ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA

# HARMONIZATION OF ENVIRONMENTAL STANDARDS IN THE TRANSPORT SECTOR IN ESCWA MEMBER COUNTRIES

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# HARMONIZATION OF ENVIRONMENTAL STANDARDS IN THE TRANSPORT SECTOR IN ESCWA MEMBER COUNTRIES

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# Foreword

Transport activities are increasing worldwide, and the ESCWA region is no exception. Roads and highways are still the predominant mode of transport, and the number of vehicles is continually increasing in the region. The rates of vehicle ownership in some ESCWA member countries exceed those in many developed countries. Increased transport activity generally signifies increased economic activity; however, it also has some negative effects, such as increased air and noise pollution and traffic accidents. More attention should be given to the implementation and enforcement of standards for vehicle emissions and gasoline that will control the emissions of gaseous pollution in the region. The use of alternative and more environmentally friendly fuels such as natural gas and unleaded gasoline is one of the solutions being implemented in the region.

This study represents one of the ongoing activities currently being undertaken by the Sectoral Issues and Policies Division at ESCWA aimed at assessing the standards situation in various sectors, including transport, industry and agriculture. The ultimate objective of this study is to contribute to the development of a harmonized set of standards for these sectors in the region.

It should be noted that the major difficulty in achieving harmonization is the lack of information on existing standards and regulations in the ESCWA member States. In the road transport sector, in particular, sparse information is available from the various government agencies. As a first step towards providing information, this study presents a review of the environmental impact of land transport and identifies the factors that affect it. It defines the status of legislation in selected member States with regard to fuels, emissions and ambient air quality. It establishes that there is still a need to harmonize national standards so that attainability and compatibility are guaranteed before regional harmonization is attempted.

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# ABBREVIATIONS AND EXPLANATORY NOTES

The following symbols have been used in the tables throughout the publication:

Two dots (..) indicate that data are not available or not separately reported.

An em dash (—) indicates that the amount is nil or negligible.

A minus sign (-) in front of a number indicates a deficit, decrease or an amount subtracted, except otherwise indicated.

A slash indicate a crop year, a school year or a financial year (e.g. 1981/1982).

Use of a hyphen (-) between dates representing years, for example, 1981-1983, signifies the full period involved, indicating the beginning and end years.

| | |
|---|---|
| < | less than |
| > | greater than |

Details and percentages do not necessarily add up to totals, because of rounding.

Bibliographical and other references have, wherever possible, been verified.

The following abbreviations have been used:

<u>Organizations/entities</u>

| | |
|---|---|
| ASMO | Arab Standardization and Metrology Organization |
| ASTM | American Society for Testing and Materials |
| EC | European Community |
| ECE | Economic Commission for Europe |
| EEC | European Economic Community |
| EPA | Environmental Protection Agency (United States) |
| ESCWA | Economic and Social Commission for Western Asia |
| EU | European Union |
| GCC | Gulf Cooperation Council |
| OAPEC | Organization of Arab Petroleum Exporting Countries |
| OECD | Organization of Economic Cooperation and Development |
| OPEC | Organization of Petroleum Exporting Countries |
| SASMO | Syrian Arab Standardization and Metrology Organization |
| WHO | World Health Organization |

<u>Technical, scientific and other terms</u>

| | |
|---|---|
| $\mu g/m^3$ | microgram per cubic metre |
| C | Celsius (centigrade) |
| CFC | chloro-fluorocarbon |
| $CH_4$ | methane |
| $cm^2$ | square centimetre |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| dB | decibel |
| dB(A) | A-weighted decibel level |
| F | Fahrenheit |
| GDP | gross domestic product |
| g/l | grams per litre |

**ABBREVIATIONS AND EXPLANATORY NOTES** (*continued*)

| | |
|---|---|
| goe/pkm | grams of oil equivalent per person-kilometre |
| $H_2S$ | Sulphuric acid |
| HC | hydrocarbon |
| kg | kilogram |
| km | kilometre |
| kW | kilowatt |
| LPG | liquefied petroleum gas |
| ml | millilitre |
| $N_2O$ | dinitrogen oxide |
| $NO_2$ | nitrogen dioxide |
| $NO_x$ | nitrogen oxides |
| $O_3$ | ozone |
| $O_x$ | oxides |
| Pb | lead |
| PM | particulate matter |
| ppb | parts per billion |
| ppm | parts per million |
| rpm | revolutions per minute |
| SNS | Syrian National Standard |
| $SO_2$ | sulphur dioxide |
| $SO_x$ | sulphur oxides |
| SPM | suspended particulate matter |
| TSP | total suspended particulates |
| VOC | volatile organic compound |

## INTRODUCTION

Transport plays a major role in the development of the ESCWA member countries. Most countries in the region are witnessing an increase in transport demand greater than their gross domestic product (GDP) growth, mainly owing to the continuing increase in rural-urban migration. Since economic activities rely on transportation, the socio-economic benefits extended by the various transport projects include such elements as increased access to markets for local products, access to new employment centres, and passage to health and recreation centres. In general, transport is a means of strengthening local economies. Roads and highways are the prevailing mode of transport. There are no alternatives to roads that fulfil the functions of providing relatively fast and inexpensive land transportation. Air, rail, and water transport are more likely to complement rather than to substitute for roads and highways.[1]

The prevailing modes of transport have changed in terms of their significance over the years. In the early years of the twentieth century more emphasis was given to rail transport, which became less significant in the early 1930s, during the Depression. The motor vehicle started to become the preferred mode of transport only in the middle of the century, but it has since become an indispensable part of modern life. In 1950 the number of vehicles in the world was about 53 million, in comparison with more than 430 million in 1990, indicating an average annual increase of about 9.5 million vehicles. Worldwide, the transport sector accounts for more than 60 per cent of the market for oil products, which provide about 98 per cent of transport fuels. This figure was 92 per cent in 1960, indicating that dependence on oil in the transport sector is continuously increasing. Because the trend worldwide is towards more frequent use of private automobiles, it is becoming evident that effective steps should be taken to reduce their detrimental impact on the environment. Besides the direct impact of increased demand for motor fuels, there are a number of other direct negative effects of road and highway use, including traffic accidents, noise pollution from vehicle operations (especially in densely populated urban areas), environmental damage from accidents involving hazardous materials in transit, and water pollution from spills or accumulated contaminants on road surfaces.

In the foreseeable future, transportation will continue to be the primary source of the growing world oil demand. During the period 1970-1994, transportation energy demand grew by an annual rate of more than 5 per cent in the developing world. This trend towards increased energy consumption in the transport sector is mainly due to population increases, rising standards of living, and the predominance of road transport. [2]

Big strides have been made in controlling air pollution, most notably in the countries that have undergone major industrial development. However, there are many activities besides transport-related activities that can cause air pollution. The motor vehicle did not attract much attention as a source of air pollution until about 1950. Prior to that, attention was totally focused on emissions from industry and coal combustion. The first real observation was in the city of Los Angeles, where a type of eye- and nose-irritating air pollutant, later named smog, was emitted. Since that time, steps have been taken to regulate emissions from vehicles.

The current study reviews the status of legislation in selected ESCWA member countries with regard to controlling pollution from mobile sources. The emphasis is on the maximum limits imposed for some pollutants, the specifications relating to the quality of the fuels used and the specifications for the importation of new vehicles. Inspection schemes and enforcement measures have a significant role to play in mitigating the harmful impact on the environment. This study also presents a review of the environmental impact of land transport. It proposes a scheme for mitigating the harmful effect of land transport on the environment and recommends specific procedures that may result in improved environmental conditions. The current situation in some ESCWA member countries with respect to their existing standards and regulations relating to vehicle emissions and operation is presented. Finally, it will be illustrated that efforts

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[1] World Bank, *Environmental Assessment Sourcebook*: *Policies, Procedures and Cross-Sectional Issues*, World Bank Technical Paper No. 139 (Washington, D.C., 1991), p. 170.

[2] United Nations Environment Programme, Industry and Environment, *Energy Savings in the Transport Sector*, Technical Report No. 25 (Paris, 1994).

are needed to assess the situation before the harmonization of environmental standards in the transport sector can be achieved.

The need to harmonize environmental standards in the transport sector is recognized. However, this study focuses on establishing national standards and highlights the need to harmonize those standards before the concerned regional harmonizing bodies become involved in the process of issuing regional standards.

# I. POLLUTION ISSUES RELATED TO LAND TRANSPORT

The effects of road transport on the environment are multiple and widespread. A systems approach to motor vehicle pollution shows the need to consider what happens from the moment oil comes out of the ground until the vehicle consumes it. There are emissions in oil production, oil transport, oil refining, gasoline storage, gasoline transfer to the service stations, and gasoline transfer to the user's automobile, and in the direct burning of the fuel by the vehicle. Similarly, factors related to the construction of the road infrastructure and its maintenance and, more importantly, traffic operation have a direct impact on the environment. The main construction-related effects include the loss of agricultural and fertile land; modification of the natural drainage patterns; soil and water contamination by oil, grease and fuel spillage at asphalt plants and equipment yards; and landscape mutilation by steep embankments and deep cuts. Adverse environmental effects are also associated with paving operations.

