

An aerial photograph of a snowy mountain landscape. In the foreground, a small settlement of buildings is situated on a snow-covered slope. A large body of water, likely a lake or bay, is visible in the middle ground. In the background, a range of snow-capped mountains stretches across the horizon under a clear blue sky. The text "POLLUTION AND HEALTH" is overlaid in the center of the image.

POLLUTION AND HEALTH

GUY COULSON

POLLUTION AND HEALTH

1. What is pollution?
2. Where does it come from?
3. How is it transported?
4. Effects on health

POLLUTION AND HEALTH

What is pollution?

The wrong stuff in the wrong place at the wrong time

Anthropogenic Pollution

- Substances that are not naturally occurring in the Earth/ocean/atmosphere system
- Substances that cause harm



POLLUTION AND HEALTH

What is pollution?

The wrong stuff in the wrong place at the wrong time

Anthropogenic Pollution

Result of human activities

Waste products
By-products



POLLUTION AND HEALTH

What is pollution?

The wrong stuff in the wrong place at the wrong time

Air

- Gasses
- Particulates

Water

- Solid
- Liquid

Land

- Solid
- liquid

Other

- Noise, light etc



POLLUTION AND HEALTH

What is pollution?

The wrong stuff in the wrong place at the wrong time

Air

Gas

- carbon monoxide
- carbon dioxide
- nitrogen dioxide
- ozone
- sulphur dioxide
- CFCs



POLLUTION AND HEALTH

What is pollution?

The wrong stuff in the wrong place at the wrong time

Air

Particulates

- industrial dust
 - mining
 - quarrying
- Soot/carbonaceous
- sulphates from SO₂
- nitrates from NO_x
(primary, secondary)



POLLUTION AND HEALTH

What is pollution?

Is responsible for



Acid rain

Climate change (global warming)

Ozone holes

Kills plants and animals

Illness (including death) in humans

POLLUTION AND HEALTH

What is pollution?

Source - Origin of pollutant

- Direct emission
- Chemical processes
- Resuspension - winds picking up pollutants (dust) from ground

Sink - Removal of pollutant

- Winds (dispersal)
- Chemical processes
- Deposition (sedimentation, filtration)

POLLUTION AND HEALTH

1. What is pollution?
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POLLUTION AND HEALTH

Where does it come from?

History

Sources

Industrial (including agriculture)

Transportation

Domestic - Indoor/outdoor

POLLUTION AND HEALTH

Where does it come from?

History

Air Pollution and Control

Air pollution and its effects are not a recent occurrence, as evidenced by the following quote:

"... whosoever shall be found guilty of burning coal shall suffer the loss of his head."

King Edward II, circa 1300 a.d.



Last of the suffocating London peasoupers

POLLUTION AND HEALTH

Where does it come from?

Sources

Industrial (including agriculture)

- | | |
|------------------|---|
| Mining/quarrying | - dust, heavy metals |
| Manufacturing | - gasses, particulates, liquids |
| Power generation | - soot, NO _x and SO _x |
| Agriculture | - pesticides, fertilisers |

Transportation

Traffic, Shipping, Aviation (contrails – global dimming)

Domestic

- Heating
- Cooking
- Refuse – landfill
- cleaning products - sewerage

POLLUTION AND HEALTH

Where does it come from?

Sources of air pollution

Burning fossil fuels

coal,

oil

natural gas



Fuel + oxygen = carbon dioxide + water (+ energy)

Fossil fuels also contain impurities like sulphur. When the sulphur is burnt, sulphur dioxide is made.

POLLUTION AND HEALTH

Where does it come from?

- nitrogen oxides
- hydrocarbons
- sunlight
- temperatures above $\approx 20^{\circ}\text{C}$
- low wind speeds
- well defined boundary layer

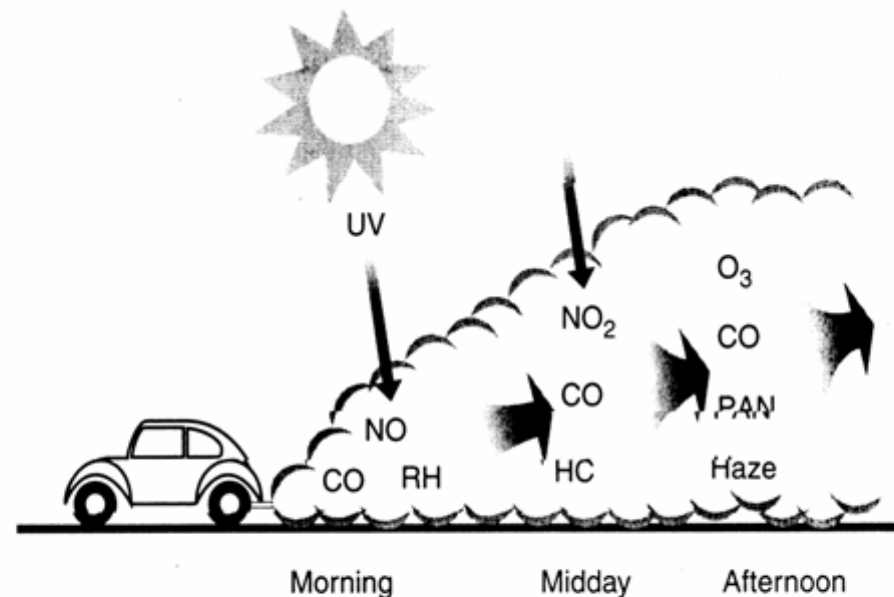


Figure 6.2 Automobiles are the primary cause of photochemical smog. The primary emissions from automobiles, NO, CO, and reactive hydrocarbons (RH), are converted by sunlight to NO₂, ozone, and a variety of other pollutants during the day.

