification
- Oil exploitation
- Oil exploration
- Oil spill
- Pharmaceuticals
- Sewage
  - Septic tanks
  - Pit latrine
- Shipping
- Stagnation
- Sulfur water
- Surface runoff
- Thermal
- Turbidity
- Urban runoff
- Water quality
- Pollutants
  - Heavy metals
  - Paint
- Brain health and pollution

## Water

## Topics

## Misc

- Area source
- Debris
- Dust
- Garbology
- Legacy pollution
- Midden
- Point source
- Waste
- Cleaner production
- Industrial ecology
- Pollution haven hypothesis
- Pollutant release and transfer register
- Polluter pays principle
- Pollution control
- Waste minimisation
- Zero waste
- Diseases
- Law by country
- Most polluted cities
- Least polluted cities by PM<sub>2.5</sub>
- Most polluted countries
- Most polluted rivers
- Treaties

## Responses

## Lists

 Categories (by country)  Commons  WikiProject Environment  WikiProject Ecology  Environment portal  Ecology portal

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Asia pollution topics

	<b>Dust storm</b>	<ul style="list-style-type: none"> <li>○ 2010 China dust storms</li> <li>○ 1997 SEA haze</li> <li>○ 1997 Indonesian forest fires</li> <li>○ 2005 Malaysian haze</li> <li>○ 2006 SEA haze</li> <li>○ 2009 SEA haze</li> <li>○ 2010 SEA haze</li> </ul>
<b>Notable incidents</b>	<b>Forest fires and haze</b>	<ul style="list-style-type: none"> <li>○ 2013 SEA haze</li> <li>○ 2015 SEA haze</li> <li>○ 2016 Malaysian haze</li> <li>○ 2016 SEA haze</li> <li>○ 2017 SEA haze</li> <li>○ 2019 SEA haze</li> <li>○ 2019 Vietnam forest fires</li> <li>○ 2024 Indo-Pakistani smog</li> </ul>
<b>Air pollution</b>	<b>Air radioactive contamination</b>	<ul style="list-style-type: none"> <li>○ 1982 Bukit Merah radioactive pollution</li> </ul>
	<b>By countries</b>	<ul style="list-style-type: none"> <li>○ China</li> <li>○ Hong Kong</li> <li>○ India</li> <li>○ Macau</li> <li>○ Malaysia</li> <li>○ Taiwan</li> </ul>
<b>Recurrent issues</b>		<ul style="list-style-type: none"> <li>○ Asian brown cloud</li> <li>○ Asian Dust</li> <li>○ Shamal</li> <li>○ Southeast Asian haze</li> <li>○ ASEAN Agreement on Transboundary Haze Pollution</li> </ul>
<b>Counter-measures</b>		<ul style="list-style-type: none"> <li>○ Operation Haze</li> <li>○ Pollutant Standards Index</li> <li>○ Great Green Wall (China)</li> </ul>

**Water  
pollution**

**Water  
radioactive  
contamination  
Notable  
incidents**

**Marine  
pollution**

- 2011 Fukushima Daiichi nuclear disaster
- 2016 Vietnam marine life disaster
- 2019 Kim Kim River toxic pollution
- Pollution of the Pasig River

**By  
countries**

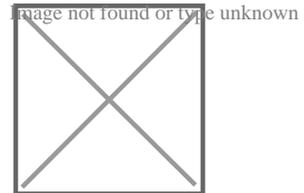
- China
  - Water crisis
- India
- Japan
- Philippines
- Vietnam

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**Environmental science**

**Main fields**

- Atmospheric science
- Biogeochemistry
- Ecology
- Environmental chemistry
- Geosciences
- Hydrology
- Limnology
- Oceanography
- Soil science



- Biology
- Chemistry
  - green
- Ecological economics
- Environmental design
- Environmental economics
- Environmental engineering
- Environmental health
  - epidemiology
- Environmental studies
- Environmental humanities
- Environmental statistics
- Environmental toxicology
- Geodesy
- Physics
- Radioecology
- Sustainability science
- Systems ecology
- Urban ecology
- Energy conservation
- Environmental technology
- Natural resource management
- Pollution control
- Public transport encouragement
- Recycling

**Related fields**

**Applications**

**Lists**

**See also**

- Remediation
- Renewable energy
- Road ecology
- Sewage treatment
- Urban metabolism
- Water purification
- Waste management
- Degrees
- Journals
- Research institutes
- Glossary
- Environment by year
- Human impact on the environment
- Sustainability
- Technogaianism