This chapter will focus mainly on the pollution associated with traffic use. The effects of direct road use are more significant and may include increased gas emissions resulting from increased demand for motor fuels, accidents that result in fatalities or injuries, health risks from accidents involving hazardous materials in transit, and water pollution from spills of contaminants on road surfaces. The three problems associated with traffic use that will be highlighted in this study are gas emissions, noise and accidents.

## A. GAS EMISSIONS

Transport is never environmentally neutral since all modes of transport consume one or another kind of fuel, which results in varying degrees of pollution. It is estimated that the transport sector accounts for more than 60 per cent of world oil consumption and that there has been a constant increase in energy consumption in this vital sector. In developing countries, motorization has been more concentrated in urban areas than in rural areas. This has led to increased traffic congestion within cities, with consequent higher emissions and lower fuel efficiency. Higher emissions from transport have increased concentrations of harmful air pollutants to levels that frequently exceed limits established by public health guidelines and standards.

The total daily emissions from automobiles in any area can be estimated as the product of the vehicle miles driven per day multiplied by the emissions per vehicle mile. Reducing either or both of these two factors can control gas emissions. It is important to mention that motor vehicle pollution is not easy to measure and can vary drastically from one vehicle to another. The same vehicle emissions can also vary from one street to another depending on the traffic and the location characteristics. The age of the vehicle and the type of fuel it uses can also change the amount and quality of emitted gases. The box below indicates the various factors that may affect the amount of emissions from vehicles.

**Box. Factors affecting motor vehicle emissions**

1. Vehicle/fuel characteristics

(a) Engine type and technology: two-stroke, four-stroke, diesel, Otto, Wankel, and other engines; fuel injection, turbocharging, and other engine design features; and type of transmission system;

(b) Exhaust, crankcase, and evaporative emission control systems, in-place catalytic converters, exhaust gas recirculation, air injection, and stage II and other vapour recovery systems;

(c) For engine, mechanical condition and adequacy of maintenance;

(d) Air-conditioning, trailer hitches, and other vehicle appurtenances;

(e) Fuel properties and quality: contamination, deposits, sulphur, distillation characteristics, composition (such as aromatics and olefin content) additives (such as lead), oxygen content, and gasoline and diesel octane levels;

(f) Alternative fuels;

**Box** (*continued*)

(g) Deterioration of emission control equipment;

(h) Deployment and effectiveness of inspection/maintenance and anti-tampering programmes.

2. Fleet characteristics

(a) Vehicle mix (number and types of vehicles in use);
(b) Vehicle utilization (kilometres per vehicle per year) by vehicle type;
(c) Age profile of the vehicle fleet;
(d) Traffic mix and choice of mode for movement of passengers/goods;
(e) Emission standards in effect and incentives/ disincentives for the purchase of cleaner vehicles;
(f) Adequacy and coverage of fleet maintenance programmes;
(g) Clean fuel programme in effect.

3. Operating characteristics

(a) Altitude, temperature, humidity (for nitrogen oxide emissions);

(b) Vehicle use patterns and number and length of trips, number of cold starts, speed, loading, and aggressiveness in driving;

(c) Degree of traffic congestion, capacity and quality of road infrastructure, and traffic control systems;

(d) Transport demand management programmes in effect.

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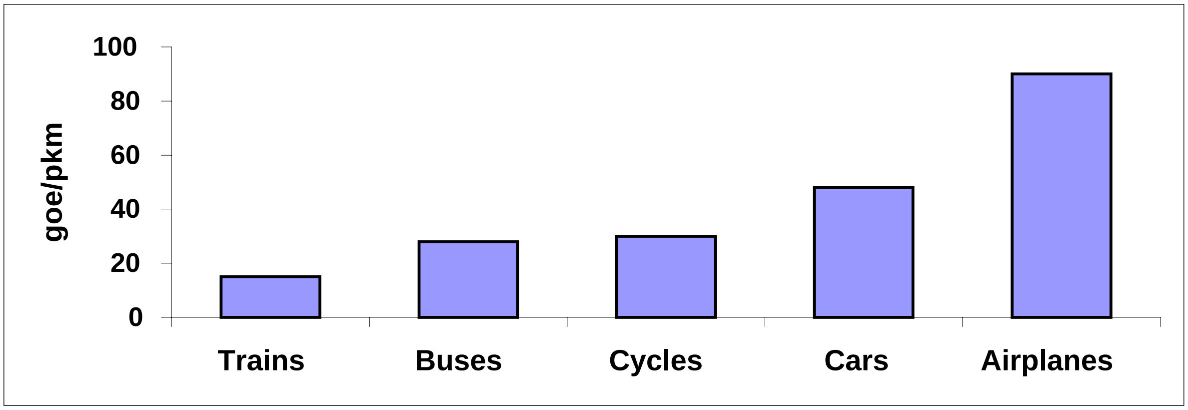
*Source*: Asif Faiz, Christopher Weaver and Michael Walsh, *Air Pollution from Motor Vehicles: Standards and Technologies for Controlling Emissions* (Washington, D.C., World Bank, 1996).

Petroleum products cover most energy needs in the transport sector. Internal combustion engines (ICEs) power the vast majority of vehicles, mainly because of their high efficiency, high power-to-weight and power-to-volume ratios and their low cost in comparison with alternative prime movers. Almost all of these engines are fuelled by distillates of petroleum—gasoline, diesel, liquefied petroleum gas (LPG) or kerosene. Another factor peculiar to road transport is the predominant role of car transport, which has the lowest intrinsic energy efficiency of all forms of transport, especially with the low quality of roads in many developing countries. The combined average for all countries indicates that the transport sector is about 95 per cent dependent on hydrocarbons. Dependence is especially high in developing countries, which have less electrified transport than industrialized countries. In 1989, this sector accounted for 43 per cent of world fuel product consumption, compared with 36 per cent 10 years ago. Transport within the Organization for Economic Cooperation and Development (OECD) member countries alone accounts for half of world fuel product consumption. Figure I shows that energy consumption by cars, expressed as grams of oil equivalent per person-kilometre (goe/pkm), is very high compared with other modes of transport and is only exceeded by air transport.

Burning fossil fuels will result in producing pollutants that are harmful not only to human beings but also to plants and infrastructures. Motor vehicle emissions are a critical class of pollutants. The most important environmental problems related to land transport are climate change and depletion of the ozone layer, the spread of acidifying and oxidant-forming substances, and the spread of organic compounds. The environmental impact of motor vehicles can have a local, regional and even global impact, as shown in table 1. The pollution caused by traffic affects most urban areas.

**Figure I. Energy consumption by mode of passenger transport**




*Source*: United Nations Environment Programme, Industry and Environment, *Energy Savings in the Transport Sector*, Technical Report No. 25 (Paris, 1994).

TABLE 1. POTENTIALLY MEASURABLE TRANSPORT-RELATED EFFECTS BY DOMAIN AND TYPE OF OBJECTIVE

| | Type of objective | | |
|---|---|---|---|
| Domains | Public health | Ecosystem quality | Resource management |
| Global | Stratospheric $O_3$<br>Persistent compounds | Greenhouse gases<br>Stratospheric $O_3$<br>Biodiversity | Energy use<br>Materials use<br>Recyclability |
| Regional | Tropospheric $O_3$<br>Persistent compounds | Tropospheric $O_3$<br>Acidification ($NO_x$, $SO_x$)<br>Persistent compounds<br>Nitrogen deposition | Land use<br>Energy use<br>Waste |
| Local | $O_x$, VOCs, PM<br>Carcinogens<br>Individual health and quality of life<br>Noise<br>Safety | Impact on the urban ecosystem, including landscape and separation of functions by transport and its infrastructure | Damage to buildings<br>Energy use<br>Land use<br>Waste |

*Source*: Organization for Economic Cooperation and Development, "Pollution prevention and control: environmental criteria for sustainable transport", report on phase I of the Project on Environmentally Sustainable Transport OECD/GD(96)136 (Paris, 1996), p. 53.

The most important transport-related pollutants are nitrogen oxides ($NO_x$), carbon monoxide (CO), carbon dioxide ($CO_2$), hydrocarbons, sulphur oxides ($SO_x$), and numerous gaseous organic carbon compounds—mainly hydrocarbons—referred to collectively as volatile organic compounds (VOCs). Lead and suspended particulate matter (SPM) are also considered major pollutants. Motor vehicles are a major source of toxic and carcinogenic air pollutants, including VOCs such as benzene, butadiene, formaldehyde, acetaldehyde and polynuclear aromatic hydrocarbons. Emission of such pollutants is primarily associated with fuel composition or fuel additives and results mainly from incomplete combustion.