POLLUTION AND HEALTH

Where does it come from?

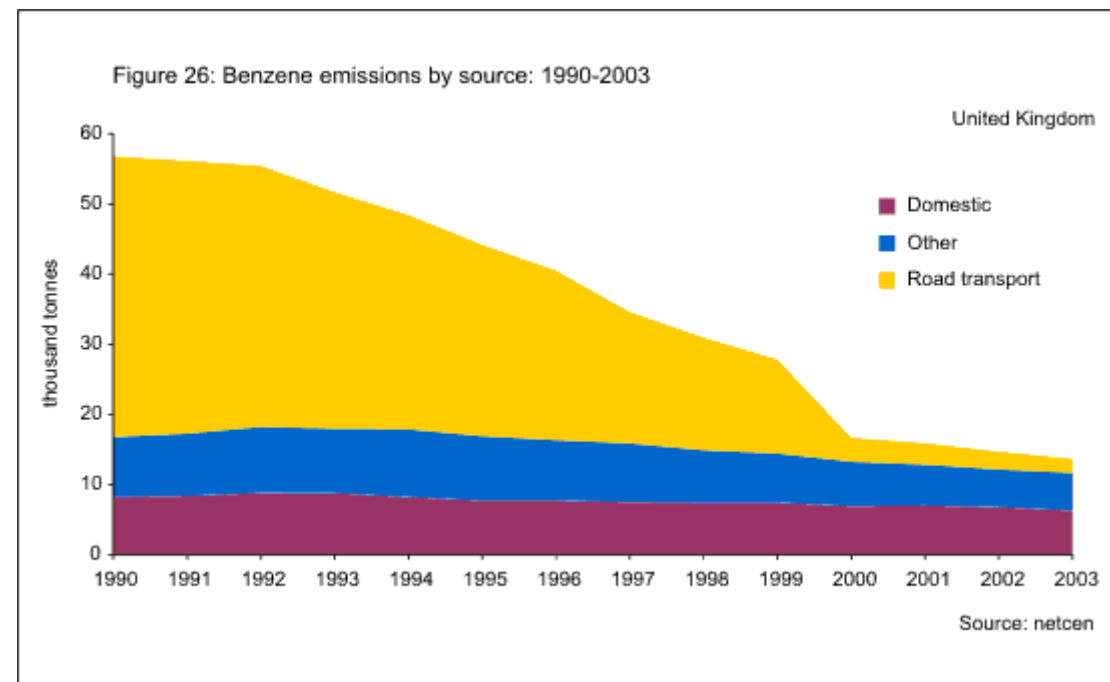
There are 8 main pollutants of concern for human health. These are:

Benzene,
1,3-Butadiene,
carbon monoxide,
lead,
nitrogen dioxide,
ozone,
particulates (PM10) and
sulphur dioxide.

POLLUTION AND HEALTH

Where does it come from?

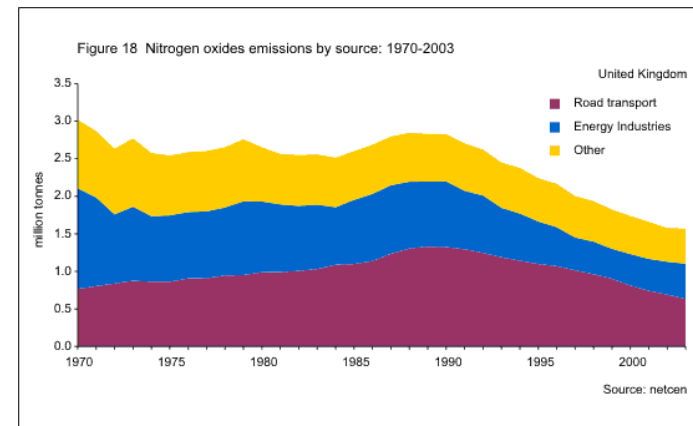
The majority of benzene emissions originate from un-burnt fuel in petrol vehicle exhaust gases and fuel evaporation during refuelling. It is also present in cigarette smoke and some glues and cleaning products.



