

# ENVIRONMENTAL HISTORY OF AIR POLLUTION AND PROTECTION

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## Summary

Concerns about air pollution have a long history. Complaints about its effects on human health and the built environment were first voiced by the citizens of ancient Athens and Rome. Urban air quality, however, worsened during the Industrial Revolution, as the widespread use of coal in factories in Britain, Germany, the United States and other nations ushered in an ‘age of smoke.’ Despite the tangible nature of this form of air pollution, and the harm it caused to the public’s health, early laws to control smoke were generally weak and ineffective. Not until the mid-twentieth century, after air pollution disasters such as London’s ‘Great Smog’ demonstrated conclusively the damage it caused to human health, were stringent national laws to abate smoke finally introduced to clear the skies over the cities of the first industrial nations.

In terms of their scale, the effects of coal smoke in the nineteenth and early twentieth centuries were mainly local and regional. But after the Second World War a number of invisible threats began to emerge – acid rain, photochemical smog, ozone depletion and climate change – that were transnational and global in character. It often required the cooperation of scientific experts across both disciplinary and national borders, as well as computer simulation of the impacts of air pollution, to make these new threats ‘visible’ to the public. Global environmental problems also required collective political and legislative action on the part of nations if solutions were to be found.

## 1. Introduction

Air pollution is a major environmental problem and it comes in a variety of forms, from visible particles of soot or smoke to invisible gases such as sulfur dioxide and carbon

monoxide, and it can be created indoors and outdoors. Although some sources of atmospheric pollution are emitted naturally, from volcanoes or forest fires, most are the result of human activity in the home or workplace. This chapter aims to provide an overview of anthropogenic air pollution problems, and attempts to solve them, focusing in particular on the past two centuries. Atmospheric pollution, however, has a longer history. It was also a significant issue for pre-modern societies, with the burning of biomass and fossil fuels damaging both human health and the local environment. But the rise of modern urban-industrialism – and the shift from fuelwood to coal and then to oil – extended the scale and scope of air pollution problems dramatically. Indeed, some harmful airborne contaminants like chlorofluorocarbons (CFCs), chemicals used in aerosol cans, refrigerators and air-conditioning systems that deplete the ozone layer, did not exist before the twentieth century.

The chapter is set out in three main parts. Firstly, it examines early examples of air pollution and its effects, especially in northern Europe and the Mediterranean basin where archaeological records and a variety of written sources provide clear evidence of environmental change. Secondly, it will explore the development of air pollution problems between 1780 and 1950, as the availability of cheap wood supplies declined and coal became the chief source of energy in the rapidly industrializing world. Lastly, it will discuss transboundary pollution caused by acid rain, high levels of emissions from gasoline-fuelled cars, and the emergence of new global threats from invisible air pollutants after 1950, such as CFCs and human-induced climate change, as well as the various international measures put in place to tackle them.

## **2. Preindustrial Air Pollution**

Indoor air pollution caused by cooking and heating with open fires in poorly ventilated dwellings was a significant cause of ill-health from the earliest times. Scientific studies of samples of mummified lung tissues from Egypt, Peru, Britain and elsewhere have revealed that ancient societies suffered from anthracosis, (blackening of the lungs), from long exposure to the acrid smoke of domestic fires. Smoke was most likely tolerated indoors because it helped to keep mosquitoes and other insect pests at bay. But poor domestic air quality – with concentrations of harmful particulates high in cramped conditions – undoubtedly increased the risk of illness and death from chronic respiratory diseases. The testimonies of Aretaeus of Cappadocia, Aulus Cornelius Celsus, Pliny the elder and other medical writers indicate that diseases of the lungs were widespread in the classical civilizations of the Mediterranean basin. However, deaths from ‘normal’ diseases like bronchitis have to date attracted little sustained attention from medical historians of the classical period. In the developing world, where heating and cooking with smoky biomass fuels such as wood and animal dung remains commonplace, in 2004 around 1.6 million deaths were linked to indoor air pollution.

Outdoor air pollution only became a major issue with the rise of cities. Early cities were very different in many respects from their modern counterparts. They were, for example, compact ‘walking cities’, with the marketplace, religious and public buildings all being easily accessible on foot. The influential Hippocratic treatise *Airs, Waters, Places*, written c.400BCE, stressed the importance of good air quality, as well as pure water and a salubrious setting, in choosing settlement sites. But where large numbers of

people crowded into urban centers, smoke and other noxious fumes from households and small manufacturing works soon became a cause for concern. Air pollution was an everyday part of life for the inhabitants of cities like Athens (population c.200,000 in 430BCE) and Rome (population c.1 million in 150CE), where the emissions from homes, smelting furnaces, potteries and other preindustrial workshops darkened the skies.

The residents of ancient Rome referred to their city's smoke cloud as *gravioris caeli* ('heavy heaven') and *infamis aer* ('infamous air'), and several complaints about its effects can be found in classical writings. The poet Horace (65BCE - 8 CE), for instance, lamented the blackening of Rome's marble buildings by countless wood-burning fires, while the statesman and philosopher Seneca (4BCE - 65CE) wrote in a letter to a friend:

I expect you're keen to hear what effect it had on my health, this decision of mine to leave [Rome]. No sooner had I left behind the oppressive atmosphere of the city and that reek of smoking cookers which pour out, along with clouds of ashes, all the poisonous fumes they've accumulated in their interiors whenever they're started up, than I noticed the change in my condition at once. You can imagine how much stronger I felt after reaching my vineyards.