Between one third and one half of the $NO_x$ emitted into the atmosphere is believed to come from mobile sources. The most pronounced effect of these oxides is attributed to their combination with other air pollutants to form various oxidants. Most important is the formation of ozone ($O_3$), which results from the reaction between $NO_x$ and hydrocarbons in the sunlight. Another product associated with the reaction of $NO_x$ and $SO_x$ with unburned hydrocarbons is acid rain.

Carbon monoxide, which results from the incomplete combustion of carbon and carbon compounds, is considered hazardous, since it interferes with oxygen absorption by the red blood cells and causes a decline in the supply of oxygen by the blood to body tissues. There are various locations where high concentrations of CO are observed, such as in tunnel sections and in parking garages. Measurements in Saudi Arabia have shown that the concentration of CO can be five times as high in a tunnel section as in adjacent road sections, especially in the early morning hours.

Carbon dioxide from mobile sources is estimated to constitute at least 15 per cent of all $CO_2$ emitted into the atmosphere.[3] With the increase in the number of vehicles, this percentage will rise. It is expected that global warming will result from the increasing concentration of this gas. It is estimated that burning 1 ton of petrol produces 3.21 tons of $CO_2$, and 1 ton of diesel produces 3.17 tons of $CO_2$.[4]

Sulphur oxides have been associated with many environmental crises in major cities. Sulphur is removed from fuel during the refining process, but owing to the cost associated with this process and depending on the original sulphur content in the crude oil, a certain amount of remnant sulphur is always found in the fuel.

Lead was added to gasoline as early as 1920 in order to suppress "engine knock", which degrades performance and fuel economy and can result in engine damage. Lead from mobile sources has been found to have a major effect on human health. Unleaded gasoline is now finding worldwide acceptance and gradual implementation.

Table 2 summarizes the effects of various pollutants on human beings.

### B. NOISE POLLUTION

Noise is defined as any unwanted sound, sound without value, or vibrational energy out of control. It has many different sources but comes mainly from traffic, industry, homes and recreational activities. People usually think first of aircraft noise when transportation noises are considered, yet many surveys in different countries have shown that the noises from vehicles such as trucks and motorcycles are more notable and prevalent. According to the World Health Organization (WHO), noise can affect human health and well-being in a number of ways, leading to feeling of annoyance, sleep disturbances, interference with communication and performance, changes in social behaviour and hearing loss.[5] Sound is measured in decibels (dB); however, for highway traffic noise, an adjustment, or weighting, of high- and low-pitched sounds is made to approximate the way an average person hears sounds. The adjusted measures are called A-weighted levels dB(A). There is some evidence that prolonged exposure to noise levels above 80 dB(A) can cause deafness; the amount of deafness depends upon the degree of exposure. The noise level exposure recommended by WHO is 55 dB.

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[3] United Nations, Department of Industrial and Social Affairs, General Analysis and Policy Division, *Transport Bulletin* (issues on road transport and environment), vol. 13 (Geneva, May 1991).

[4] S. Bernow and others, eds., *Energy policy* (special issue on climate strategy for the United States: "bottom-up" analysis of $CO_2$ reductions, costs and benefits), vol. 22, No. 6 (June 1994).

[5] Institute of Transportation Engineers, *Transportation and Traffic Engineering Handbook,* John Baerwald, ed. (New Jersey: Prentice-Hall, Inc., 1976).

TABLE 2. SOURCES, EFFECTS, AND EXCESS QUANTITIES OF THE PRINCIPAL MOTOR-VEHICLE-RELATED AIR POLLUTANTS

| Pollutant | Type of impact | | | | | | Source of emission | Health effects of pollutant |
|---|---|---|---|---|---|---|---|---|
| | Local | Regional | | Global | | | | |
| | High concentration | Acidification | Photo-chemical oxidants | Indirect greenhouse effect | Direct greenhouse effect | Stratospheric ozone depletion | | |
| Suspended particulate matter (SPM) | x | | x | | | | Products of incomplete combustion of fuels; also from wear of brakes and tires | Irritates mucous membranes; increases respiratory symptoms, pulmonary effects; carcinogenic |
| Lead (Pb) | x | | | | | | Added to gasoline to enhance engine performance | Affects circulatory, reproductive, and nervous systems |
| Carbon monoxide (CO) | x | | x | x | | | Incomplete combustion product of carbon-based fuels | Reduces oxygen-carrying capacity of red blood cells |
| Nitrogen oxides ($NO_x$) | x | x | x | x | | x | Formation from fuel combustion at high temperatures | Irritates lungs; increases susceptibility to viruses |
| Volatile organic compounds (VOCs) | x | | x | x | | | Combustion of petroleum products; also evaporation of unburned fuel | Irritates eyes, causes intoxication; carcinogenic |
| Tropospheric ozone ($O_3$) | | x | x | x | | | Not exhaust gas; product of photochemical reaction of $NO_x$ and VOCs in the presence of sunlight | Irritates mucous membranes of respiratory system; impairs immunity |
| Methane ($CH_4$) | | | | x | x | | Leakage during production, transport, filling and use of natural gas | |
| Carbon dioxide ($CO_2$) | | | | | x | | Combustion product of carbon-based fuels | |
| Dinitrogen oxide ($N_2O$) | | | | | x | x | Combustion product of fuel and biomass; also formed in catalytic converters | |
| Chloro-fluorocarbons (CFCs) | | | | x | x | x | Leakage of coolant from air-conditioning systems | |

*Source*: Organization for Economic Cooperation and Development, “Pollution prevention and control: environmental criteria for sustainable transport”, report on phase 1 of the Project on Environmentally Sustainable Transport OECD/GD(96)136 (Paris, 1996), table 1.

Vehicle noise is a combination of the noises produced by the engine, exhaust and tires. Traffic noise can be increased by defective mufflers or other faulty equipment in a vehicle; the overall noise level also depends factors such as volume of traffic and speed of traffic, and the number of trucks in the flow of traffic. It is estimated that the noise generated by a stream of traffic doubles when the volume of traffic increases from 200 vehicles per hour to 2,000 vehicles per hour. Speed actually produces variations in the noise. An average traffic speed of 55 miles per hour generates twice the sound of traffic moving at a speed of 30 miles per hour. There are remarkable variations in the noise generated by various vehicle types. The effect of heavy vehicles on noise levels is well-established. Large diesel trucks, even though they constitute only a small proportion of the traffic stream, contribute significantly to the noise produced by traffic and are usually clearly audible in the traffic stream. Studies have shown that one heavy truck travelling at 90 miles per hour produces as much noise as 28 cars running at the same speed.[6]

A number of noise abatement measures have been adopted to reduce the level of undesirable noise from highway and street traffic. Strict standards for noise in vehicle and engine design, coupled with traffic-calming measures such as reducing speed limits, placing time and space restrictions on noisy vehicles, and constructing sound barriers, can attenuate traffic noise pollution. Prohibiting trucks from using certain residential streets or even permitting them the use of those streets during daylight hours only in order to avoid making noise during night hours can reduce noise problems as well.

Vehicles could be designed with enclosures for the engine fans that turn off when not needed and with better mufflers, since quieter vehicles reduce traffic noise. Setting standards and limits for vehicle noise can reduce overall traffic noise. Table 3 shows the limits set in the United Kingdom of Great Britain and Northern Ireland for different types of vehicles.

TABLE 3. VEHICLE NOISE LIMITS IN THE UNITED KINGDOM

| Vehicle type | | Old limits dB(A) | New limits dB(A) |
|---|---|---|---|
| Passenger cars | | 77 | 74 |
| Buses and coaches more than 3.5 tons | Engine < 150 kW | 80 | 78 |
| | Engine > 150 kW | 83 | 77 |
| Buses and light goods vehicles less than 3.5 tons | Gross weight < 2 tons | 78 | 76 |
| | Gross weight < 2 tons | 79 | 77 |
| Heavy goods vehicles more than 2 tons | Engine < 75 kW | 81 | 77 |
| | Engine 75-50 kW | 83 | 78 |
| | Engine > 150 kW | 84 | 80 |

*Source*: http://www3.mistral.co.uk/cleanair/fs57.htm.

Creating buffer zones, constructing barriers, planting vegetation or even installing noise insulation can reduce noise further on roads. Buffer zones are created when land near highways is purchased so that buildings cannot be constructed there; however, this measure involves the purchase of tremendous amounts of land, which can be quite expensive in some countries. Noise barriers are solid obstructions built between the highway and the buildings along that highway. These barriers can reduce noise levels by 10 to15 dB(A) and can be formed from earth mounds or high vertical wood, concrete or metal walls. Planting vegetation along the roads or preserving already existing vegetation decreases traffic noise if the plants are high, wide and dense enough. Insulating buildings with noise-absorbing material and sealing windows and cracks also affects the level of noise.