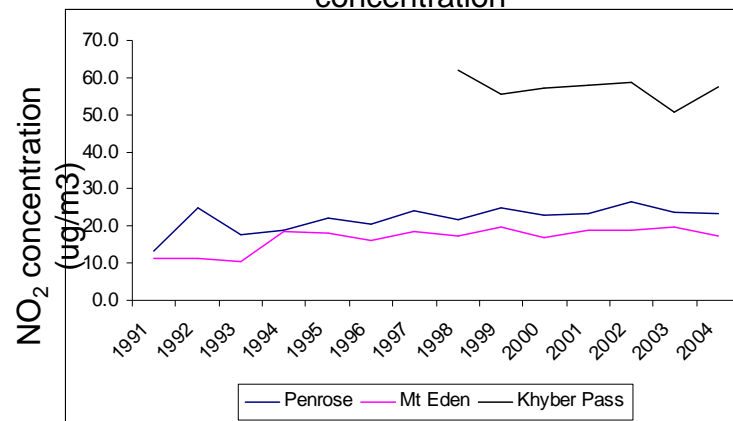
POLLUTION AND HEALTH

Where does it come from?

Nitrogen dioxide is produced by burning fossil fuels, e.g. road vehicles, power generation and industrial processes. Indoor sources include gas cookers, other unflued gas appliances and cigarette smoke.



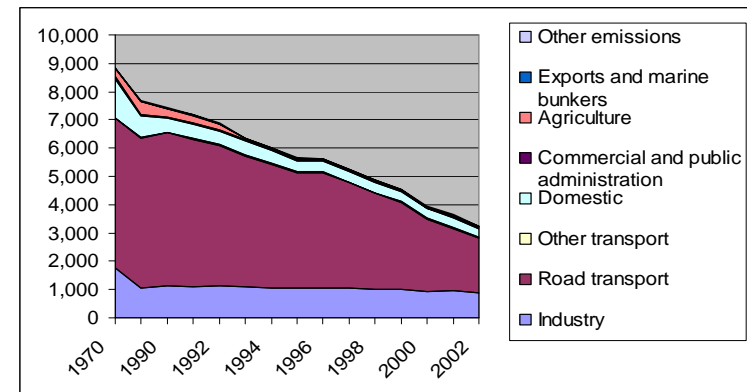
Annual average NO₂ concentration



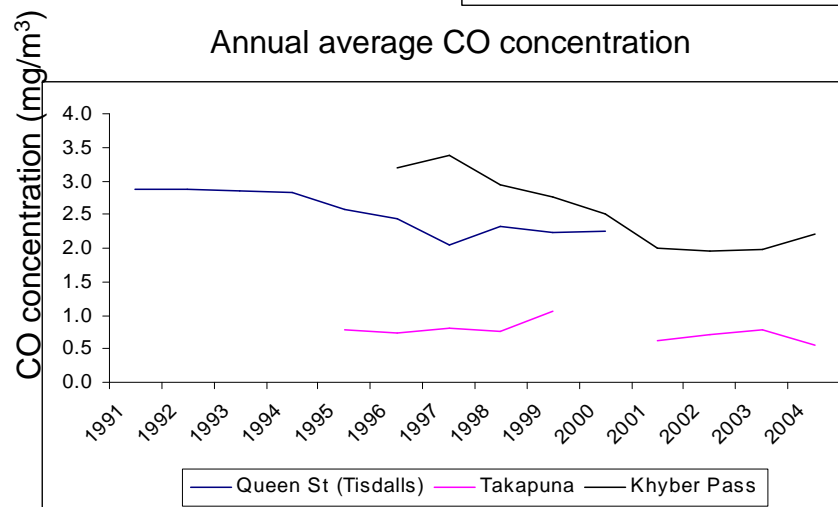
POLLUTION AND HEALTH

Where does it come from?

Carbon monoxide is produced by the incomplete combustion of carbon containing fuels, such as wood, coal and oil. The main sources which affect human health are smoking, car exhausts and heating / cooking appliances.



