AIR QUALITY IN LONDON AND TOKYO: A COMPARISON

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INTRODUCTION

London and Tokyo are two of the world's larger capital cities, and have many common features.. They both have well-developed public transport systems and the majority of people use them to travel to work [1]. However, there are also significant differences. London lies at 51º 30' north (equivalent to the centre of Sakhalin Island, to the north of Japan) whilst Tokyo lies some 1,100 miles closer to the equator at 35º 40' (which is equivalent to Crete in Europe).

London is a much older city than Tokyo, having developed over 2,000 years from its Roman foundations. The city grew concentrically, absorbing existing towns, until the 1950s when further outward expansion was curtailed by the designation of the Metropolitan Green Belt [2]. The estimated population for 2003 is 7.41 million. Tokyo, on the other hand, was the insignificant small town of Edo until the shogun Tokugawa Ieyasu moved his government there in 1603. 8.34 million people live in the 23 wards (*ku* in Japanes) and 4.00 million in the Tama area to the west [3].

CONCERN ABOUT AIR POLLUTION

Smoke was recognised as a problem long before the great London smog of December 1952. In 1661 John Evelyn presented King Charles II with a treatise suggesting that smoke pollution would shorten the lives of people living in London. Various Acts were passed during the 19th century to control smoke nuisance and to limit emissions of other pollutants. Initially enforcement was by the police in both London and Tokyo, but powers were later transferred to the sanitary authorities. By the beginning of the twentieth century there had been some improvement, but in London there remained the problem of smoke from coal burning in houses.

Whilst thick winter fogs, or smogs [4], were common, it was not until the London fog of 5-8 December 1952 that serious action was taken to limit smoke emissions from all sources. It was subsequently estimated that between 3,500 and 4,000 more people had died than would have been expected under normal conditions [5]. This event led directly to the passing of the Clean Air Act 1956. Extended in 1968 and consolidated with other legislation in 1993, the Clean Air Act is still the primary legislation limiting smoke pollution from domestic fires as well as sources not covered by other legislation. The improvements achieved are shown in Figure 1.

In Tokyo, the police began to regulate boilers in 1877. In 1912, after many years of lobbying, the government passed the Factory Law. The law enabled government personnel to inspect factories and, although the law did not expressly include pollution control as one of the aims of inspection, this was done under the rubric of protecting the public. In 1927 Tokyo began measurements of particulate matter.

Michio Hashimoto, in his *History of Air pollution Control in Japan* [6] , says that although these early efforts at air pollution control were largely ineffective, developments during the pre-war period enabled the formulation and implementation of strong pollution-control policies two decades later. Local initiatives provided the first programmes of pollution control and compensation upon which later programmes were modelled. The pre-war period saw the establishment of a network of national and local hygiene laboratories, and the education system produced a pool of talented bureaucrats and technicians equipped to deal with the complex issues of pollution control. This provided the basis for the first true pollution-control legislation which was the Factory Pollution Control Ordinance introduced by Tokyo Metropolitan Government in 1949.

Five years after the end of the war, Tokyo was on its way toward a positive recovery. With the outbreak of the Korean War in June of 1950, Tokyo experienced a burst of new energy and a “special procurements boom” [3]. It was the prelude to Tokyo's characteristic suburbanization of the outer circle and industrialization of the central wards, in response to this rapid economic growth

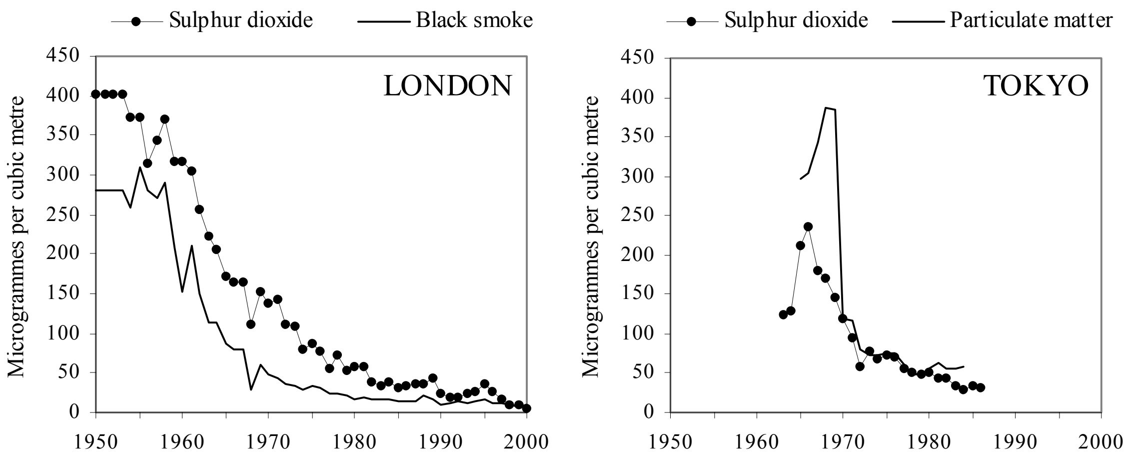

Figure 1 Trends in annual average SO_2, black smoke (London) and airborne particle matter (Tokyo) concentrations