[6] Washington State, Department of Transportation, "Highway traffic noise", http://www.wsdot.wa.gov/regions/northwest/noise/2.html.

## C. ACCIDENTS

There is a growing concern that pollution is closely linked to some types of accidents. Temporary loss of vision or lack of concentration owing to the presence of some motor vehicle emissions (a significant class of pollutants) in the air can result in accidents. It is difficult, however, to identify which accidents are attributable to traffic pollution. As indicated earlier, accidents involving the spillover of hazardous materials are of major concern at the local, regional and international levels. The detrimental effects of such accidents are enormous, in spite of the fact that their rate of occurrence is low.

There are a number of possible measures to decrease road accidents and fatalities. One measure is improving vehicle safety so that crashes can be avoided, or if a crash does occur, the injuries inflicted are minimized. Other measures include optimizing the road environment through safe road design, roadside treatment and promotion of road safety awareness in all aspects of road network development and management; and raising road safety awareness in the community to promote its acceptance as an important community health issue to emphasize the need for greater responsibility to be taken by all road users. Finally, promoting coordination and cooperation between key government industries and the community at the national level is important to identify road safety priorities and make optimal use of resources.

## II. LAND TRANSPORT ISSUES RELATED TO ENVIRONMENTAL POLLUTION IN THE ESCWA REGION

In this chapter, the major factors that have a direct impact on the amount of pollution from traffic in the ESCWA region will be illustrated. The focus will be primarily on the impact of increased vehicle use and energy consumption in the transport sector. Finally, selected measured concentrations of various pollutants in various member States will be presented. The chapter will also give a brief review of the other two forms of negative environmental and social externalities from land transport in the ESCWA region, namely noise and accidents.

### A. POPULATION GROWTH

The trend of increased energy consumption in the transport sector is unique in that there is a progressive incline towards more intensified use. Among the major factors contributing to this is the continuous increase in the population in various countries, with the inevitable growth in travel frequency and transport volume. Table 4 provides population figures for ESCWA members.

TABLE 4. POPULATION FIGURES FOR ESCWA MEMBERS

| Member | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|---|
| Bahrain | 334 000 | 425 000 | 503 000 | 508 000 | 519 000 | 537 000 | 557 000 | 577 000 | 599 000 |
| Egypt | 40 875 000 | 46 511 000 | 52 442 000 | 53 616 930 | 54 780 090 | 55 929 590 | 57 063 530 | 58 180 000 | 59 272 000 |
| Iraq | 13 007 000 | 15 317 000 | 18 078 000 | 18 642 610 | 19 196 960 | 19 739 090 | 20 267 090 | 20 779 000 | 21 366 430 |
| Jordan | 2 181 000 | 2 644 000 | 3 170 000 | 3 545 000 | 3 733 000 | 3 905 930 | 4 060 840 | 4 195 000 | 4 311 720 |
| Kuwait | 1 375 000 | 1 712 000 | 2 125 000 | 1 363 000 | 1 422 000 | 1 461 000 | 1 503 000 | 1 545 000 | 1 589 520 |
| Lebanon | 3 002 350 | 3 274 880 | 3 635 000 | 3 707 690 | 3 781 050 | 3 855 070 | 3 929 730 | 4 005 000 | 4 078 510 |
| Oman | 1 101 000 | 1 397 000 | 1 627 000 | 1 762 000 | 1 892 000 | 2 018 000 | 2 076 000 | 2 135 000 | 2 173 000 |
| Palestine | 1 195 000 | 1 365 000 | 1 637 000 | 1 727 000 | 1 819 000 | 1 901 000 | 2 015 000 | 2 151 000 | 2 278 770 |
| Qatar | 229 000 | 358 000 | 486 000 | 509 000 | 533 000 | 580 000 | 610 000 | 642 000 | 658 000 |
| Saudi Arabia | 9 372 000 | 12 379 000 | 15 803 000 | 16 301 000 | 16 831 000 | 17 385 000 | 18 348 000 | 18 979 000 | 19 409 000 |
| Syrian Arab Republic | 8 704 000 | 10 348 000 | 12 116 000 | 12 514 700 | 12 914 390 | 13 314 340 | 13 713 800 | 14 112 000 | 14 501 690 |
| United Arab Emirates | 1 043 000 | 1 379 000 | 1 844 000 | 2 011 000 | 2 083 000 | 2 230 000 | 2 387 000 | 2 460 000 | 2 532 260 |
| Yemen | 8 538 000 | 10 077 900 | 11 876 000 | 13 411 000 | 13 854 000 | 14 312 000 | 14 785 000 | 15 272 000 | 15 778 060 |

*Source*: World Bank, *World Development Indicators 1998* (Washington, D.C., April 1998).

The table above shows a continuous increase in population in the ESCWA region, from approximately 91 million in 1980 to 145 million in 1995.

The high rate of population growth in the ESCWA region should be carefully considered, since increasing population intensities in the limited urban spaces available will result in more traffic congestion. The rate of population increase in the region ranges from approximately 1.7 to 5.9 per cent, as shown in table 5.

When growth rates for the ESCWA region are compared with those for developed countries such as the United States of America (0.95 per cent) and Sweden (0.6 per cent), it becomes clear that serious measures have to be undertaken. Such measures are essential in order to deal with increased pollution effects associated with the mobility of people, as the current rates of vehicle ownership (number of vehicles per 1,000 persons), urbanization and traffic congestion are not likely to decrease.

TABLE 5. RATE OF POPULATION GROWTH AMONG ESCWA MEMBERS

| Members | 1980-1985 | 1985-1990 | 1990-1991 | 1991-1992 | 1992-1993 | 1993-1994 | 1994-1995 | 1995-1996 |
|---|---|---|---|---|---|---|---|---|
| Bahrain | 4.3 | 3.1 | 1.0 | 2.1 | 3.4 | 3.6 | 3.5 | 3.7 |
| Egypt | 2.4 | 2.3 | 2.2 | 2.1 | 2.1 | 2.0 | 1.9 | 1.8 |
| Iraq | 3.0 | 3.1 | 3.0 | 2.9 | 2.7 | 2.6 | 2.5 | 2.7 |
| Jordan | 3.5 | 3.3 | 10.6 | 5.0 | 4.4 | 3.8 | 3.2 | 2.7 |
| Kuwait | 3.9 | 3.9 | -55.9 | 4.1 | 2.7 | 2.8 | 2.7 | 2.8 |
| Lebanon | 1.7 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.9 | 1.8 |
| Oman | 4.2 | 2.8 | 7.7 | 6.9 | 6.2 | 2.8 | 2.8 | 1.7 |
| Palestine | 2.5 | 3.3 | 5.2 | 5.1 | 4.3 | 5.7 | 6.3 | 5.6 |
| Qatar | 7.2 | 5.3 | 4.5 | 4.5 | 8.1 | 4.9 | 5.0 | 2.4 |
| Saudi Arabia | 4.9 | 4.3 | 3.1 | 3.1 | 3.2 | 5.2 | 3.3 | 2.2 |
| Syrian Arab Republic | 3.2 | 2.9 | 3.2 | 3.1 | 3.0 | 2.9 | 2.8 | 2.7 |
| United Arab Emirates | 4.9 | 5.0 | 8.3 | 3.5 | 6.6 | 6.6 | 3.0 | 2.9 |
| Yemen | 3.1 | 3.0 | 11.4 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 |

*Note*: Computed based on table 4 of the present study.

## B. VEHICLE OWNERSHIP

It has been estimated that the number of cars (commercial and passenger) in the world will reach a staggering 1 billion in the year 2015, compared with only 550 million cars in 1990. ESCWA member countries have experienced and will continue to experience similar trends. Table 6 shows that there was a sizeable increase in the number of registered vehicles in the ESCWA region between the mid-1980s and mid-1990s. For instance, in the period between 1985 and 1997 the number of vehicles in Egypt and Jordan almost doubled, and in a shorter period from 1989 and 1997, the number of vehicles in Yemen increased by a factor of around 2.7.

