

An impressionist painting of a city street scene, likely London, with a boat in the water. The scene is characterized by soft, blended colors of blue, purple, and pink, suggesting a hazy or overcast day. The brushstrokes are visible and textured, typical of the Impressionist style. The overall mood is atmospheric and somewhat somber.

Air Pollution Challenges in Cities and Contribution from Mobile Sources

ICCT TRUE Workshop, London
7-8th June

David Carslaw

University of York

Ricardo Energy & Environment

Outline of talk

- Brief historical perspective
- Current day issues and concerns
- Looking to the future

Looking back ...

- Some interesting LANCET articles from early 1900s
- THE PETROL HAZE OF THE STREETS published in 1913 discusses London
- Many more interesting articles from around that time

Annotations.

"Ne quid nimis."

THE PETROL HAZE OF THE STREETS.

ATTENTION may be drawn to the increasing murkiness of the atmosphere of the streets arising from the incomplete burning of the petrol in the motor engine. As most of the vehicles in the metropolis are now propelled by motor, the nuisance is rapidly increasing, and it will do so until the facilities of combustion in the motor engine are improved. In stagnant conditions of weather, as on a fine sunny day or during a windless drizzle of rain, quite a haze of petrol fumes accumulates, which is very unpleasant to the pedestrian. Such an atmosphere is, of course, inimical to healthy conditions. Unburnt petrol or partially burnt oil is frequently present in notable quantity, which is not favourable to healthy respiration, and a suspicion has been entertained that the presence of so much oil in the air disturbs the protective qualities of paint. Modern traffic has, in fact, introduced a totally new condition of things in regard to the state of the air in the streets, and it will not be surprising if in the long run mischief in more than one direction comes to be traced to the acrid fumes which are accompanying the motor traffic. We anticipated some years ago that the contamination of the streets would pass from a purely physiological kind to one of a chemical nature as we discontinued horse traffic in favour of motor traffic. That has practically come to pass. We have to deal now with the products of the imperfect combustion of a hydrocarbon, whereas formerly the offences of street traffic arose mainly out of animal products. To an extent this latter pollution was dealt with satisfactorily by our sanitary authorities, but little success appears to have attended any attempt to suppress the production of motor fumes. It is, at all events, common enough to see motor vehicles discharging into the streets from their exhaust tube a succession of rapid puffs of smoke with an evil smell. In the case of modern motor traffic the remedy lies in prevention by the perfection of the machine, or in the retention of a driver qualified to control the working of his combustion engine. In the case of horse traffic the evil could not be prevented, but the best measures were taken to minimise it. From a chemical point of view it would not be surprising if analyses of the air of London streets came to show in terms of carbonic acid gas, hydrocarbons, and probably carbon monoxide, a much worse state of affairs than existed when the horse was exclusively used for vehicular traffic. Improvements have, however, manifestly been made during the past few years in the engines of the motor-car, and we may hope that soon they will be rendered practically fumeless, which will imply a more economical use of fuel in addition to the suppression of an obvious nuisance.

sequence was the late Sir Jonathan Hutchinson, and some 30 cases are now on record. In Mr. Pye-Smith's case the patient was a woman, aged 29, who had been treated for psoriasis from the age of 7 to 14. No ill-effects were apparently observed until eight years later, when a condition of hyperkeratosis developed, with warty growths scattered over the skin. The first appearance of epithelioma was on the finger where the patient constantly wore her wedding ring, this possibly acting as a local irritant. Later on, malignant ulcers developed on the neighbouring finger, on the pubes, and on the labia minora, this appearance of multiple growths being characteristic of the arsenical affection. In spite of operative removal death occurred, apparently from internal metastatic growths, about two years after the woman first came under medical treatment. The exact method of causation of the form of cancer associated with arsenic is not certain. A direct influence as a stimulant to epithelial growth is possible, the element acting as what Mr. H. C. Ross has termed an auxetic or producer of cell-division. More probably the process is indirect, the poison first tending to cause degeneration of the cells of the skin, and the products of their destruction constituting the stimulus to undue proliferation of epithelium. The clinical sequence would seem to be, first, hyperkeratosis or heaping up of the horny layer of the skin, then formation of fissures in the diseased epidermis, with subsequent invasion of these by parasitic bacteria. Ulcers are then formed, in the edges of which epithelioma develops. The use of arsenic for psoriasis is probably less general in these days than it was some years ago, but even now it is not uncommonly used for this affection and also for chorea over somewhat prolonged periods. New arsenical compounds have also been introduced, such as salvarsan and atoxyl, which may not be free from danger, though they are usually given in comparatively short courses. It is therefore well to bear in mind the possible ill-effects of arsenic and carefully to watch for the appearance of any signs of thickening of the skin, which should lead to immediate suspension of the drug. It is noteworthy that in Mr. Pye-Smith's case the onset of the skin affection was only noted many years after the treatment had been discontinued, a somewhat disquieting circumstance suggesting that even such a warning may come too late, and that the safer rule would be to avoid altogether the prolonged use of arsenic.

THE SOCIETY OF TROPICAL MEDICINE AND HYGIENE.

AT the recent election of officers and council of the Society of Tropical Medicine and Hygiene Sir R. Havelock Charles was elected president for the next two years, and Dr. F. M. Sandwith vice-president. The Society has been in negotiation with the Royal Society of Medicine with reference to the suggestion that it should become the Tropical Section of the latter body. We are now informed that the council of the Society of Tropical Medicine and Hygiene, after giving careful consideration to the matter,

The LANCET 1913

“We have to deal now with the products of the imperfect combustion of a hydrocarbon, whereas formerly the offences of the street traffic arose mainly out of animal products.”