Until 1961 economic growth in Tokyo was fuelled by coal, but from then on oil was the fuel of choice and coal use declined. In 1955 coal met 49.2% of energy needs and oil 19.2% but in 1965 coal was 27.3% and oil 68.0% [7]. Although the use of heavy fuel oil temporally increased SO_2 emissions and concentrations, the introduction of desulphurisation processes for heavy fuel oil reduced the concentrations drastically [8]. Monitoring data for Chiyoda ward (central Tokyo) shows SO_2 concentrations peaking in 1966 and airborne particle concentrations in 1968. Figure 1 shows trends in London and Tokyo.

A practical measure of pollution in Tokyo is how frequently Mt. Fuji can be seen. In 1689, Matsuo Bashō, the greatest of the Japanese *haiku* poets, wrote at the beginning of his journey to the Deep North, “The faint shadow of Mount Fuji and the cherry blossoms of Ueno and Yanaka were bidding me a last farewell”[9]. Records kept by Seikei High School show the minimum number of days when Mt. Fuji could be seen was 22 days in 1965, rising to an averaged of 70 between 1973 and 1993 [10].

ADMINISTRATION OF AIR QUALITY

The first step towards the present system of air pollution control in Japan was the enactment of the Soot and Smoke Control Law of 1962. Whilst this law helped to reduce dust levels, it failed to halt the worsening air pollution from sulphur dioxide because of the construction of new industrial and chemical plants. The Basic Law for Pollution Control was enacted in 1968 and provided a much broader basis for pollution control, including the establishment of Environmental Quality Standards, but it was still inadequate to achieve major improvements..

The Japan Environment Agency was established in 1971 as the national agency in charge of the environment including air pollution control. It did not become a full Ministry until 2000. In Tokyo the Metropolitan Government established an Urban Pollution Division and in 1969 it passed the Tokyo Metropolitan Environmental Pollution Control Ordinance in order to strengthen what was seen as inadequate national regulation.

In the UK, the Alkali Act 1874 required the adoption of the 'best practical means' to prevent the release of noxious and offensive gases. The Act also introduced emission limits for the first time. The Alkali Inspectorate was set up to implement the Act, and remained in operation until 1983 when it became Her Majesty's Industrial Air Pollution Inspectorate. In 1987, it was absorbed into the unified HM Inspectorate of Pollution, which was itself absorbed into the much larger Environment Agency in 1996. Today, the Environment Agency regulates the larger and more hazardous industrial processes whereas the smaller processes are regulated by local authorities.

AMBIENT AIR QUALITY STANDARDS

The 2002 OECD *Environmental Performance Review: Japan* [11] comments "Japan's national environmental quality standards (EQS) for air are in general stricter than those of the European Union and the United States, although the parameters (e.g. measurement methods, averaging times) of Japan's standards often differ from those used in other OECD countries, making direct comparison difficult." Table 1 lists the standards that apply in Tokyo and London. In Japan the Standards were first established under the Basic Law for Pollution Control in 1968.

It was nearly 30 years before the UK adopted its first ambient air quality standards. The Environment Act 1995 required the government, for the first time, to produce a national air quality strategy containing standards, and measures to achieve them. This was first published in 1997. The standards and objectives are derived from the EU Air Quality Framework Directive and the daughter Directives, which identify twelve pollutants for which limit or target values will be set [12].

CURRENT AIR QUALITY

Figure 2 below compares annual average air pollutant concentrations at background sites in the centres of London and Tokyo over the past ten years. In most cases concentrations in London are declining, but in the case of ozone, concentrations are slowly increasing. Whilst London may possibly meet the current PM_{10} standard of 40 $\mu g/m^3$, on current trends it is unlikely to meet the more stringent objective of 23 $\mu g/m^3$ set for 31 December 2010. Similarly, London will fail to meet the NO_2 target of 40 $\mu g/m^3$ set by the UK for 31 December 2005 and by the EU for 1 January 2010.