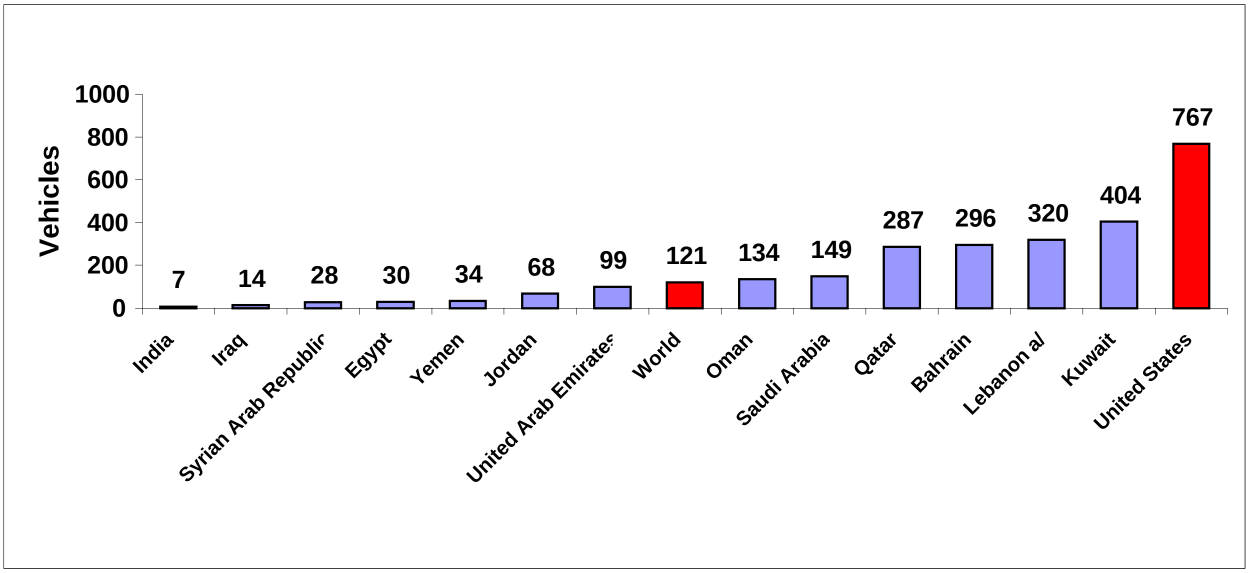
TABLE 6. MOTOR VEHICLES IN USE IN THE ESCWA REGION

| Country | 1983 | 1985 | 1987 | 1989 | 1991 | 1993 | 1995 | 1997 |
|---|---|---|---|---|---|---|---|---|
| Bahrain | 85 998 | 102 030 | 108 337 | 117 653 | 125 942 | 145 922 | 160 600 | .. |
| Egypt | .. | 1 012 045 | 1 115 219 | 1 175 499 | 1 265 064 | 1 557 403 | 1 819 530 | 1 987 493 |
| Iraq | .. | 684 080 | 807 552 | 944 351 | 955 165 | 981 664 | .. | .. |
| Jordan | .. | 191 190 | 207 635 | 213 221 | 217 583 | 235 589 | 253 960 | 283 821 |
| Kuwait | | 536 500 | 544 588 | 598 573 | 683 371 | 724 259 | 791 696 | .. |
| Lebanon | .. | .. | .. | .. | .. | 1 115 918 | 1 282 257 | 1 391 473 |
| Oman | | | 170 248 | 190 116 | 236 299 | 272 843 | 295 384 | 352 184 |
| Qatar | .. | .. | 139 938 | 153 751 | 179 875 | 198 801 | 212 921 | 247 003 |
| Saudi Arabia | 3 560 698 | 4 131 846 | 4 415 219 | 4 950 466 | 5 328 455 | 5 580 000 | 6 111 137 | .. |
| Syrian Arab Republic | 235 982 | 229 272 | 242 574 | 242 792 | 245 907 | 312 173 | 387 008 | .. |
| United Arab Emirates | 206 915 | 232 431 | 234 746 | 286 629 | 284 727 | 369 952 | .. | .. |
| Yemen | .. | .. | .. | 276 347 | 326 571 | 432 717 | 528 746 | 740 189 |

*Note*: Data compiled by the ESCWA Statistics Division.

Figure II shows the number of vehicles per 1,000 people in selected countries. The figure indicates large variations in vehicles ownership. The world average for 1998 was 121 vehicles per 1,000 people. One factor that affects this ratio is average income per capita; however, other factors such as tax laws and limitations on the number of vehicles that one person can own contribute as well. It is to be noted, however, that the amount of pollution experienced in one country can hardly be based on this indicator alone. For instance, air pollution in Egypt, where the average number of vehicles per 1,000 people is 30, is much worse than that of Bahrain, where the corresponding number is 296. Therefore, it is more appropriate to measure, traffic volumes at certain locations and other related factors such as the volume-to-capacity ratio, operating speeds, and the average distance of a trip.

**Figure II. Number of vehicles per 1,000 people in the ESCWA region, India and the United States**




*Source*: World Bank, *World Development Indicators 1998* (Washington D.C., 1998).
a/ Actual number is probably higher since not all cars are registered.

One problem associated with efforts to control the amount of pollution emitted from vehicles is the continuously increasing number of vehicles. In the ESCWA region, as shown in table 7, the rate of growth in the number of vehicles indicates a continuous rise. Some countries, such as Yemen, are still witnessing very high rates of increase. On average, the high increase indicates that more of an environmental impact will be encountered over time, which calls for the formulation of appropriate strategies.

TABLE 7. RATE OF ANNUAL GROWTH IN THE NUMBER OF VEHICLES IN THE ESCWA REGION

| Country | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bahrain | 9 | 7 | 4 | 2 | 4 | 5 | 4 | 3 | 7 | 7 | 6 | 4 | 3 | .. |
| Egypt | .. | .. | 6 | 4 | 2 | 3 | 5 | 3 | 4 | 16 | 7 | 8 | 4 | 5 |
| Iraq | .. | 9 | 7 | 9 | 9 | 6 | 8 | -7 | 2 | 1 | 5 | .. | .. | .. |
| Jordan | .. | 4 | 4 | 4 | 2 | 0 | 1 | 1 | 6 | 1 | 1 | 6 | 9 | 2 |
| Kuwait | .. | 7 | -2 | 4 | 4 | 5 | 9 | 4 | 3 | 2 | 4 | 5 | 5 | |
| Lebanon | .. | .. | .. | .. | .. | .. | .. | .. | .. | 9 | 9 | 4 | 4 | 4 |
| Oman | .. | .. | .. | .. | 4 | 7 | 9 | 11 | 7 | 7 | 5 | 3 | 5 | 11 |
| Qatar | .. | .. | .. | 6 | 6 | 3 | 4 | 11 | 3 | 6 | 2 | 4 | 6 | 9 |
| Saudi Arabia | 9 | 5 | 3 | 3 | 3 | 8 | 3 | 4 | 3 | 2 | 5 | 4 | 3 | .. |
| Syrian Arab Republic | 1 | -4 | 5 | 1 | 3 | -3 | 1 | 1 | 6 | 16 | 9 | 11 | 8 | .. |
| United Arab Emirates | 5 | 6 | -3 | 3 | 6 | 13 | -3 | 2 | 11 | 14 | .. | .. | .. | .. |
| Yemen | .. | .. | .. | .. | .. | .. | 3 | 13 | 11 | 15 | 7 | 12 | 13 | 18 |

*Note*: Based on table 6 of the present study.

## C. ENERGY CONSUMPTION IN THE TRANSPORT SECTOR

Burning fossil fuels produces pollutants that are harmful not only to human beings but also to plants and infrastructures. Motor vehicle emissions into the atmosphere will increase as the consumption of energy increases. Data on transport activity and actual energy consumption remain problematic in terms of completeness, reliability and comparability. Road transport in the ESCWA region, as in other regions in the world, continues to be almost 100 per cent dependent on oil. The only exception in the region relates to the very limited use of natural gas in Egypt and to a lesser extent in the Syrian Arab Republic.

The consumption of gasoline, the main fuel for vehicles in the ESCWA region, has increased significantly in the last few years. This is mainly attributed to the sharp increase in the number of vehicles. Table 8 indicates total gasoline consumption (estimated in barrels per day) in the ESCWA region.