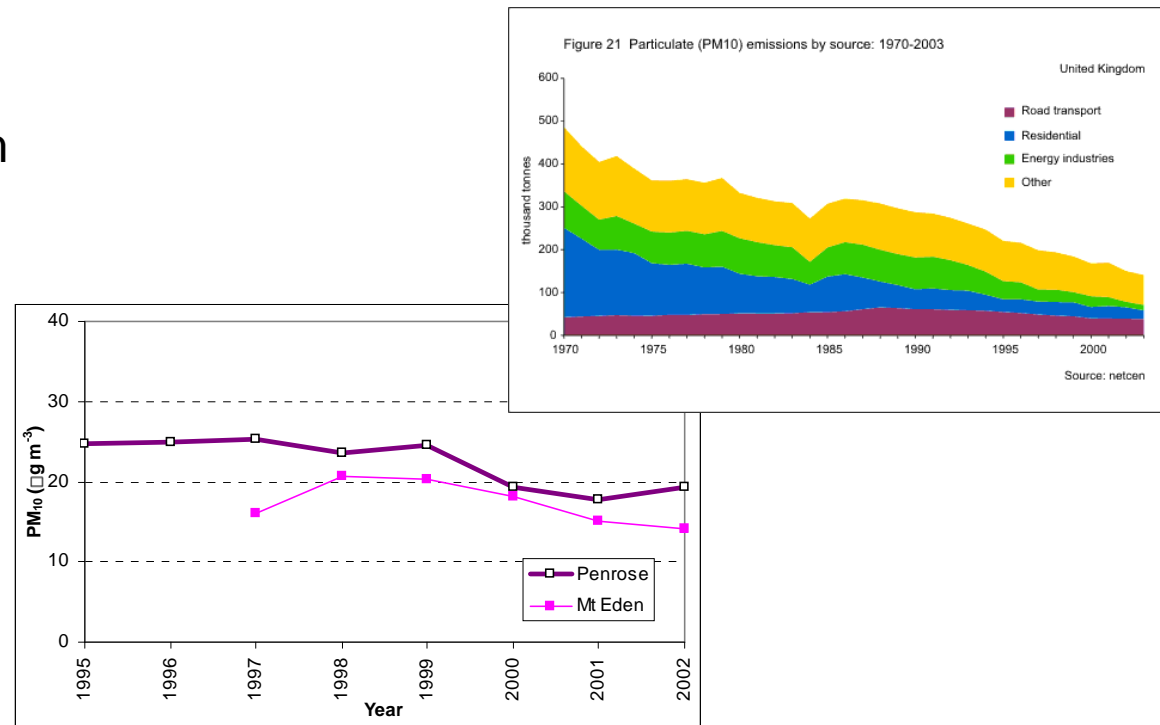
Annual average CO concentration



POLLUTION AND HEALTH

Where does it come from?

Particulates (PM10) are dispersed into the air from combustion processes, industry and natural activities such as the weathering of soils. They are also produced as 'secondary particles' by chemical reactions in the air.



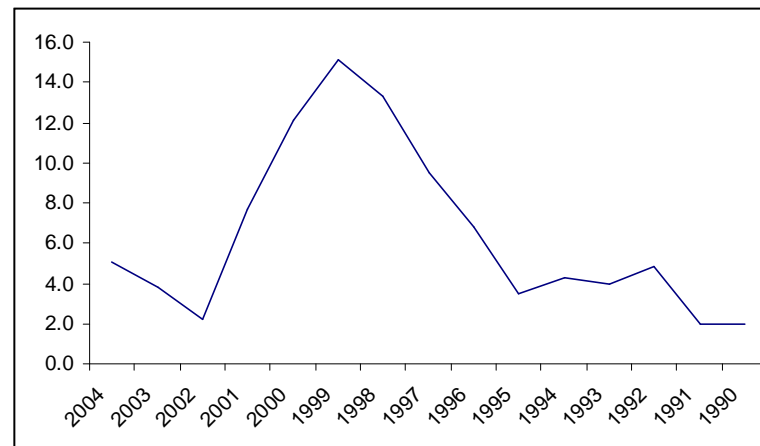
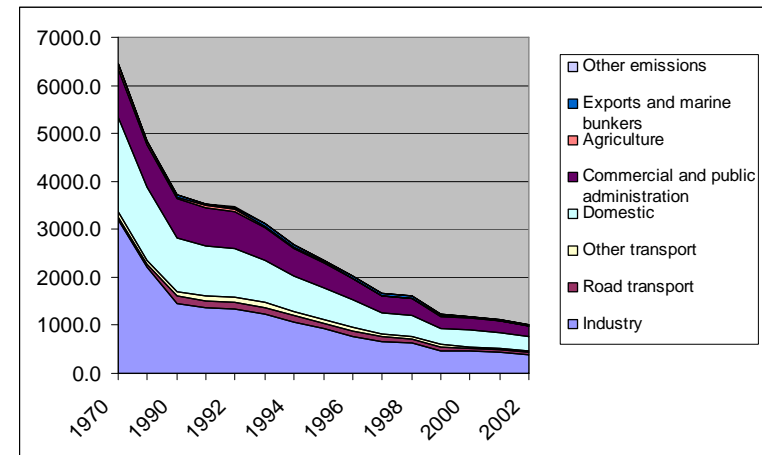
As a rule, particles produced from combustion and condensation tend to be 'fine' while those from mechanical processes tend to be 'coarse'.

POLLUTION AND HEALTH

Where does it come from?

Sulphur Dioxide is a colourless gas with a choking taste. It is produced by the burning of sulphur compounds which are a natural constituent of coal and oil.

