ABSTRACT

Changes in the way the world produces and uses energy have become important for a number of compelling reasons, including the negative impacts of indoor, outdoor and transboundary air pollution on human health and the environment.

Modern energy services can help meet the basic human needs of nutrition, warmth, and lighting as well as reduce the burden of timeconsuming domestic labour – all of which also contribute to improvements in areas such as education and public health.

An effective environmental planning and management process will help decision makers to formulate and implement realistic and effective strategies and action plans to improve air quality. These strategies and action plans have to systematically address the short and long-term causes of urban air pollution and help the city to achieve a sustainable growth pattern.

Keywords: air pollution, emission, quality, transport, WHO

1 INTRODUCTION

On our planet, the air we breathe is one of the most important things around us. It is a vital natural resource on which all life depends. Clean air is something that we all need for good health and the well-being of humans, animals, and plants. Sadly, however, our atmosphere is being continuously polluted. Bad air quality affects human health as well as other environmental resources such as water, soil, and forests. Thus, air pollution also hampers development. Larger cities with highly concentrated industry, intensive transport networks and high population density are a major source of air pollution.

Many cities around the world, particularly in developing countries, are experiencing rapid growth. Yet, in the absence of adequate environmental policy and action, this growth is occurring at a considerable, and often increasing, economic and social cost. More people, more industry, and more motor vehicles cause ever-worsening air pollution which poses a serious environmental threat in many cities. The World Health Organization (WHO) and other international agencies have long identified urban air pollution as a critical public health problem. Many developing countries and emerging economies, for example China, Indonesia, and Mexico, have therefore included air pollution into their list of priority issues to be tackled.

Urban air pollution also has profound regional and global impacts. Urban emissions are major contributors to the problems of ozone layer depletion and ground level ozone, global warming and climate change (through CO₂ emissions).

Urban air pollution also causes respiratory disease and property damage. Meeting these challenges at the global level requires that the air quality in cities be monitored and improved.

The technical aspects of urban air pollution are well understood while the necessary technologies for improving air quality are available on a larger scale. Compared to earlier times, today's citizens are generally better informed about the kind of air pollution they are
exposed to and are increasingly unwilling to let the problem continue, let alone worsen. A growing political commitment to improve air quality can be observed in many cities. In order to convert these new attitudes into action, decision makers require a systematic approach to managing a city’s air quality that also deals with the complex and difficult issues connected to the problem.

2 URBAN OUTDOOR AIR POLLUTION

Almost half of the world’s population presently lives in urban areas (UNPD 2004). Energy is needed in cities for lighting, transportation, industrial processes, and various household uses (such as cooking, heating, cooling and ventilation). Along with urbanization comes an increase in the concentration of economic activities and, since these activities rely heavily on the combustion of fossil fuels, associated increase in outdoor air pollution and its negative impacts (Figure 1). In many regions of the world, outdoor air pollution problems are aggravated by rapid economic development and industrialization, and a lag in adopting pollution control strategies. Of the 800 000 premature deaths attributed to urban air pollution every year, about 65 per cent occur in the developing countries of Asia. Air pollution from transport and industry contributes to an increased risk of death from cardiopulmonary causes; increased risk of respiratory symptoms; an increased incidence of lung cancer in people with long-term exposure; and adverse outcomes in pregnancy, such as premature birth and low birth weight (Krzyzanowski and others 2005). As with indoor air pollution, the type of pollutant, intensity of exposure and the age and health of the individual exposed determine the severity of the impacts.

Figure 1: Urban air pollution has serious implications for human health and environmental quality; Source: Binsyo Yoshida/UNEP/Still Pictures
A growing body of evidence indicates that small particulates are associated with an increased mortality risk. Accordingly, attention has focused on exhaust from diesel engines, which contains finer particulates than gasoline. Moreover, these particulates contain polycyclic aromatic hydrocarbons (PAHs), which are potent carcinogens and mutagens. Although the impact increases with the exposure level, WHO guidelines have been revised to reflect that there is no safe level of particulates – they have negative health impacts on humans no matter how low the concentration in the atmosphere (WHO 2000). Trends towards higher levels of urban air pollution around the world have been addressed in the more developed economies by more efficient technology and pollution control policies. The level of development also influences the sources of pollution, the ambient levels and the ‘pollution mix’ in a particular urban area.