○  **Category**

○ scientists

○  **Commons**

○  **Environment portal**

○  **WikiProject**

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Public health

## General

- Auxology
- Biological hazard
- Chief Medical Officer
- Cultural competence
- Deviance
- Environmental health
- Eugenics
  - History of
  - Liberal
- Euthenics
- Genomics
- Globalization and disease
- Harm reduction
- Health economics
- Health literacy
- Health policy
  - Health system
  - Health care reform
- Housing First
- Human right to water and sanitation
- Management of depression
  - Public health law
  - National public health institute
- Health politics
- Labor rights
- Maternal health
- Medical anthropology
- Medical sociology
- Mental health (Ministers)
- Occupational safety and health
- Pharmaceutical policy
- Pollution
  - Air
  - Water
  - Soil
  - Radiation
  - Light
- Prisoners' rights
- Public health intervention
- Public health laboratory
- Right to food
- Right to health
- Right to housing
- Right to rest and leisure
- Right to sit
- Security of person
- Sexual and reproductive health

**Preventive  
healthcare**

- Behavior change
  - Theories
- Family planning
- Health promotion
- Human nutrition
  - Healthy diet
  - Preventive nutrition
- Hygiene
  - Food safety
  - Hand washing
  - Infection control
  - Oral hygiene
- Occupational safety and health
  - Human factors and ergonomics
  - Hygiene
  - Controlled Drugs
  - Injury prevention
  - Medicine
  - Nursing
- Patient safety
  - Organization
- Pharmacovigilance
- Safe sex
- Sanitation
  - Emergency
  - Fecal–oral transmission
  - Open defecation
  - Sanitary sewer
  - Waterborne diseases
  - Worker
- School hygiene
- Smoking cessation
- Vaccination
- Vector control

**Population health**

- Biostatistics
- Child mortality
- Community health
- Epidemiology
- Global health
- Health impact assessment
- Health system
- Infant mortality
- Open-source healthcare software
- Multimorbidity
- Public health informatics
- Social determinants of health
  - Commercial determinants of health
  - Health equity
  - Race and health
- Social medicine
- Case-control study
- Randomized controlled trial
- Relative risk

**Biological and epidemiological statistics**

- Statistical hypothesis testing
  - Analysis of variance (ANOVA)
  - Regression analysis
  - ROC curve
  - Student's *t*-test
  - Z-test
- Statistical software
- Asymptomatic carrier
- Epidemics
  - List

**Infectious and epidemic disease prevention**

- Notifiable diseases
  - List
- Public health surveillance
  - Disease surveillance
- Quarantine
- Sexually transmitted infection
- Social distancing
- Tropical disease
- Vaccine trial
- WASH

**Food hygiene  
and  
safety  
management**

- Food
  - Additive
  - Chemistry
  - Engineering
  - Microbiology
  - Processing
  - Safety
  - Safety scandals
- Good agricultural practice
- Good manufacturing practice
  - HACCP
  - ISO 22000
- Diffusion of innovations
- Health belief model
- Health communication
- Health psychology
- Positive deviance
- PRECEDE–PROCEED model
- Social cognitive theory
- Social norms approach
- Theory of planned behavior
- Transtheoretical model

**Health  
behavioral  
sciences**

**Organizations,  
education  
and history**

**Organizations**

- Caribbean
  - Caribbean Public Health Agency
- China
  - Center for Disease Control and Prevention
- Europe
  - Centre for Disease Prevention and Control
  - Committee on the Environment, Public Health and Food Safety
- India
  - Ministry of Health and Family Welfare
- Canada
  - Health Canada
  - Public Health Agency
- U.S.
  - Centers for Disease Control and Prevention
  - Health departments in the United States
  - Council on Education for Public Health
  - Public Health Service
- World Health Organization
- World Toilet Organization
- (Full list)
- Health education
- Higher education

**Education**

- Bachelor of Science in Public Health
- Doctor of Public Health
- Professional degrees of public health
- Schools of public health

**History**

- Sara Josephine Baker
- Samuel Jay Crumbine
- Carl Rogers Darnall
- Joseph Lister
- Margaret Sanger
- John Snow
- Typhoid Mary
- Radium Girls
- Germ theory of disease
- Social hygiene movement

-  **Category**
-  **Commons**
-  **WikiProject**

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## Natural resources

### Air

#### Pollution / quality

- Ambient standards (US)
- Index
- Indoor
- Law
  - Clean Air Act (US)
- Ozone depletion
- Airshed
- Trading
- Deforestation (REDD)

#### Emissions

### Energy

- Bio
- Law
- Resources
- Fossil fuels (gas, peak coal, peak gas, peak oil)
- Geothermal
- Hydro
- Nuclear
- Solar
  - sunlight
  - shade
- Wind

## Land

- Agricultural
  - arable
    - peak farmland
- Degradation
- Field
- Landscape
  - cityscape
  - seascape
  - soundscape
  - viewshed
- Law
  - property
- Management
  - habitat conservation
- Minerals
  - gemstone
  - industrial
  - ore
    - metal
  - mining
    - law
    - sand
  - peak
    - copper
    - phosphorus
  - rights
- Soil
  - conservation
  - fertility
  - health
  - resilience
- Use
  - planning
  - reserve