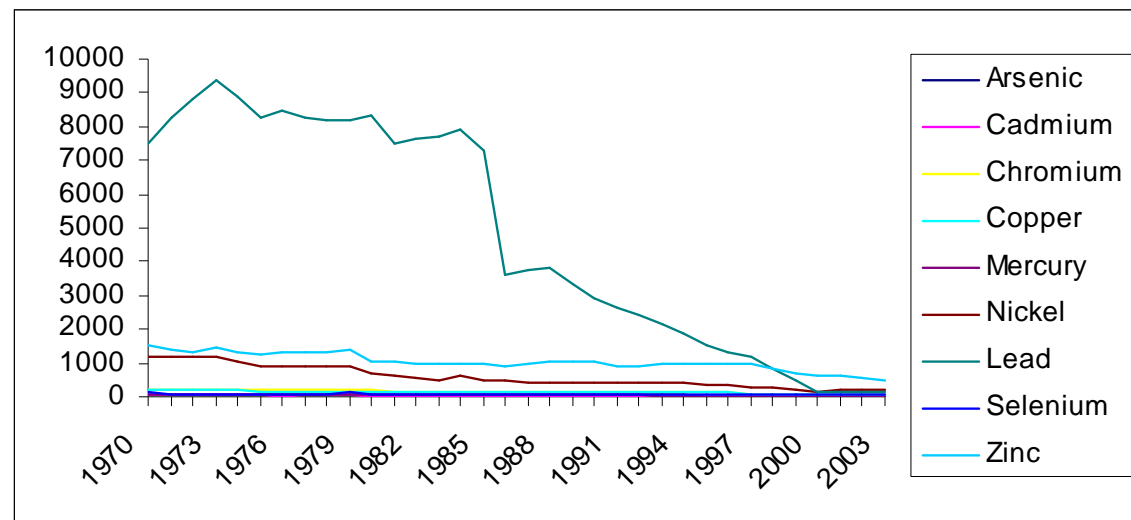
Major sources include: fossil fuel combustion, smelting, manufacture of sulphuric acid, conversion of wood pulp to paper and the incineration of refuse.



POLLUTION AND HEALTH

Where does it come from?

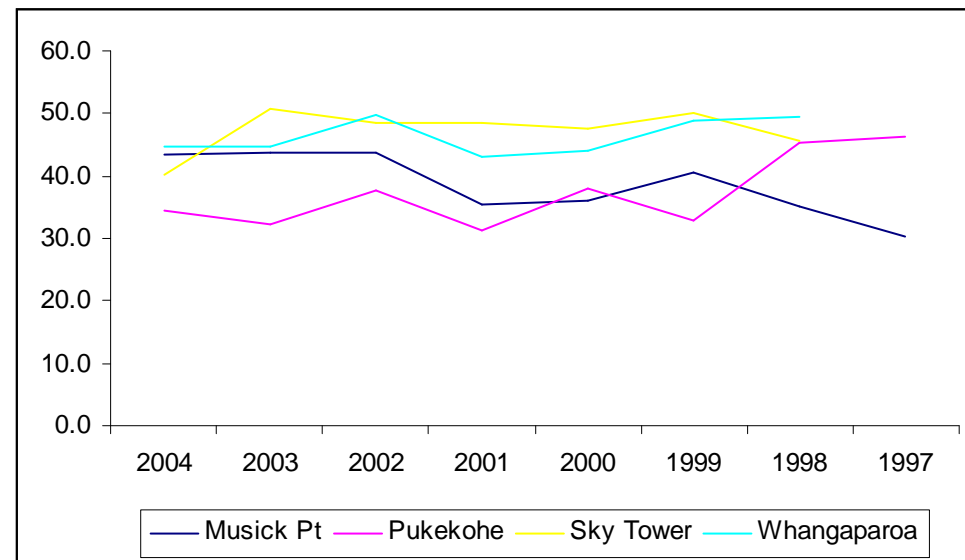
Lead is emitted into the air from industries and from old cars which are unable to use unleaded petrol.



POLLUTION AND HEALTH

Where does it come from?

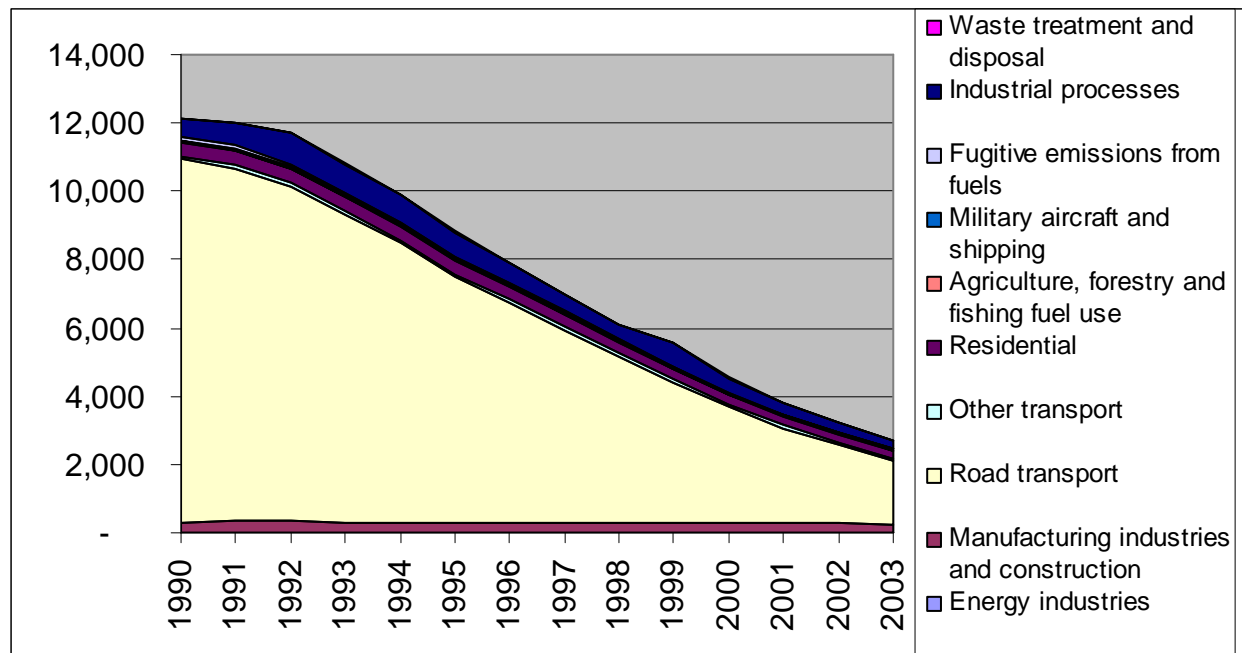
Ozone is a 'secondary pollutant'. It is produced as a result of chemical reactions between nitrogen oxides and hydrocarbons, in the presence of sunlight. These reactions occur over a period of some hours, and elevated ozone concentrations are frequently found away from the original source of nitrogen oxides.