Some 2,000 years ago civil claims over smoke pollution were heard before Roman courts, and in 535CE the emperor Justinian promulgated the *Institutes* which included a section that acknowledged the importance of clean air to breathe (and pure water to drink) as a birthright: 'By the law of nature these things are common to mankind – the air, running water, [and] the sea'. Earlier Babylonian and Assyrian laws dealt with similar issues, and around 200CE the Hebrew Mishnah sought to control sources of air pollution in Jerusalem. Atmospheric pollution in the ancient world, then, was recognized as damaging to both human health and the built environment, and it was in early cities that the first legislative steps were taken to abate it – and to protect the air as common property – albeit with limited success.

Domestic smoke problems from wood and charcoal burning were mainly confined to a limited area in and around urban centers. The noxious emissions from smelting and mining metals, however, had more serious and far-reaching consequences. The leading sources of metallic pollutants were lead and copper production, which had environmental impacts on a regional and hemispheric level long before the Industrial Revolution. First smelted in Anatolia and Mesopotamia around 5000BCE, the production of lead increased sharply during the Greco-Roman period (peaking at around 80,000 tonnes per annum). Indeed, it was central to the Roman's daily lives, and they used it extensively for everything from domestic water pipes and roofing to kitchen utensils and coinage – and even as a sweetener of wine (lead arsenate). The adverse health effects of long-term exposure to lead (impaired fertility and neurological damage), which disproportionately affected the Roman aristocracy and upper classes, have been linked to the end of empire. Lead extraction and smelting also posed a serious health hazard for workers (often forced labor) in Roman mining operations in the Iberian Peninsula, England, Gaul, Greece and elsewhere, as well as leaving behind hill-sized mounds of black slag that transformed the landscape. The Greek geographer and historian Strabo (c.64BCE – c.23CE) described how toxic metallic emissions from smelter furnaces were discharged into the air from 'high chimneys'; and small-sized

particles were transported on the prevailing winds to pollute large regions of the northern hemisphere. Analysis of Arctic ice-core studies has shown that imperial Rome increased the release of lead into the environment by a factor of ten, mainly due to inefficient smelting in open furnaces.

The Roman period also saw a marked rise in copper production, which – often alloyed with tin to form the harder metal bronze – was utilized to make tools, weapons and coins. Reaching a peak of over 15,000 tonnes per annum approximately 2,000 years ago, Roman copper supplies were sourced mainly from Spain, Cyprus and central Europe. The widespread use of copper coinage in medieval China under the Sung Dynasty contributed to a second preindustrial boom in production (rising to about 13,000 tonnes per annum at its peak; a scale comparable to that of Roman times). But the primitive technologies and techniques employed by Roman and Chinese metallurgists resulted in around 15 per cent of all smelted copper being expelled into the atmosphere. The data from Arctic ice-cores shows that the cumulative deposition of copper pollution in the northern hemisphere was much greater before the Industrial Revolution than afterwards, when smelting technologies had improved. It is important to note that because smelters and other smoky trades (such as brick-making) made disagreeable neighbors, they were usually situated well beyond the boundaries of a city (often by official decree). Pragmatically, they were generally located in the countryside close to forest and woodland areas where fuel was abundant, its transportation costs were low, and where few people would be troubled by air pollution problems.

A shortage of fuelwood and charcoal in sixteenth-century London, as its growing population placed unsustainable demands on surrounding woodlands, led to the increasing use of coal as a substitute – a harbinger of things to come. One of the largest cities in Europe, London's population is estimated to have more than doubled from 75,000 in 1550 to 200,000 in 1600, with an almost threefold increase to 575,000 in 1700. As wood became scarce its price increased dramatically, by some 780 per cent between 1540 and 1640, forcing large numbers of Londoners to switch to cheaper supplies of 'sea-coal' as an alternative source of fuel for their homes and businesses. Imported into London via coastal shipping routes and the Thames, mainly from north-eastern England, the growing consumption of 'sea-coal' – up from c.10,000 tonnes in 1580 to c.360,000 tonnes in 1680 – brought increasing complaints about smoke emissions.

Coal had been shipped to London since medieval times, where it was burned mainly by tradesmen in small workshops during fuelwood shortages. The dense smoke billowing from smiths' forges, breweries and lime kilns soon attracted criticism from its citizens, who were worried about deteriorating air quality in the city. In the late thirteenth century, for example, two royal commissions were appointed to inquire into complaints about pollution caused by coal-fired lime kilns operating in London. And Edward I issued a royal proclamation in 1307 to prohibit the use of smoky 'sea-coal' in the city's kilns because of the 'annoyance' caused to its inhabitants and concern over 'the injury of their bodily health'. In 1578 Queen Elizabeth I objected to the 'taste and smoke' of sea-coal issuing from brewing houses sited near the Palace of Westminster. By the seventeenth century the city's smoke-cloud had thickened, as more and more Londoners made the transition from wood and charcoal to fossil fuel consumption. This provoked

some influential figures of the day to protest about the state of London's atmosphere, best exemplified by the publication of John Evelyn's pamphlet *Fumifugium* in 1661, in which he spoke indignantly of:

... that Hellish and dismal Cloud of SEA-COAL ...perpetually imminent over her head ... mixed with the otherwise wholesome and excellent *Aer*, that her *Inhabitants* breathe nothing but an impure and thick Mist accompanied with a fuliginous and filthy vapour, which renders them obnoxious to a thousand inconveniences, corrupting the *Lungs*, and disordering the entire habits of their Bodies; so that *Catharrs*, *Phthisicks*, *Coughs* and *Consumptions* rage more in this one City than in the whole Earth besides.

In addition, he described how the smoke-cloud damaged the city's architecture and green spaces, as well as Londoner's clothes and possessions. Smoke emissions on such a scale would not be tolerated in the other great cities of Europe, Evelyn argued, and he recommended that polluting industries be relocated outside of London. But from the end of the eighteenth century, rapid urban-industrial growth would see air pollution from the burning of fossil fuels become a major environmental problem throughout Europe and the wider world.

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