TABLE 8. TOTAL GASOLINE CONSUMPTION AMONG ESCWA MEMBERS
(*Thousands of barrels per day*)

| Member | 1975 | 1980 | 1985 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bahrain | 1.2 | 2.6 | 4.1 | 5.2 | 5.4 | 5.8 | 6.2 | 6.4 | 6.5 | 6.8 | 10.3 |
| Egypt | 15.3 | 27 | 45.6 | 50.6 | 48.5 | 45.8 | 43.7 | 43.7 | 45.4 | 46.9 | 48.5 |
| Iraq | 14.6 | 33 | 51 | 74 | 55 | 70 | 68 | 66 | 68 | 71 | 74.1 |
| Jordan | 3.6 | 6.3 | 8.4 | 8.4 | 8.9 | 9.8 | 10.1 | 10.6 | 11.4 | 12 | 12.6 |
| Kuwait | 10.9 | 20.9 | 26.2 | 18.4 | 14 | 26.9 | 29.9 | 31.8 | 34.3 | 36.4 | 38.4 |
| Lebanon | 11.2 | 13.9 | 17.2 | 14 | 17.5 | 24.2 | 28.1 | 29 | 30.9 | 32.6 | 34.3 |
| Oman | 2 | 4.8 | 9.2 | 11.2 | 12.2 | 13.1 | 13.8 | 13.9 | 14.4 | 14.9 | 15.7 |
| Palestine | .. | .. | .. | .. | .. | .. | .. | .. | 5.4 | 5.8 | 6.2 |
| Qatar | 1.6 | 3.9 | 5.4 | 6.7 | 6.9 | 7.3 | 7.6 | 7.7 | 10.5 | 8.4 | 9.2 |
| Saudi Arabia | 26.6 | 87.3 | 142.1 | 157.5 | 150.7 | 169.4 | 183.1 | 197.9 | 178.6 | 200.5 | 210.5 |
| Syrian Arab Republic | 9.3 | 12.3 | 18.4 | 16.3 | 16 | 16.8 | 17.3 | 18.4 | 18.7 | 19 | 19.6 |
| United Arab Emirates | 5.1 | 13.6 | 18 | 24 | 26 | 28 | 29 | 31 | 33 | 36.6 | 40.6 |
| Yemen | 3.2 | 5.2 | 5.2 | 15.3 | 19.4 | 21.2 | 22.2 | 22.2 | 24.4 | 23.2 | 24 |

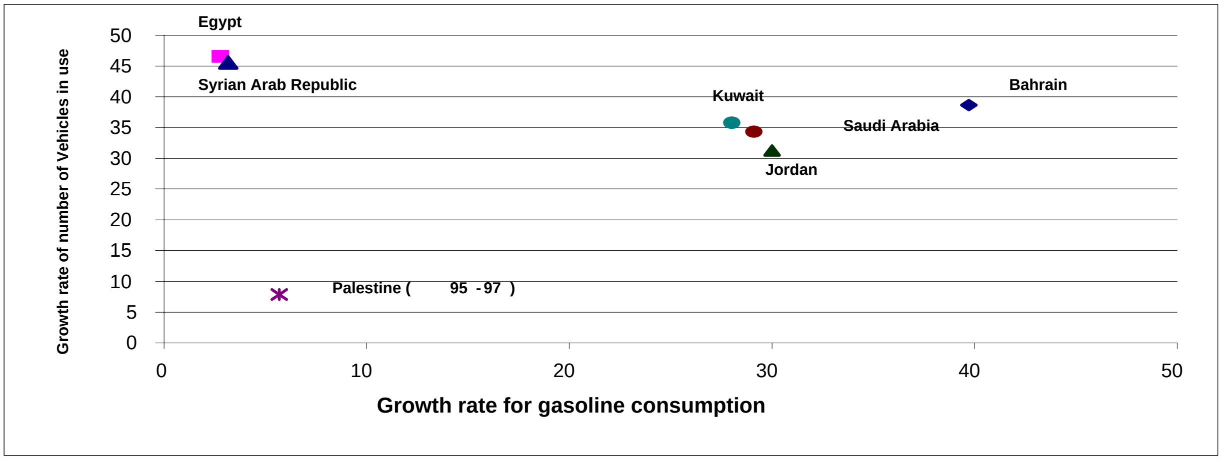
*Source*: Organization of Arab Petroleum Exporting Countries, "Annual statistical report 1998" (Kuwait, 1998).

Figure III shows the relationship between the growth rate for the number of vehicles in use and growth rate for gasoline consumption for selected ESCWA members during the period 1985-1996. It indicates that for those members, except for Egypt and the Syrian Arab Republic, the growth rate for the number of vehicles in use increased in proportion with the growth rate in gasoline consumption, as expected. However, for Egypt and the Syrian Arab Republic, the rates of growth in gasoline consumption were not influenced by the increasing rates of vehicle ownership. This could be explained by the fact that other fuels such as diesel have increasingly been used as a source of energy for vehicles. In addition, these two countries have witnessed greater dependence on public transport than others. The average number of kilometres (km) per passenger car in these two countries has decreased over time, and thereby neutralizing the effect of the increase in the vehicle fleet.

The transport sector is a major consumer of energy in the ESCWA region (and worldwide). However, energy consumption in the transport sector as a percentage of total energy consumption ranges from as low as 29 per cent in Egypt to a remarkably high 74.3 per cent in Qatar, as shown in table 9.

Although the figures in table 9 reflect total oil consumption in the transport sector, it is well-established that road transport is the major consumer. One explicit and related indicator that could illustrate the intensity of motor gasoline consumption would be approximate consumption per capita. Table 10 gives the total consumption of motor gasoline expressed as kilograms (kg) per capita. The table shows that the average world consumption of motor gasoline was approximately 140 kg per capita in 1995. The figures for the ESCWA region range from 31 kg per capita in Egypt to as high as 871 kg per capita in Kuwait.

**Figure III. Growth rates for the number of vehicles in use and gasoline consumption for selected ESCWA members**




*Note*: Based on tables 6 and 9 of the present study.

TABLE 9. PERCENTAGE OF OIL CONSUMPTION BY THE TRANSPORT SECTOR IN SELECTED ESCWA MEMBER COUNTRIES, 1995

| Country | Million barrels of oil equivalent | Transport as percentage of total energy consumption |
|---|---|---|
| Bahrain | 5 654 | 30.7 |
| Egypt | 49 456 | 29 |
| Iraq | 45 023 | 32 |
| Jordan | 9 192 | 41 |
| Kuwait | 14 282 | 39.8 |
| Lebanon | 18 478 | 50.6 |
| Oman | 8 284 | 64.1 |
| Qatar | 4 637 | 74.3 |
| Saudi Arabia | 122 570 | 46.9 |
| Syrian Arab Republic | 19 725 | 29.3 |
| United Arab Emirates | 33 215 | 49.4 |
| Yemen | 16 605 | 50.66 |

*Source*: ESCWA, "Improving energy utilization efficiency within a regional prospective in the ESCWA member countries", (in Arabic), E/ESCWA/ENR/1997/13.

TABLE 10. PRODUCTION, TRADE AND CONSUMPTION OF MOTOR GASOLINE , 1995
(*Thousands of tons*)

| Country | Production | Import | Export | Consumption | Kilograms/capita |
|---|---|---|---|---|---|
| India | 4 362 | .. | .. | 4 362 | 5 |
| Egypt | 4 520 | .. | 2 590 | 1 930 | 31 |
| Syrian Arab Republic | 1 342 | .. | 339 | 1 023 | 72 |
| Yemen, Republic | 990 | 150 | .. | 1 140 | 76 |
| World | 797 863 | 75 206 | 90 127 | 797 455 | 140 |
| Iraq | 2 990 | .. | .. | 2 990 | 149 |
| United Arab Emirates | 1 498 | .. | 340 | 1 158 | 524 |
| Saudi Arabia | 9 971 | .. | 156 | 9 805 | 537 |
| Bahrain | 1 050 | .. | 746 | 301 | 540 |
| Kuwait | 1 902 | .. | 429 | 1 473 | 871 |
| United States | 325 854 | 11 378 | 4 486 | 334 458 | 1 252 |

*Source*: United Nations, Department for Economic and Social Information and Policy analysis, *1995 Energy Statistics Yearbook* (United Nations publication, Sales No. E/F.97.XVII).

One important factor that may explain the high rates of motor gasoline consumption in the region, mainly in the oil-producing countries, is the relatively low cost of gasoline, especially during the 1980's and early 1990s. Gasoline prices in most of the oil-producing countries in the ESCWA region were very low compared with other places, mainly owing to government subsidies. Two factors closely associated with this that had a major impact on the environment were the fast growth of larger-sized vehicles in the traffic fleet and the increase in the average distance travelled by cars. The development of both regular and premium gasoline prices is shown in tables 11 and 12.