POLLUTION AND HEALTH

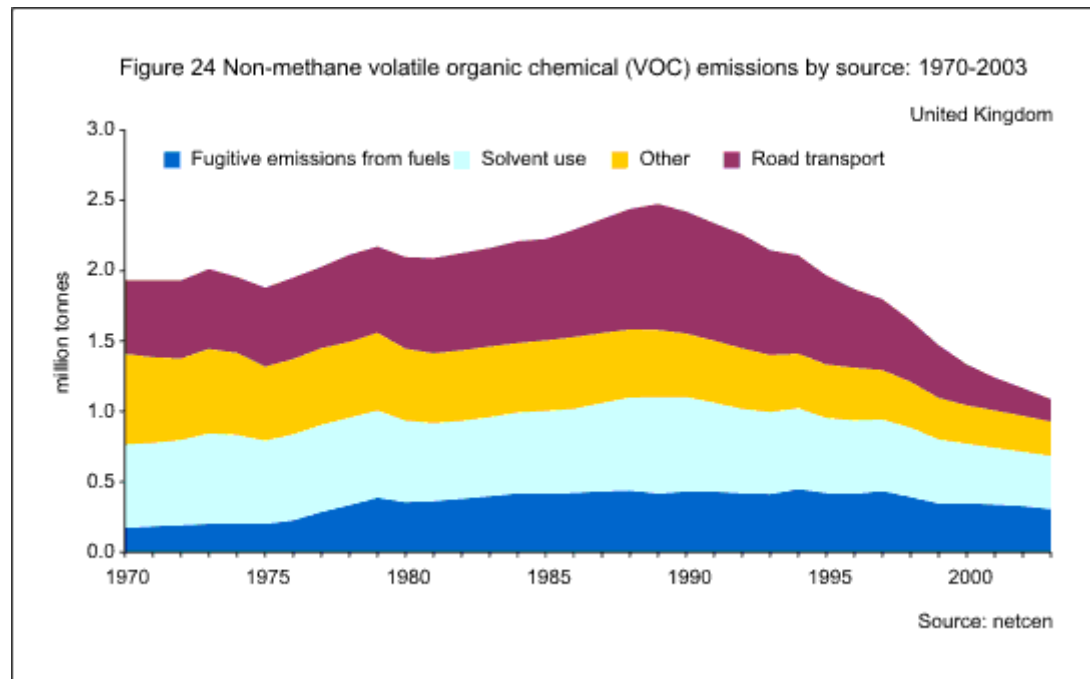
Where does it come from?

1,3-Butadiene is formed during the combustion of petrol and diesel. It is also used in some industries - mainly the manufacture of synthetic rubber tyres.



POLLUTION AND HEALTH

Where does it come from?



POLLUTION AND HEALTH

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4. Effects on health

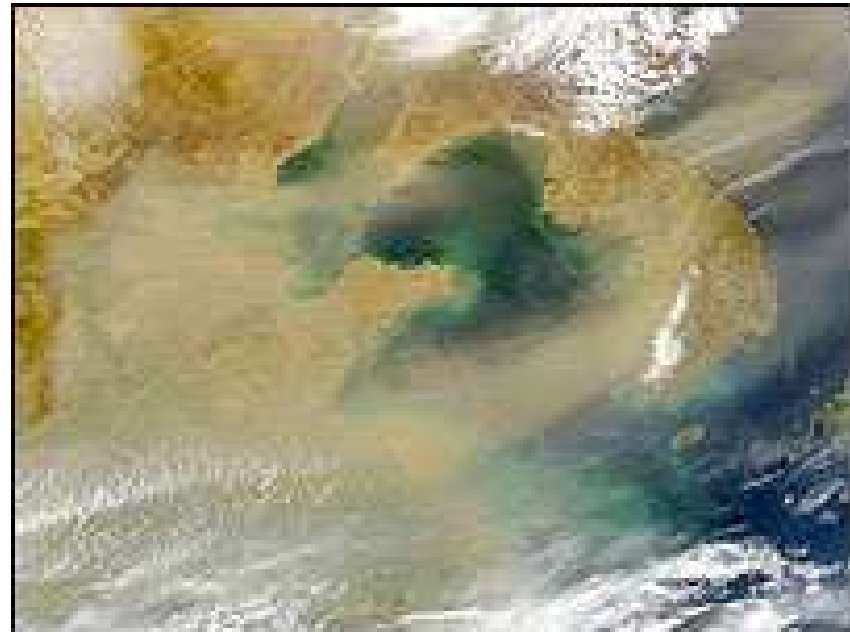
POLLUTION AND HEALTH

How is it transported?