## **Life**

- Biodiversity
- Bioprospecting
  - biopiracy
- Biosphere
- Bushfood
- Bushmeat
- Fisheries
  - climate change
  - law
  - management
- Forests
  - genetic resources
  - law
  - management
  - non-timber products
- Game
  - law
- Marine conservation
- Meadow
- Pasture
- Plants
  - FAO Plant Treaty
  - food
  - genetic resources
  - gene banks
  - herbal medicines
  - UPOV Convention
  - wood
- Rangeland
- Seed bank
- Wildlife
  - conservation
  - management

## Water

### Types / location

- Aquifer
  - storage and recovery
- Drinking
- Fresh
- Groundwater
  - pollution
  - recharge
  - remediation
- Hydrosphere
- Ice
  - bergs
  - glacial
  - polar
- Irrigation
  - *huerta*
- Marine
- Rain
  - harvesting
- Stormwater
- Surface water
- Sewage
  - reclaimed water
- Watershed
- Desalination
- Floods
- Law
- Leaching
- Sanitation
  - improved
- Scarcity
- Security
- Supply
- Efficiency
- Conflict
- Conservation
- Peak water
- Pollution
- Privatization
- Quality
- Right
- Resources
  - improved
  - policy

### Aspects

- Commons
  - enclosure
  - global
  - land
  - tragedy of
- Economics
  - ecological
  - land
- Ecosystem services
- Exploitation
  - overexploitation
  - Earth Overshoot Day
- Management
  - adaptive
- Natural capital
  - accounting
  - good
- Natural heritage
- Nature reserve
  - remnant natural area
- Systems ecology
- Urban ecology
- Wilderness

**Related**

- Common-pool
- Conflict (perpetuation)
- Curse
- Resource
  - Depletion
  - Extraction
  - Nationalism
  - Renewable / Non-renewable
- Politics
  - Oil war
  - Petrostate
  - Resource war

-  **Category**

**Authority control databases**  **Edit this at Wikidata**

## National

- Germany
- United States
- France
- BnF data
- Japan
- Czech Republic
  - 2

## Other

- Spain
- Israel
- NARA

## About Durham Supply Inc

### Photo

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## Things To Do in Tulsa County

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### Photo

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## **Gathering Place**

**4.8 (12116)**

### **Photo**

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## **Center of the Universe**

**4.4 (4471)**

### **Photo**

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## **Tulsa Air and Space Museum & Planetarium**

**4.3 (419)**

### **Photo**

**The Blue Dome**

**4.5 (60)**

**Photo**

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**Guthrie Green**

**4.7 (3055)**

**Photo**

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**The Cave House**

**4.6 (249)**

**Driving Directions in Tulsa County**

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**Driving Directions From Oakwood Homes to Durham Supply Inc**

Driving Directions From Best Western Airport to Durham Supply Inc

Driving Directions From Church on the Move Tulsa to Durham Supply Inc

Driving Directions From Subway to Durham Supply Inc

Driving Directions From Harmon Security Group LLC. to Durham Supply Inc

Driving Directions From Dollar General to Durham Supply Inc

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[https://www.google.com/maps/dir/Tulsa+VA+Behavioral+Medicine+Clinic/Durham+Supply+Inc/@36.95.8620661,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sChIJP1coZeTytocRFxBglazhJ!2m2!1d-95.8620661!2d36.1490383!1m5!1m1!1sChIJDzPLSlrytocRY\\_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e2](https://www.google.com/maps/dir/Tulsa+VA+Behavioral+Medicine+Clinic/Durham+Supply+Inc/@36.95.8620661,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sChIJP1coZeTytocRFxBglazhJ!2m2!1d-95.8620661!2d36.1490383!1m5!1m1!1sChIJDzPLSlrytocRY_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e2)

[https://www.google.com/maps/dir/Oakwood+Homes/Durham+Supply+Inc/@36.157059,95.836308,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sChIJBexf2QzztocRV\\_e5kJ6lxH!2m2!1d-95.836308!2d36.157059!1m5!1m1!1sChIJDzPLSlrytocRY\\_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e1](https://www.google.com/maps/dir/Oakwood+Homes/Durham+Supply+Inc/@36.157059,95.836308,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sChIJBexf2QzztocRV_e5kJ6lxH!2m2!1d-95.836308!2d36.157059!1m5!1m1!1sChIJDzPLSlrytocRY_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e1)

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Driving Directions From Oxley Nature Center to Durham Supply Inc