For example, in higher-income cities, air pollution is dominated by finer particles and photochemical smog – mainly from the transport sector. In lower income cities particulate matter, sulphur dioxide from coal and other fossil fuel burning, and suspended dust from disturbed land, unpaved roads and construction are more common (Molina and others 2004).

The level of development also determines the transport mix in a city. Poorer countries have fewer cars, but more two- and three-wheeled vehicles with dirtier two-stroke engines, and older fleets of vehicles with inefficient or badly maintained engines, and no or poorly functioning emission control devices. In richer countries, vehicle technologies are more efficient and less polluting, but the number of vehicles is higher. Urban planning – or lack thereof – can determine how well a city manages rising energy demands from transport and industry. Some cities are more services-oriented, while others may have a concentration of industries nearby, contributing to air pollution. Historic and social-cultural reasons often explain the differences – and often also determine factors such as the early creation of an underground transport system, or bicycle lanes to encourage more sustainable forms of transport. Investments in reliable public transport can help rein in urban pollution levels.

Geographical and demographic factors have an important role to play. For instance, the location of a city is an important factor (enclosed basin versus open plain; sea level versus high altitude where the lower level of oxygen affects combustion; latitude with corresponding differences in radiation levels for photochemical pollution). The size and shape of a city; meteorological and climate conditions (for instance, temperature, wind speed and the existence of thermal inversions); number of inhabitants per square kilometre (hence emission density); and the seasonal distribution of the emissions are also important.

3 LONG-RANGE TRANSPORT OF AIR POLLUTION

Long-range air pollution, sometimes referred to as transboundary air pollution, was recognized in the 1960s when scientists demonstrated the relationship between sulphur emissions in Europe and the acidification of Scandinavian lakes (UNECE 2005). Many studies have since confirmed that nitrogen, particulates, acidifying gases, heavy metals, and organic pollutants travel in the atmosphere for thousands of kilometers within and across national borders, interacting with each other and forming secondary pollutants before being deposited.

One of the defining early activities of European environmental regulation, under the United Nations Economic Commission for Europe (UNECE), was action on the sulphur emissions that contribute to acid rain. Since then, there have been other national and regional efforts to address long-range pollution.

Sulphur dioxide emissions in the region are projected to increase substantially (Figure 2). Data availability to monitor the trends is improving, as the Acid Deposition Monitoring Network East Asia (EANET), formed in 1998 by 12 countries, has a monitoring programme in place since 2003. As anthropogenic emissions of nitrogen increased, it also emerged that
the deposition of nitrogen compounds, including ammonia, causes problems such as eutrophication of freshwaters and marine and terrestrial ecosystems.

![Figure 2: Global emissions of sulphur dioxide and projections](image)

Improvements in emission standards of vehicles and in fuel quality have brought down urban air pollution levels in many developed countries. Tightening of vehicle emission standards have led to improvements of vehicle technology (such as the use of modern material for lighter cars, engine technology, end-of-pipe solutions such as catalytic converters and soot traps, and more recently, the development of ‘hybrid’ cars). In Europe, progressively stringent ‘Euro’ standards specify limits for vehicular emissions of CO, HC, NOx and particles. Euro 5 standards for personal cars and light duty vehicles were adopted in late 2005, and the more stringent Euro 6 standards for heavy duty vehicles are currently being discussed. These could result in a 50–90 per cent reduction for particulates and NOx in bigger vehicles, and up to a 40 per cent reduction in NOx emissions in personal cars (EEA 2005b). Acute urban air pollution problems are also leading to tougher measures in developing countries, including the adoption of vehicular standards (Figure 3).

![Figure 3: Emission standards for gasoline vehicles around the world, equivalent to Euro standards](image)
Further clarification of the city's air quality issues may require an analysis of the problems at different levels within the city. On the one hand, a clear understanding of issues resulting from individual industries or traffic sections, and how they impact their vicinity, may be required. On the other hand, clarification may be needed on the overall impact in the city by the various activities.