How far? Short or long range

Gasses – globally
depends on residence time

Particulates – globally
Saharan dust found in US
Lead from Roman workings in Greenland ice cores
Lead from industrial revolution in Antarctic ice cores



Dust from China blows across the Korean peninsula

POLLUTION AND HEALTH

How is it transported?

Atmospheric mixing times,

two weeks from ground to Tropopause,

three months from pole to tropic

one year between hemispheres.

POLLUTION AND HEALTH

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POLLUTION AND HEALTH

Effects on health

Less Serious
reversible
not debilitating
not life-threatening



More Serious
irreversible
debilitating
life-threatening



POLLUTION AND HEALTH

Effects on health

Research into air pollution effects has tended to concentrate on two things

- the effect on people of short pollution “episodes” when levels are very high (acute effects),
- the effects of long term exposure to pollution, such as living in a polluted city (chronic effects).

POLLUTION AND HEALTH

Effects on health

Acute effects may cause up to 24,000 premature deaths each year in the UK.

Around half of these are a result of ground level ozone.

The majority of these deaths will be among people who are already very ill, and it is not possible to calculate how “premature” they are.

Recent research has focussed more on chronic effects, and while precise figures are difficult to obtain, it is thought that the impact of chronic exposure is many times more than acute exposure.

POLLUTION AND HEALTH

Effects on health



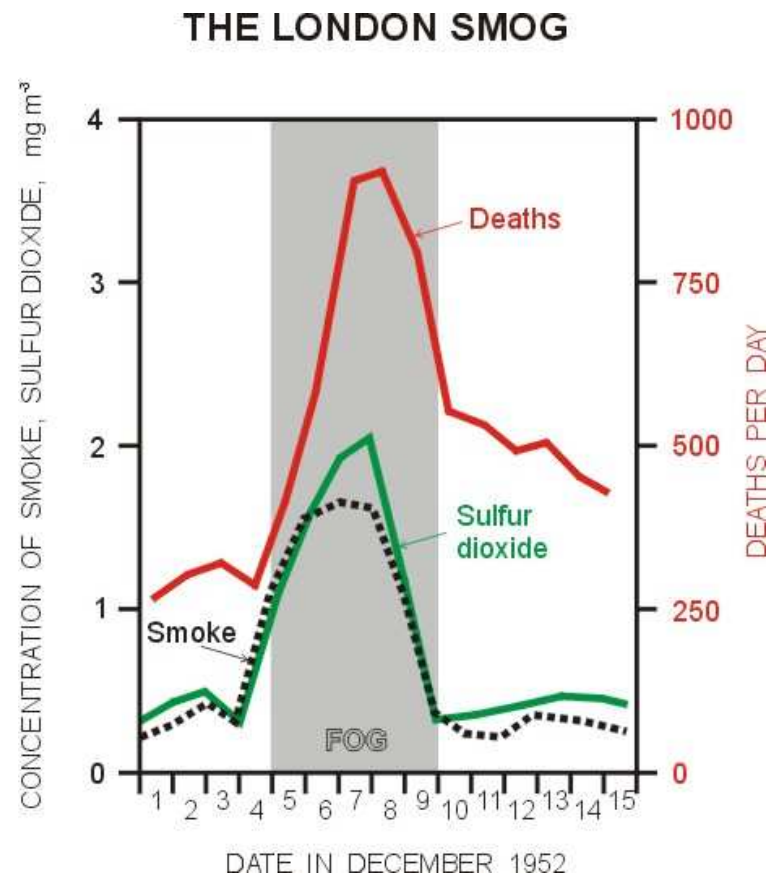
During the early hours of 3 December 1984 the world's worst industrial accident unfolded in the Indian city of Bhopal.

Poisonous gas escaped from a chemical plant and killed 3,000 people, according to official estimates. Other estimates put the number at between 8,000 and 10,000.

Around 50,000 suffered permanent disabilities, and more died later.

POLLUTION AND HEALTH

Effects on health



POLLUTION AND HEALTH

Effects on health

Benzene

Benzene is known to be a human carcinogen and is particularly linked to leukaemia.

Benzene is highly poisonous with serious acute and chronic effects.

Exposure to high levels or persistent exposure can cause anaemia.

Benzene has a cumulative effect and repeated exposure can cause mounting damage.

POLLUTION AND HEALTH

Effects on health

1,3-Butadiene

damages the genetic structure of cells and can cause cancer.

