



How Claude Monet saw London in 1899



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### The London Smog Disaster of 1952.

Days of toxic darkness.

Early on 5th of December 1952 the London sky was clear, the weather was considerably colder than usual, as it had been for some weeks. As a result the people of London were burning large amounts of coal and smoke bellowed from the chimneys. The winds were light and the air near the ground was moist, conditions ideal for formation of radiation fog.

During the day of 5th December the fog was not particularly dense, it possessed a dry smoky character, however when nightfall came the fog thickened and visibility dropped to a few metres.

In central London the visibility remained below 500 meters continuously for 114 hours and below 50 meters continuously for 48 hours.

At Heathrow airport visibility remained below 10 for almost 48 hours from the morning of 4 December.

Road, rail and air transport were brought to a standstill. Theatres had to be suspended when fog in the auditorium made conditions intolerable. But, most importantly the smoke laden fog that shrouded the capital brought the premature death of an estimated 12,000 people and illness to many others.

This "pea soup" smog stayed stewing away for five days from the 5 to the 10 December as more and more pollution entered it before winds from the west blew it down the Thames Estuary and out into the North sea.

### Some SO<sub>2</sub> Chemistry in the atmosphere

**X** In the gas phase (clear sky, no clouds):

$$\text{SO}_2 + \cdot\text{OH} \rightarrow \text{HSO}_3$$

$$\text{HSO}_3 + \text{O}_2 \rightarrow \text{HO}\cdot + \text{SO}_3$$

$$\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$$

In mist:

$$\text{H}_2\text{SO}_{4(g)} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_{4(aq)}$$

$$\text{SO}_{2(g)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2\text{SO}_{3(aq)}$$

### The science.

The fog was triggered by the formation of a static layer of cooler air close to the ground as the night time temperature dropped. This is known as **temperature inversion**.

Normally, air closer to the ground is warmer than the air above it, and therefore rises. Inversions are frequent on winter nights after the ground has cooled down so much that it begins to chill the air closest to it often causing mist to form as water vapour precipitates on dust particles. Normally the morning sun swiftly breaks through the mist and heats the ground, which warms the air above it, breaking the inversion. But in December 1952 the accumulation of smoke close to the ground was so great that the sun never broke through, and the air stayed cool and static.

The term **smog** simply describes fog that has soot in it. Winter smog in which smoke, sulphur dioxide from the city's chimneys, accumulated in the foggy air had been a feature of London life since at least the 17th century. However the industrial revolution of the 19th century in Britain's major cities gave a dramatic increase in air pollution.

On 5th December 1952 hanging in the air were thousands of tonnes of black soot, sticky particles of tar and gaseous sulphur dioxide, which had mostly come from coal burnt in domestic hearths. Smoke particles trapped in the fog gave it a yellow-black colour.

The water from the fog condensed around the soot and tar particles. The sulphur dioxide reacted inside these foggy, sooty droplets to form a sulfate sulphuric acid creating in effect a very intense form of acid rain.

During the four days between the 4 and 8 December 1952 smoke measurements taken at the National Gallery in London suggest that the PM<sub>10</sub> concentration reached 14mg/m<sup>3</sup> which was 56 times the level normally experienced at the time and the levels of sulphur dioxide in the air increased by 7 fold peaking at around 70ppb.

Smoke and Sulphur dioxide pollution was monitored at various sites in London at the time of the December Smog. The daily average measurements for 10 of these sites are given.

Site and distance from Charing Cross (miles)	Mean Dec. 1952	Smoke (milligrams per cubic metre) December 1952 (foggy days only)									
		2nd	3rd	4th	5th	6th	7th	8th	9th	10th	
1. Lambeth (0.5)	0.43	0.42	0.51	0.49	2.54	3.45	4.46	4.46	1.22	1.22	
2. Westminster (0.0)	0.34	0.30	0.30	0.52	1.93	2.40	1.20	1.20	1.44	0.40	
3. Southwark (1.0)	0.44	0.78	0.65	0.49	1.44	2.95	2.08	2.08	3.55	0.88	
4. City (2.0)	0.20	0.21	0.26	0.26	1.00	1.02	1.08	1.08	1.10	0.22	
5. Greenwich (5.5)	0.34	0.19	0.36	0.36	0.99	1.09	2.08	2.08	0.95	0.19	
6. Chislewick (6.0)	0.20	0.21	0.22	0.68	0.84	0.42	0.38	0.38	0.50	0.09	
7. Layton (6.3)	0.48	0.35	0.57	0.43	1.12	1.55	1.68	1.68	2.05	0.45	
8. Wrotham (9.0)	0.43	0.27	0.79	0.41	1.47	1.62	3.38	3.38	0.92	0.25	
9. Twickenham (11.3)	0.15	0.20	0.31	0.29	0.83	1.44	0.67	0.67	0.48	0.05	
10. Homchurch (15.3)	0.12	0.03	0.19	0.03	0.03	0.34	0.58	0.58	0.37	0.07	

Sulphur dioxide (ppm)	
1. Lambeth (0.5)	0.22 0.16 0.22 0.14 0.75 0.86 1.34 1.34 0.47 0.47
2. Westminster (0.0)	0.16 0.16 0.24 0.89 0.83 0.83 1.25 0.89
3. Southwark (1.0)	0.11 0.18 0.26 0.10 0.41 0.86 1.14 1.14 0.80 0.34
4. City (2.0)	0.17 0.12 0.19 0.19 0.52 0.72 0.80 1.22 1.21 0.22
5. Greenwich (5.5)	0.10 0.09 0.27 0.27 0.33 0.42 0.72 0.72 0.38 0.09
6. Chislewick (6.0)	0.05 0.05 0.02 0.07 0.34 0.85 0.31 0.31 0.17 0.02
7. Layton (6.3)	0.11 0.05 0.12 0.09 0.25 0.29 0.62 0.62 0.64 0.17
8. Wrotham (9.0)	0.23 0.02 0.20 0.09 0.33 0.23 0.67 0.67 0.21 0.11
9. Twickenham (11.3)	0.07 0.05 0.21 0.22 0.32 0.89 0.59 0.57 0.14 0.03
10. Homchurch (15.3)	0.07 0.02 0.08 0.05 0.17 0.14 0.34 0.34 0.19 0.06