	Tokyo		London	
	Parameter	**Limit value**	**Parameter**	**Limit value**
Sulphur dioxide (SO_2)	Hourly values	0.1 ppm (266 µg/m³)	15-minute mean, not to be exceeded more than 35 times a year by 31 December 2005	266 µg/m³ (0.1ppm)
	Daily average of hourly values	0.04 ppm (106 µg/m³)	1-hour mean, not to be exceeded more than 24 times a year by 31 December 2004	350 µg/m³ (0.132 ppm)
			24-hour mean, not to be exceeded more than 3 times a year by 31 December 2004	125 µg/m³ (0.047ppm)
Carbon monoxide (CO)	Average hourly value in 8 consecutive hours	20 ppm	Running 8-hour mean	10 mg/m³ (8.6 ppm)
	Daily average of hourly values	10 ppm		
Particulate matter less than 10 microns in diameter (PM_{10})	Hourly values	200 µg/m³	24-hour mean, not to be exceeded more than 35 times a year by 31 December 2004	50 µg/m³
	Daily average of hourly values	100 µg/m³	24-hour mean, not to be exceeded more than 10 times a year by 31 December 2010	50 µg/m³
			Annual mean by 31 December 2004	40 µg/m³
			Annual mean by 31 December 2010	23 µg/m³
Nitrogen dioxide (NO_2)	Daily average of hourly values	0.04-0.06 ppm (76-115 µg/m³)	1-hour mean, not to be exceeded more than 18 times a year by 31 December 2005	200 µg/m³ (0.105ppm)
			Annual mean by 31 December 2005	40 µg/m³ (0.021ppm)
Photochemical oxidants *	Hourly values	0.06 ppm (120 µg/m³)		
Ozone			Daily maximum of a running 8-hour mean by 31 December 2005	100 µg/m³ (0.05ppm)
Lead			Annual mean by 31 December 2004	0.5 µg/m³
			Annual mean by 31 December 2008	0.25 µg/m³
Benzene	Annual average	3 µg/m³	Running annual average	16.25 µg/m³
			Annual average by 31 December 2010	5 µg/m³
1,3 -Butadiene			Running annual average	2.25 µg/m³
Trichloroethylene	Annual average	200 µg/m³		
Tetrachloroethylene	Annual average	200 µg/m³		
Dichloromethane	Annual average	150 µg/m³		
Dioxins	Annual average	0.6 pg-TEQ/m³		
Polycyclic aromatic hydrocarbons			Annual average by 31 December 2010	0.25 ng/m³

* In Japan, photochemical oxidants are oxidizing substances such as ozone and peroxiacetyl nitrate produced by photochemical reactions (only those capable of isolating iodine from neutral potassium iodide , excluding nitrogen dioxide).

Table 1 Ambient air quality standards in Tokyo and London

Trends are similar in London and Tokyo, but concentrations are significantly different in some cases. PM_{10} is higher in Tokyo, which may be the effect of secondary aerosols as well as the differences between TEOM measurements in London and beta-ray method used in Tokyo. Higher ozone in Tokyo is likely to be the result of climatic differences. Higher carbon monoxide is probably the result of a higher proportion of cars, taxis and vans having petrol and liquid petroleum gas (LPG) engines than in London. SO_2 concentrations are similar in the two cities.