TABLE 11. PRICES OF PREMIUM GASOLINE IN THE ESCWA REGION[a/]
(*Cents/litre*)

| Year | Bahrain | Egypt | Iraq | Kuwait | Qatar | Saudi Arabia | Syrian Arab Republic | United Arab Emirates |
|---|---|---|---|---|---|---|---|---|
| 1970 | .. | 1.8 | .. | .. | 7.4 | 7 | 1.1 | 8.4 |
| 1971 | .. | .. | .. | 8.4 | .. | .. | .. | .. |
| 1972 | .. | .. | .. | 8.4 | .. | .. | .. | .. |
| 1973 | .. | .. | .. | 8.4 | .. | .. | .. | .. |
| 1974 | .. | .. | 0.5 | 8.4 | .. | .. | 1.6 | 11.4 |
| 1975 | .. | 2.1 | 0.6 | 8.4 | .. | 3.9 | 1.5 | 12.6 |
| 1976 | .. | .. | .. | 8.4 | .. | .. | 2.4 | 11.4 |
| 1977 | .. | .. | .. | 8.4 | .. | .. | 2.4 | .. |
| 1978 | 16 | .. | .. | 8.4 | 9.6 | 5.7 | 2.6 | .. |
| 1979 | 16 | .. | .. | 8.4 | .. | .. | .. | 19.8 |
| 1980 | .. | 3.8 | .. | 8.4 | .. | 5.7 | 5.7 | 19.2 |
| 1981 | 16 | 3.8 | .. | 8.4 | .. | .. | 5.7 | 19.2 |
| 1982 | 19.9 | .. | 0.8 | 16.7 | .. | .. | 6.3 | 22.2 |
| 1983 | .. | .. | 1 | 16.7 | 16.5 | .. | .. | 29.8 |
| 1984 | .. | 4.4 | 1 | 16.7 | .. | .. | .. | .. |
| 1985 | .. | .. | 1 | .. | .. | .. | 8 | 29.4 |
| 1986 | .. | 7.4 | .. | .. | .. | .. | 10.9 | 27 |
| 1987 | .. | 7.4 | .. | .. | .. | 14.3 | 18.6 | 23.7 |
| 1988 | .. | .. | .. | 16.7 | .. | .. | 28.6 | .. |
| 1989 | .. | 10.3 | .. | .. | .. | .. | 42.9 | .. |
| 1990 | .. | .. | 1.3 | .. | .. | .. | .. | 23.7 |
| 1991 | .. | 20.7 | 1 | .. | .. | .. | 50.1 | 23.7 |
| 1992 | .. | .. | 1 | .. | .. | 8.8 | 50.8 | 23.7 |
| 1993 | .. | 26.6 | 1 | .. | .. | .. | .. | .. |
| 1994 | .. | .. | 2.8 | .. | .. | .. | 58.1 | .. |
| 1995 | .. | .. | .. | .. | .. | 16 | .. | .. |
| 1996 | 26.6 | .. | 20.9 | .. | .. | .. | .. | 23.7 |

*Source*: Organization of Arab Petroleum Exporting Countries, "Annual statistical report 1998" (Kuwait, 1998).
a/ Based on 1996 exchange rates.

TABLE 12. PRICES OF REGULAR GASOLINE IN THE ESCWA REGION[a/]
(*Cents/litre*)

| Year | Bahrain | Egypt | Iraq | Kuwait | Qatar | Saudi Arabia | Syrian Arab Republic | United Arab Emirates |
|---|---|---|---|---|---|---|---|---|
| 1970 | 5.8 | 1.5 | 0.5 | .. | 6 | 6.2 | 0.9 | 7.8 |
| 1971 | 6.4 | .. | .. | 5 | .. | .. | .. | .. |
| 1972 | .. | .. | 0.5 | 8.4 | .. | .. | .. | .. |
| 1973 | .. | .. | .. | 6.7 | .. | .. | .. | .. |
| 1974 | .. | .. | 0.5 | 6.7 | .. | .. | 1.5 | 10.5 |

TABLE 12 (*continued*)

| Year | Bahrain | Egypt | Iraq | Kuwait | Qatar | Saudi Arabia | Syrian Arab Republic | United Arab Emirates |
|---|---|---|---|---|---|---|---|---|
| 1975 | .. | 1.8 | 0.5 | 5.7 | .. | 3.2 | 1.3 | 11.1 |
| 1976 | 8 | .. | .. | 5 | .. | .. | 2.2 | 10.2 |
| 1977 | 8 | .. | .. | 5 | .. | .. | 2.2 | .. |
| 1978 | 10.6 | .. | .. | 5 | 6 | 4.3 | 2.2 | .. |
| 1979 | 10.6 | .. | .. | 5 | .. | .. | .. | 16.8 |
| 1980 | .. | 3.2 | .. | 5 | .. | 4.3 | 5.2 | 16.8 |
| 1981 | 10.6 | 3.2 | .. | 5 | .. | .. | 5.4 | 16.8 |
| 1982 | 16 | .. | 0.6 | 13.4 | .. | .. | 5.9 | 19.8 |
| 1983 | .. | .. | 0.7 | 13.4 | 15.1 | .. | .. | 27 |
| 1984 | .. | 3.2 | 0.7 | 13.4 | .. | .. | .. | .. |
| 1985 | .. | .. | 0.8 | .. | .. | .. | 7.6 | 25.2 |
| 1986 | .. | .. | .. | .. | .. | .. | 10.4 | 25.2 |
| 1987 | .. | .. | .. | .. | .. | .. | 18 | 21.8 |
| 1988 | .. | .. | .. | 13.4 | .. | .. | 27.7 | .. |
| 1989 | .. | .. | .. | .. | .. | .. | 42 | .. |
| 1990 | .. | .. | 1.3 | .. | .. | .. | .. | 21.9 |
| 1991 | .. | .. | 1 | .. | .. | .. | 49.2 | 21.9 |
| 1992 | .. | .. | 1 | .. | .. | .. | 49.9 | 21.8 |
| 1993 | .. | .. | 1 | .. | .. | .. | .. | .. |
| 1994 | .. | .. | 2.8 | .. | .. | .. | 56.5 | .. |
| 1995 | .. | .. | .. | .. | .. | .. | .. | .. |
| 1996 | 21.3 | .. | 20.9 | .. | .. | .. | .. | 21.9 |
| 1997 | .. | .. | .. | .. | .. | .. | .. | .. |

*Source*: Organization of Arab Petroleum Exporting Countries, "Annual statistical report1998" (Kuwait, 1998).

a/ Based on 1996 exchange rates.

## D. EMISSION OF TRAFFIC GASES

There is a rising concern in the major cities in the ESCWA region, including Cairo and Damascus, that pollution levels from traffic operations are reaching unacceptable levels. However, in order to determine the extent of the problem, it is essential first to establish programmes for measuring the actual emissions of pollutants and then to compare the resulting figures with the standards for maximum allowable emissions. In the ESCWA region the issue of land transport pollution has not yet received sufficient attention. Findings of the studies funded by the World Bank indicate that there is potential for significant health problems associated with poor air quality owing to the following:

(a) The estimated maximum hourly CO concentrations in the vicinity of some main roads during rush-hour traffic are likely to approach or exceed WHO health guidelines;

(b) Total vehicle lead emissions deposited in the atmosphere may also cause significant health problems;

(c) Over 70 per cent of total $NO_x$ emissions are attributed to mobile sources;

(d) Particulate emissions from vehicles are at levels high enough to damage health.

Despite the fact that there are standards for pollutant emissions, there are very few monitoring programmes, and those that do exist are fragmented. The probable reason for this is that the measurement of gaseous emissions from vehicles requires expensive equipment and well-trained personnel. In addition, established standards for allowable emissions are sometimes too stringent and very difficult to abide by. Finally, there is a lack of genuine concern among the general public and official parties, with regard to controlling emissions.

The programmes for actual field measurements of emissions are scattered and do not follow a systematic approach. The amounts of emissions in most cases are based on approximations rather than actual measurements. In other words, the yearly calculations of emissions of various pollutants, such as $NO_x$, CO and $SO_2$ are based on the total energy consumed by vehicles. For each ton of fuel burnt, it is estimated that a certain value of emission for each class of pollutant is produced; thus, the annual emission is estimated. In Jordan, for instance, monitoring of air pollution has been carried out in several downtown locations since the early 1990s. Measurements of concentrations of $SO_2$, CO, $NO_x$, and total suspended particulates (TSPs) were carried out at one location from October 1991 to January 1992 (over a period of three months). These measurements included all sources of pollution. However, since there were no factories or other pollution sources, it was safely assumed that traffic activities were the prime source of pollution. The yearly $NO_2$ emissions from the transport sector in selected countries in the ESCWA region are presented in table 13.

TABLE 13. YEARLY EMISSIONS OF $NO_2$ IN THE TRANSPORT SECTOR IN SELECTED COUNTRIES
(*Thousands of tons*)

| Country | | 1980 | 1990 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|
| Egypt | Transport emissions | 0.09 | 0.15 | 0.16 | 0.16 | 0.16 | 0.18 | 0.19 |
| | Total emissions | 0.3 | 0.52 | 0.48 | 0.46 | 0.48 | 0.53 | 0.55 |
| | Percentage | 30 | 28.8 | 33.3 | 34.8 | 33.3 | 34.0 | 34.5 |
| Jordan | Transport emission | | | 2 | 2 | 1.35 | 1.4 | 1.45 |
| | Total emissions | | | 18.4 | 18.4 | 22.61 | 24.53 | 25.6 |
| | Percentage | | | 10.9 | 10.9 | 6.0 | 5.7 | 5.7 |
| Syrian Arab Republic | Transport emissions | | 0.19 | 0.26 | 0.3 | 0.32 | 0.3 | 0.28 |
| | Total emissions | | 1.25 | 1.52 | 1.55 | 1.44 | 1.45 | 1.39 |
| | Percentage | | 15.2 | 17.1 | 19.4 | 22.2 | 20.7 | 20.1 |
| United States | Transport emissions | | 132 | 136 | | | | |
| | Total emissions | | 179 | 179 | | | | |
| | Percentage | | 73.7 | 76.0 | | | | |

*Source*: World Energy Council, http://www.worldenergy.org/wec-geis.