In addition huge quantities of impurities were released during the period on question.  
 1,000 tonnes of smoke particles  
 2,000 tonnes of carbon dioxide  
 140 tonnes of hydrochloric acid  
 14 tonnes of fluorine  
 Also 370 tonnes of sulphur dioxide were converted to 800 tonnes of sulphuric acid.

**The health effects of the London smog.**

On the week beginning the 5<sup>th</sup> December 1952 thousands of Londoners died in the worst air pollution disaster on record. Nobody realised what was happening until it was noticed that the undertakers were running out of coffins and the florists out of flowers. Only later it was realised that the number of deaths during the days of the smog was three or four times normal.

**Health Effects.**

The deaths which resulted from the smog can be attributed primarily to:

- Pneumonia
- Bronchitis
- Tuberculosis
- Heart failure

People with bronchitis and other respiratory conditions such as asthma wheezed to their deaths in their beds. Most deaths were a result of respiratory and cardiac distress. Many victims died in their beds from asphyxiation because of the smog.

Since that time the adverse health effects of smog have been identified, including:

As increased number of deaths

Increased hospital admissions and sick days

Respiratory effects

- Short term decrease in breathing ability and increase in chest pains
- Inflammation of the lungs and damage to respiratory cells
- Permanent lung damage and reduced quality of life due to ozone.
- Increased number of asthma attacks due to nitrogen dioxide.

Cardiovascular effects

- A lack of oxygen in the bloodstream in those with heart disease due to carbon monoxide.

Plus

- Increased risk of cancer
- Increased susceptibility to infection among children

**Death rates**

During the smog the death rate rose dramatically. The previous week the death rate had been 0.062, which was close to normal for that time of year. In the following week 4703 people died. The death rate peaked on the 8<sup>th</sup> and 9<sup>th</sup> at 900 per day. In parts of the East End, death rates during the period of the London smog were nine times the normal. The death rate remained above normal through the winter and was still 2 per cent up the following summer. There were almost a thousand more deaths per week than expected according to the normal winter rates until the spring of that year.

**How many people actually died?**

The accepted figure is that the London smog killed around 4000 people. The official reports published at the time used these figures. However they count only the deaths during and for two weeks after the smog. The reason this was done was that death rate returned to normal at this time for a short while. However, there was a second peak in deaths and people have since realised that the rates returning to normal was due to registrations being delayed because of Christmas holidays. Deaths remained higher than normal for a long time after this point. These delayed deaths add an extra 8000, bringing the total number of people the smog killed up to 1,2000. Many people nowadays accept this as the real figure for deaths due to the London smog. Exactly how many people died as a result of the Great London Smog can never be known.

**Who died?**

The majority of the people who died were old and many already suffered from chronic respiratory and cardiovascular complaints. Mortality from bronchitis and pneumonia increased more than sevenfold.

However, Officials at the time stated that the smog's victims had been only the old and the sick. One medical officer wrote in his official account of the smog published in 1954:

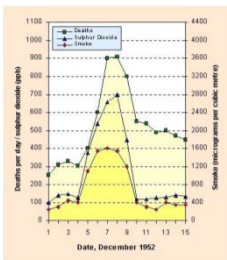
*The fog was in fact a precipitating agent, operating on a susceptible group of patients whose life expectation, judging from their pre-existing diseases, must even in the absence of fog, have been short.*

However in private many doctors disagreed with this. In fact only two thirds of the 4000 victims were over 65. The death rate actually rose most in the 45 to 64 year olds. In fact it rose to three times the normal value. Had it been true that only a 'susceptible group of patients' had been affected, then the number of deaths occurring for some time after the incident would have fallen below normal. However as we know, this did not happen.

In the official reports infant mortality was played down and often did not mention it at all. However in fact twice the normal number of babies died in the week of the smog.

**Why did these effects occur?**

Pollutants such as smoke and sulphur dioxide were partly to blame. In the following graph you can see that smoke and sulphur dioxide peaks coincide with peaks in the deaths.



However, research has shown that the adverse effects of the smog were not as much due to the original pollutants- the soot and sulphur dioxide- as to the acidity of the air. Breathing in acid aerosol irritated the bronchial tubes, which produced large amounts of mucus and became inflamed. While nobody measured the acidity at the time, the pH was probably at least as low as 2.

**Cleaning up the act!**

The Great London Smog galvanised the government to clean up the nation's air and as a consequence the first clean air acts were introduced.

**1956 Clean Air Act.**

This Act was directed at domestic sources of smoke pollution authorising local councils to set up smokeless zones and make grants to householders to convert their homes from traditional coal fires to heaters fuelled by gas, oil, smokeless coal or electricity.

**The 1968 Clean Air Act; Tall Chimneys**

This act brought in the basic principle for the use of tall chimneys for industries burning coal, liquid or gaseous fuels.

Thanks partly to pollution legislation but also to slum clearance, urban renewal, and the widespread use of central heating in the houses and offices of British pea-coopers have become a thing of the past.

Unfortunately the smog of 1991 has demonstrated that efforts will need to continue to counter air pollution and protect the environment for future generations.