The LANCET 1913

“Modern traffic has, in fact, introduced a totally new condition of things in regard to the state of the air in the streets, and it would not be surprising if in the long run mischief in more than one direction comes to be traced to the acrid fumes which are accompanying the motor traffic.”

The LANCET 1913

“Improvements, have however, manifestly been made during the past few years in the engines of the motor-car, and we may hope that soon they will be rendered practically fumeless, which will imply a more economical use of fuel in addition to the suppression of an obvious nuisance .”

So why are we still talking about this now?



- Same street today ... provides a clue

Trends in emission sources since the early 1900s

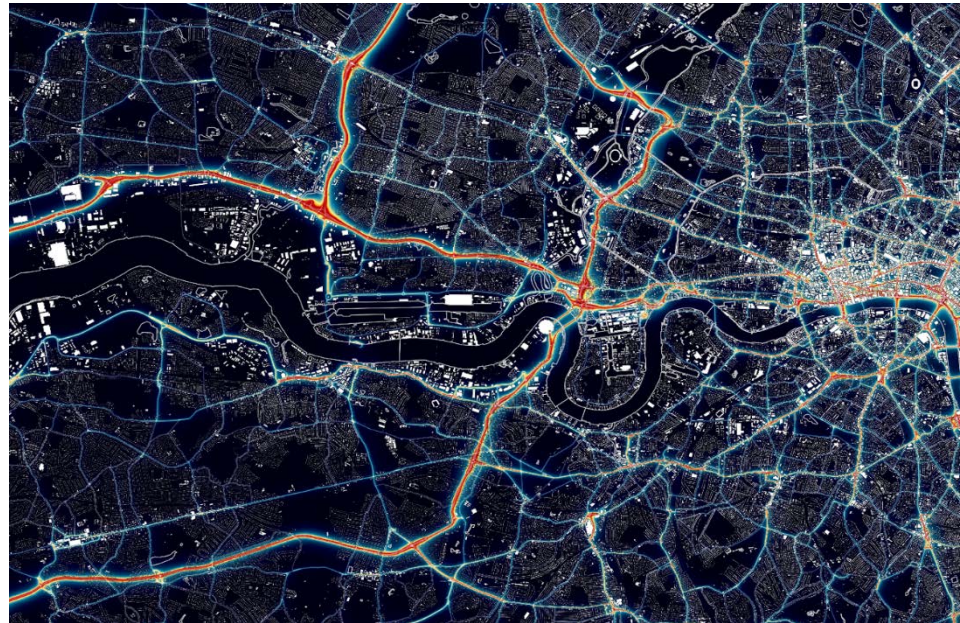
- In general:
 - Reduction in solid fuel use (coal / wood) for domestic heating and cooking
 - Power generation has moved out of cities
 - Fuel switching to cleaner fuels such as natural gas

- And at the same time ...
 - Enormous growth in the use of motor vehicles
 - Growth in population of cities; emergence of 'mega cities'

- Vehicle emissions have become more important both in a relative and absolute way

Characteristics of mobile source emissions

- Emitted for maximum impact
 - At ground-level
 - In close proximity to city populations
 - A source that is 24-7
 - Multi-pollutant, multi-impact
- Relatively more important per unit emission emitted than most other source types
 - Mobile emissions may not always be the largest emission sector but can be highest in terms of ambient concentration ... and exposure



Not all cities are equal

- There is enormous variation in size and geography
 - Many ‘mega cities’ affected by location e.g. bounded by mountain ranges, have strong inversions that results in poor dispersion, and
 - Enhanced photochemistry
- Major differences in vehicle fleets
 - The pollutants of most concern vary
 - Vehicle age distributions and technologies used
 - The rise of diesel fuel use in Europe
 - Vehicle maintenance procedures (or lack of)
 - The balance of the importance of passenger cars / two wheelers / trucks / urban buses

A wider perspective

- Emissions in cities do not just affect cities
- In cities we have been mostly concerned with primary emissions such as CO, hydrocarbons, particulate matter, NO_x (NO₂)
- Through dispersion and atmospheric chemistry, emissions in cities make important contributions to:
 - Formation of secondary particulate – probably the biggest direct or indirect impact of NO_x emissions
 - Formation of ground-level ozone (NO_x and VOCs)
 - Acidification and Eutrophication
 - Have impacts at a regional scale (1000s km) and therefore a need for international action

Looking ahead

- Exhaust emissions of most pollutants are being reduced, even taking account of traffic growth, but ...
- Non-exhaust particulate matter from brakes, tyres, re-suspension becoming increasingly important
 - Emissions of toxic metals
 - Difficult to control, difficult to measure
 - Not solved by 'zero emission' electric vehicles
- Watch out for other impacts e.g. heavy hydrocarbons (primary and secondary aerosol / ozone), other species such as ammonia
- Take the wider view again – consider life or fuel cycle impacts as energy systems change

A tricky source to quantify robustly

- There are > 35 million road vehicles in the UK alone
- Mobile sources...
 - Use different fuels
 - Are different ages
 - Cover a wide range of increasingly complex technologies
 - Are driven differently
 - Move around in space and time
 - Emit a wide range of important pollutants
 - Release their emissions at ground-level
 - ... and so on
- Can be much harder to quantify compared with other source sectors – **so how best to quantify the emissions?**

Remote sensing is one important approach



Early 'remote sensing' measurements at the Warren Spring Laboratory (predecessor to Ricardo Energy & Environment) from the early 1960s