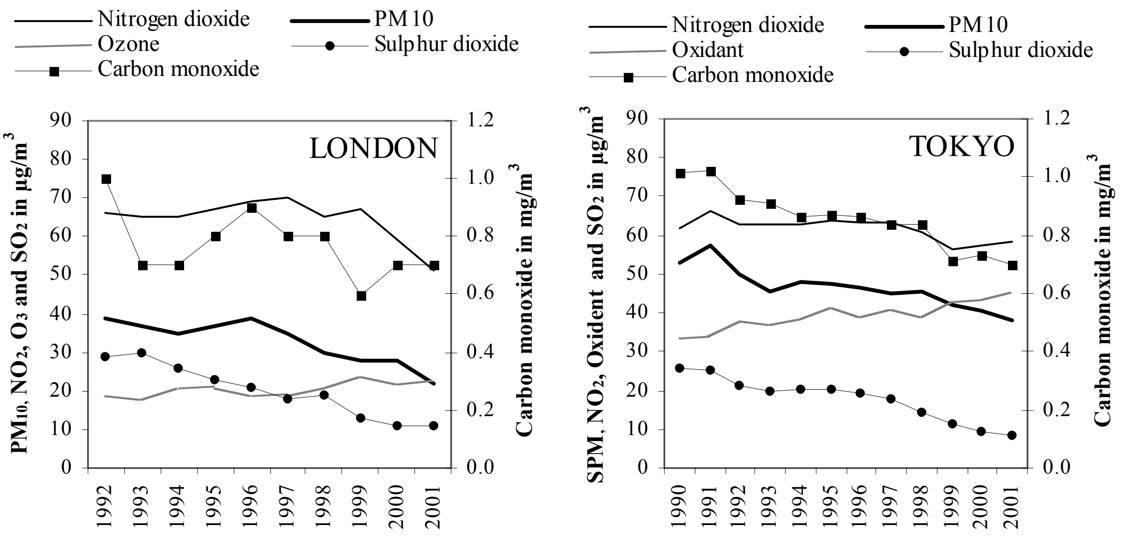

Figure 2 Annual average background air pollutant concentrations in London and Tokyo

POLICIES TO COMBAT AIR POLLUTION

In London in 2001, road traffic was responsible for an estimated 55% of NO_X and PM_{10} emissions. In Tokyo traffic was estimated to contribute 56% of NO_X and 52% of PM_{10} in 2000. As the percentages of air pollutants coming from vehicles are so high, it is hardly surprising that both cities are paying a lot of attention to ways of reducing emissions from road traffic.

When Tokyo Governor Shintaro Ishihare was elected in 1999 he vowed to "oust" dirty diesel vehicles from Tokyo roads. Diesel powered trucks and buses were seen as being responsible for much of Tokyo's air pollution problem. Whilst it was clearly impractical to remove all diesel vehicles from Tokyo streets, it rapidly became clear that action could be taken to significantly reduce emissions from these vehicles.

The Ordinance on Environmental Preservation came into force throughout Tokyo, Chiba, Saitama and Kanagawa on 1 October 2003 [13]. Under this Ordinance, all diesel trucks and buses must be fitted with a diesel particle filter within 7 years of their first registration. A vehicle that is more than 7 years old, and has not been retrofitted to meet current emission standards, cannot be driven in these areas. The same ordinance requires that, by the end of March 2006, businesses with more than 200 vehicles must have 5% of their fleet compliant with requirements for "ultra low pollution vehicles". That is vehicles fuelled by compressed natural gas (CNG), liquid petroleum gas (LPG), or compliant with the latest diesel vehicle regulations and fitted with a diesel particle filter. Initial results released by TMG showed a 49% reduction in elemental carbon in the Iogi Tunnel and 30% at the Osaka-bashi roadside monitoring site, as well as a 28-58% decrease in three kinds of carcinogen in the tunnel compared to conditions before the Ordinance came into effect [14].

As in Tokyo, a primary focus of policy in London is to reduce emissions from road traffic. For example, all London buses will have Euro II engines as a minimum, and particle traps, by the end of 2005. Following his election in 2000, the Mayor of London Ken Livingstone initiated a study into the feasibility of establishing a Low Emission Zones (LEZ). The study, completed in July 2003 [15], investigated schemes to restrict heavy vehicles unless they complied with a specified emissions limit. This could reduce both concentrations and the area of London that fails to meet the ambient air quality standards. Ken Livingstone was re-elected as Mayor in June 2004 and has pledged to introduce a London-wide LEZ by the end of 2007.

Tokyo has also been studying road pricing systems, and closely watching the results of the London Congestion Charging Scheme. Whilst this scheme has been effective in reducing congestion, and improving air quality in individual streets, the area is too small (1.8% of London) to have a major overall effect on London's air quality [16].

CONCLUSIONS

London and Tokyo lie on opposite sides of the globe but, nevertheless, there are notable similarities in their approaches to air quality management. The Mayor and Governor see the need for firm action to reduce emissions from diesel vehicles. Further comparative analysis could support the development of policy in both cities.

NOTES AND REFERENCES

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2 Clout, H; Wood, P. (eds.); *London: problems of change,* London: Longman, 1986.

3 For more information on Tokyo's history, population, geography and administration see: http://www.chijihon.metro.tokyo.jp/english/PROFILE/index.htm

4 The word 'smog' was first used by Dr Des Voeux in 1905 to describe the combination of smoke and natural fog that London used to experience.

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11 OECD *Environmental Perforamance Review: Japan*, Paris: OECD, 2002

12 See: http://www.defra.gov.uk/environment/airquality/index.htm#aqstrategy

13 See: http://www.kankyo.metro.tokyo.jp/kouhou/english2003/index.html

14 Press release from Tokyo Metropolitan Government, 19 December 2003, *"On the effects on air pollution improvement by diesels' regulation"*

15 Available at: http://www.london-lez.org

16 See: http://www.tfl.gov.uk/tfl/cclondon/cc_monitoring-2nd-report.shtml