3.1 City / area-wide urban air quality problems

Transport is a main contributor to high concentration of pollutants in the atmosphere. In many cities, traffic, sometimes in combination with industrial air pollution, is responsible for smog. Cities are increasingly experiencing these problems. On hot summer days, the ozone level may exceed the norm and warnings are given. Emergency measures may be taken such as car bans on particular days. People with cancer and asthma, the elderly, and children may have to stay indoors during such times.

Air pollution in specific streets depends on the volume of traffic and on street construction factors, i.e., distance to houses, height of houses, and trees among others. Pollution can be calculated and, if possible, verified with random measurements and included in a city map.

3.2 Reducing vehicular pollution

Although technical measures alone are not sufficient to ensure the desired reduction of urban air pollution, they are an indispensable component for any cost effective strategy for limiting vehicle emissions. Fuel and the vehicle types have a great impact on air quality situations. This is especially true in many developing countries where the growth rate in private vehicle ownership is higher than in developed countries. Cities in developing countries also have large numbers of older vehicles that were cheaply imported and/or passed down the economic chain.

Overall strategies to reduce vehicular pollution may include:

- Vehicle inspection and maintenance (I&M)
  Inspection and maintenance programmes can successfully reduce emissions from old vehicles and ensure that new vehicles remain in good condition. Pollutants such as carbon monoxide (CO) and hydrocarbons (CnHn) of individual vehicles can be reduced by up to 25% through strict I&M programmes. These programmes accelerate the disposal of old and inefficient cars. However, these programmes may at times face financial, political and enforcement difficulties.

- Improving fuel quality
  Improving fuel quality in most developing countries involves the reduction of the contents of substances like sulfur and lead. Using more volatile diesel addresses the problem of black smoke from heavy diesel-powered vehicles, such as buses and trucks. Improving fuel quality should also involve the introduction of alternative fuels as, for example, compressed natural gas (CNG) which does not contain lead or sulfur, and TSP (total suspended particulate), and is lower in NOx, SO and CO than conventional fuel. Other options are bio fuels from crops, used cooking oils or bio gas from sewerage and waste.
  For example, Delhi, India, has converted its entire public transport fleet to CNG and operates the world-wide largest bus fleet (more than 1200 buses) on this alternative fuel. In a further step, all motor rickshaws and private taxis were converted to CNG. The result is that the traffic related air pollution could be
reduced considerably. The operating costs are lower than with conventional fuels due to lower fuel prices (India exploits their own natural gas deposits).

- Introducing new vehicle technologies
  New vehicle technologies are available and research is continuing. These include promoting the use of three-way catalysts that can reduce emissions up to 90% per vehicle or particulate filters for diesel vehicles. Other types of vehicles run on electricity and the first prototypes of fuel cell powered cars are under testing. But those only fill a small niche market. Hybrid technology will take an intermediary role before switching to new technologies, such as the hydrogen economy. Installing pollution control equipment like particle traps in vehicles or switching from two-stroke to four-stroke engines that allow the use of catalytic converters, help to reduce pollution.

4 CONCLUSION

Energy use, development, air pollution, human and ecosystem health are all inextricably interrelated. Access to energy is essential for development, but energy generated by the combustion of fossil fuels and biomass often results in air pollution, with negative impacts on human and ecosystem health. The impacts of indoor and urban outdoor air pollution warrant urgent action. The good news is that clean technology is now largely available to provide access to energy, without compromising public and ecosystem health.

To achieve a more sustainable energy future we need political will and leadership at national, regional and global levels; global cooperation, particularly on technology transfer; and economic resources.

Specific tools to control air pollution include standards, enforcement and monitoring. National and regional air quality standards are needed to establish tolerable levels of pollutants. Clearly defined national and regional targets related to air quality could help in ensuring progress.

Investments in scientific and technological research on indoor and outdoor pollution need scaling up. For instance, further work is needed to:

- develop reliable clean-burning biomass stoves using pellets, blowers, secondary combustion, and other means to use biomass cleanly;
- improve fuel quality;
- study the environmental impacts of using biodiesel and ethanol in transport; and
- understand the impacts of long-range transport of pollutants.

Finally, the present time is ripe for change, when we have seen peaks in extreme weather events and in energy prices. An increasing number of polices have already been adopted to support renewables, and many companies in the energy industry have recognized that the future is ‘beyond petroleum’. International cooperation promote research and development, mobilize investment and create markets for further work in this area.

REFERENCES