Driving Directions From OkieTundra to Durham Supply Inc

Driving Directions From Tulsa Air and Space Museum & Planetarium to Durham Supply Inc

Driving Directions From Golden Driller Statue to Durham Supply Inc

Driving Directions From Oxley Nature Center to Durham Supply Inc

Driving Directions From Blue Whale of Catoosa to Durham Supply Inc

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[https://www.google.com/maps/dir/Gathering+Place/Durham+Supply+Inc/@36.12516095,9840207,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-95.9840207!2d36.1251603!1m5!1m1!1sChIJDzPLSlrytocRY\\_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e2](https://www.google.com/maps/dir/Gathering+Place/Durham+Supply+Inc/@36.12516095,9840207,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-95.9840207!2d36.1251603!1m5!1m1!1sChIJDzPLSlrytocRY_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e2)

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[https://www.google.com/maps/dir/Streetwalker+Tours/Durham+Supply+Inc/@36.152295.9886238,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-95.9886238!2d36.1522464!1m5!1m1!1sChIJDzPLSlytocRY\\_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e3](https://www.google.com/maps/dir/Streetwalker+Tours/Durham+Supply+Inc/@36.152295.9886238,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-95.9886238!2d36.1522464!1m5!1m1!1sChIJDzPLSlytocRY_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e3)

[https://www.google.com/maps/dir/The+Tulsa+Arts+District/Durham+Supply+Inc/@36.95.9918339,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-95.9918339!2d36.1589262!1m5!1m1!1sChIJDzPLSlytocRY\\_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e0](https://www.google.com/maps/dir/The+Tulsa+Arts+District/Durham+Supply+Inc/@36.95.9918339,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-95.9918339!2d36.1589262!1m5!1m1!1sChIJDzPLSlytocRY_EaORpHGro!2m2!1d-95.8384781!2d36.1563128!3e0)

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## Reviews for Durham Supply Inc

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### Durham Supply Inc

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Gerald Clifford Brewster

(5)

We will see, the storm door I bought says on the tag it's 36x80, but it's 34x80. If they return it.....they had no problems returning it. And it was no fault of there's, you measure a mobile home door different than a standard door!

### Durham Supply Inc

Image not found or type unknown

B Mann

(5)

I was in need of some items for a double wide that I am remodeling and this place is the only place in town that had what I needed ( I didn't even try the other rude place )while I was there I learned the other place that was in Tulsa that also sold mobile home supplies went out of business (no wonder the last time I was in there they were VERY RUDE and high priced) I like the way Dunham does business they answered all my questions and got me the supplies I needed, very friendly, I will be back to purchase the rest of my items when the time comes.

## Durham Supply Inc

Image not found or type unknown

Ethel Schiller

**(5)**

This place is really neat, if they don't have it they can order it from another of their stores and have it there overnight in most cases. Even hard to find items for a trailer! I definitely recommend this place to everyone! O and the prices is awesome too!

## Durham Supply Inc

Image not found or type unknown

Dennis Champion

**(5)**

Durham supply and Royal supply seems to find the most helpful and friendly people to work in their stores, we are based out of Kansas City out here for a few remodels and these guys treated us like we've gone there for years.

## Durham Supply Inc

Image not found or type unknown

Ty Spears

**(5)**

Bought a door/storm door combo. Turns out it was the wrong size. They swapped it out, quick and easy no problems. Very helpful in explaining the size differences from standard door sizes.

Checking for Proper Ventilation in Mobile Home HVAC Crawl Spaces [View GBP](#)

## Frequently Asked Questions

**How can I determine if my mobile homes HVAC crawl space has adequate ventilation?**

To determine if your mobile homes HVAC crawl space has adequate ventilation, check for vents or openings on each side of the crawl space. Ensure they are unobstructed and evenly distributed to allow cross-ventilation. You should also look for signs of moisture or mold, as

these indicate poor ventilation.

**What are the consequences of inadequate ventilation in a mobile home HVAC crawl space?**

Inadequate ventilation in a mobile home HVAC crawl space can lead to moisture buildup, which may cause mold growth, wood rot, and structural damage. It can also reduce indoor air quality and efficiency of the HVAC system due to restricted airflow and potential equipment corrosion.

**What steps can I take to improve ventilation in my mobile homes HVAC crawl space?**

To improve ventilation in your mobile homes HVAC crawl space, ensure all existing vents are clear of debris and not blocked by vegetation or other obstacles. Consider adding more vents if airflow is insufficient. Installing a vapor barrier on the ground can help control moisture levels, further enhancing air circulation and reducing humidity issues.

Royal Supply Inc

Phone : +16362969959

City : Oklahoma City

State : OK

Zip : 73149

Address : Unknown Address

**Google Business Profile**

Company Website : <https://royal-durhamsupply.com/locations/oklahoma-city-oklahoma/>

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