POLLUTION AND HEALTH

Effects on health

Carbon monoxide

acts by combining with the haemoglobin in red blood cells reducing the oxygen carrying capacity of the blood.

When oxygen is displaced by carbon monoxide, it can progressively lead to oxygen starvation.

The escalating symptoms of carbon monoxide poisoning are headache and vomiting and in severe cases collapse and death.

POLLUTION AND HEALTH

Effects on health

Lead

is a cumulative poison and in sufficient amounts can cause severe damage - particularly to the central nervous system.

Research indicates that lead exposure may damage children's learning abilities and affect their concentration.

POLLUTION AND HEALTH

Effects on health

Nitrogen dioxide

has a number of adverse health effects, including throat and eye irritation.

It is not normally present in sufficient amounts to have serious effects.

POLLUTION AND HEALTH

Effects on health

Ozone

can cause runny eyes, throat irritation and some breathing difficulties at fairly low levels. It can also reduce the resistance of the lung to disease.

Sensitivity to allergens may also be increased, and there is some evidence to suggest that asthmatics are more sensitive to the effects of ozone than other members of the public.

It is possible that the inflammatory response produced by exposure to ozone may last longer in asthmatics than in other people.

POLLUTION AND HEALTH

Effects on health

Particulates

health impacts vary according to the size of the particle.

Larger particles are trapped by the body's own defence system.

Smaller particles are more hazardous, because they can penetrate deeper into the lung tissue – Miner's lung

Particles can irritate the eyes, nose and throat.

POLLUTION AND HEALTH

Effects on health

Sulphur dioxide

High concentrations of sulphur dioxide can cause respiratory problems, particularly in sensitive individuals such as asthmatics.

Sulphur dioxide can also affect plants, causing damage to leaves and needles. Stems and buds are more resistant to harmful effects.

As sulphur dioxide is acidic it corrodes stonework and other materials.



POLLUTION AND HEALTH

Effects on health

Some people are more sensitive than others to these pollutants, particularly

children,
elderly people,
pregnant women and their unborn children,
people with heart problems,
asthmatics and
smokers.

The effects also depend on exposure time: in a town, people who work outdoors have more exposure than those who work inside.

POLLUTION AND HEALTH

Effects on health

Londoners are more likely to die from traffic pollution than in a road accident

380 deaths a year linked to air pollution from transport in the capital
-150 more than die in road accidents.

transport-related pollution puts another 1,200 people in hospital every year.

Minor breathing problems due to exhaust fumes could affect as many as half a million.

POLLUTION AND HEALTH

Effects on health

New Zealanders are just as likely to die from traffic pollution than in a road accident

400 deaths a year linked to air pollution – same as die in road accidents.

Country	Population (million)	Traffic accident deaths (A)	Mortality due to traffic air pollution (B)	Ratio B/A
France	58.3	8,919	17,629	2.0
Austria	8.1	963	2,411	2.5
Switzerland	7.1	597	1,762	3.0
New Zealand	3.7	502	399	0.8

Table 5-1. Air pollution mortality (for adults ≥ 30 years) and the road toll (1996).

POLLUTION AND HEALTH

Effects on health

	Due to Total PM ₁₀	Due to Vehicle related PM ₁₀
Auckland	436 (264-619)	253 (153-359)
Wellington	79 (48-112)	56 (34-80)
Christchurch	182 (110-259)	41 (25-58)
Dunedin	48 (29-69)	6 (3-8)
Rest of North Island**	133 (81-189)	21 (13-30)
Rest of South Island**	80 (48-114)	19 (12-27)
All of New Zealand**	970 (586-1376)	399 (241-566)

*Threshold PM₁₀ for mortality effect 7.5 µg m⁻³

**Places with more than 5,000 people

POLLUTION AND HEALTH

Effects on health

The economic argument

Effect	Domestic	Industrial	Vehicle	Total
Mortality	\$93.0M	\$13.5M	\$12.0M	\$118.5M
Cancer	\$0.8M	\$0.2M	\$0.2M	\$1.2M
Chronic bronchitis	\$2.7M	\$0.7M	\$0.6M	\$4.0M
Admission - cardio-vascular	\$0.1M	\$0.05M	\$0.05M	\$0.2M
Admission - respiratory	\$0.4M	\$0.1M	\$0.1M	\$0.6M
Restricted activity days	\$30.0M	\$7.0M	\$6.0M	\$43.0M
Minor hospital costs	\$0.15M	\$0.03M	\$0.02M	\$0.2M
Total	\$127M	\$22M	\$19M	\$168M

Table 11-7. Summary valuation of health effects of PM₁₀ pollution in Christchurch.

POLLUTION AND HEALTH

Air Pollution Bandings

Banding	Index	Health Descriptor
Low	1	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants
	2	
	3	
Moderate	4	Mild effects, unlikely to require action, may be noticed amongst sensitive individuals.
	5	
	6	
High	7	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their 'reliever' inhaler is likely to reverse the effects on the lung.
	8	
	9	
Very High	10	The effects on sensitive individuals described for 'High' levels of pollution may worsen.