Table 13 indicates that yearly $NO_2$ emissions in the transport sector in Egypt averaged about one third of the total $NO_2$ emissions during the 1990s; the ratio was much lower for both Jordan and the Syrian Arab Republic. In the United States, the transport sector accounted for more than 70 per cent of the total $NO_2$ emissions in the early 1990s. Overall it may be said that the transport sector is not a major contributor to the emissions of $NO_2$ in the region. It is important to avoid such occurrences; the smog caused by the emissions of $NO_2$ in metropolitan areas should be restricted. Ozone, a product of reactions between nitrogen oxides and hydrocarbons in the air, is the most important component of photochemical smog, which is responsible for bronchial diseases and lung damage and eats away at buildings.

$CO_2$ emissions are considered harmful for both humans and animals. There is concern worldwide over the threat it poses with respect to the greenhouse effect. The concern over the gradual increase in the concentration of this gas in the atmosphere and the subsequent increase in the global temperature has triggered the idea of imposing what has become known as the “carbon tax”. It was estimated that in the United States transport accounted for 32 per cent of $CO_2$ emissions in 1992.[7] However, the World Energy Council estimated that only 15 per cent of the total emissions of $CO_2$ were attributable to transportation

[7] United States Department of Energy, Energy Information Administration, Office of Energy Markets and End Use, *Emissions of Greenhouse Gases in the United States, 1987-1992* (Washington, D.C., November 1994).

activities between 1980 and 1996. This percentage matches that of both Saudi Arabia and Yemen, as shown in table 14. Jordan's transport sector accounted for almost half of the $CO_2$ emitted in the country in 1980; however, the figure gradually decreased, falling to only 21.7 per cent in 1996. Similar trends are indicated for the Syrian Arab Republic, except that figures show a rather low percentage of $CO_2$ emitted in the air by the transport sector (approximately 10 per cent in 1996 compared with 38 per cent in 1980). Overall, it is indicated that the emissions of $CO_2$ in the ESCWA region by the transport sector are being gradually controlled and reduced.

TABLE 14. YEARLY EMISSIONS OF $CO_2$ IN THE TRANSPORT SECTOR IN SELECTED COUNTRIES
(*Thousands of tons*)

| Country | | 1980 | 1990 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|
| Egypt | Transport emissions | 10.0 | 18.0 | 19.0 | 19.0 | 20.0 | 22.0 | 22.0 |
| | Total emissions | 39.0 | 75.0 | 72.0 | 70.0 | 73.0 | 83.0 | 85.0 |
| | Percentage | 25.6 | 24.0 | 26.4 | 27.1 | 27.4 | 26.5 | 25.9 |
| Greece | Transport emissions | 11.9 | 17.8 | 18.7 | 19.1 | 19.6 | 19.6 | 19.9 |
| | Total emissions | 48.4 | 72.3 | 74.5 | 74.1 | 76.9 | 76.4 | 77.6 |
| | Percentage | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| India | Transport emissions | 60.4 | 81.2 | 94.2 | 95.1 | 99.5 | 111.9 | 120.0 |
| | Total emissions | 306.0 | 599.8 | 672.6 | 705.2 | 750.1 | 817.3 | 863.2 |
| | Percentage | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| Jordan | Transport Emissions | 2.3 | 3.8 | 3.9 | 4.0 | 2.7 | 2.8 | 2.9 |
| | Total emissions | 5.0 | 10.2 | 11.0 | 11.4 | 11.7 | 12.7 | 13.3 |
| | Percentage | 46.4 | 37.4 | 35.6 | 35.2 | 23.1 | 22.0 | 21.7 |
| Saudi Arabia | Transport emissions | 22.3 | 28.6 | 29.9 | 32.8 | 35.6 | 35.0 | 37.1 |
| | Total emissions | 98.1 | 168.6 | 213.2 | 224.0 | 218.6 | 225.0 | 248.7 |
| | Percentage | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| Syrian Arab Republic | Transport emissions | 5.7 | 5.0 | 4.3 | 4.1 | 4.1 | 3.8 | 3.9 |
| | Total emissions | 15.0 | 33.3 | 36.0 | 35.9 | 37.3 | 39.1 | 40.4 |
| | Percentage | 38.2 | 15.0 | 11.9 | 11.4 | 11.0 | 9.6 | 9.6 |
| United States | Transport emissions | 1 257.5 | 1 462.8 | 1 468.2 | 1 493.9 | 1 548.0 | 1 583.0 | 1 625.0 |
| | Total emissions | 4 785.3 | 4 873.4 | 4 924.6 | 5 095.0 | 5 153.7 | 5 194.5 | 5 324.5 |
| | Percentage | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| Yemen | Transport emissions | 2.5 | 3.9 | 5.2 | 4.1 | 4.3 | 4.4 | 4.2 |
| | Total emissions | 3.9 | 7.6 | 9.9 | 7.8 | 8.3 | 8.3 | 8.3 |
| | Percentage | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |

*Source*: World Energy Council, http://www.worldenergy.org/wec-geis.

The emissions of other gas pollutants have also been established for some ESCWA member countries. Table 15 indicates that the emissions of $SO_2$ in Jordan and the Syrian Arab Republic from transport sources are minimal. The percentage for Jordan was even reduced from 2 per cent in 1992 to 1 per cent in 1996. The total emissions of this gas depend largely on the sulphur content in the fuel used.

TABLE 15. YEARLY EMISSIONS OF $SO_2$ IN THE TRANSPORT SECTOR IN SELECTED COUNTRIES
(*Thousands of tons*)

| Country | | 1980 | 1990 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|
| Jordan | Transport emissions | .. | .. | 0.5 | 0.5 | 0.3 | 0.31 | 0.32 |
| | Total emissions | .. | .. | 24.7 | 25.9 | 29.6 | 30.97 | 31.92 |
| | Percentage | .. | .. | 2.0 | 1.9 | 1.0 | 1.0 | 1.0 |
| Syrian Arab Republic | Transport emissions | .. | 9.71 | 13.04 | 14.94 | 16.01 | 15.27 | 13.94 |
| | Total emissions | .. | 237.58 | 263.29 | 262.98 | 258.51 | 242.22 | 222.48 |
| | Percentage | .. | 4.087044 | 4.952714 | 5.68104 | 6.193184 | 6.304186 | 6.265732 |
| United States | Transport emissions | 604 | 745 | 756 | 716 | .. | .. | .. |
| | Total emissions | 22786 | 20638 | 20022 | 20287 | .. | .. | .. |
| | Percentage | 2.65075 | 3.609846 | 3.775847 | 3.529354 | .. | .. | .. |

*Source*: World Energy Council, http://www.worldenergy.org/wec-geis.

Table 16 shows that the transport sector contributed nearly 50 per cent of the total yearly emissions of $CH_4$ in Egypt between 1980 and 1996, while in Jordan the figures ranged from 70.6 to 74.4 per cent during the mid-1990s. The figure for the United States was relatively better in this respect.

TABLE 16. YEARLY EMISSIONS OF $CH_4$ IN THE TRANSPORT SECTOR IN SELECTED COUNTRIES
(*Thousands of tons*)

| Country | | 1980 | 1990 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|
| Egypt | Transport emissions | 1.64 | 2.9 | 2.85 | 2.81 | 2.9 | 3.08 | 3.16 |
| | Total emissions | 3.33 | 5.84 | 5.56 | 5.4 | 5.6 | 6.28 | 6.48 |
| | Percentage | 49.24925 | 49.65753 | 51.25899 | 52.03704 | 51.78 | 49.04459 | 48.763 |
| Jordan | Transport emissions | .. | .. | .. | .. | 1.22 | 1.2 | 1.32 |
| | Total emissions | .. | .. | .. | .. | 1.64 | 1.7 | 1.79 |
| | Percentage | .. | .. | .. | .. | 74.394 | 70.584 | 73.7402 |
| United States | Transport emissions | .. | 266 | 242 | .. | .. | .. | .. |
| | Total emissions | .. | 723 | 745 | .. | .. | .. | .. |
| | Percentage | .. | 36.79 | 32.48 | .. | .. | .. | .. |

*Source*: World Energy Council, http://www.worldenergy.org/wec-geis.

## E. NOISE POLLUTION

In the ESCWA region, noise from traffic is not yet considered a major pollution problem warranting strict measures. However, with the increasing reliance on road transportation and the associated rise in the number of operating vehicles, noise pollution will definitely require more attention and regulatory measures. The number of vehicles per kilometre of road has been considered one indicator for measuring the severity of noise pollution. The higher this value, the greater the potential for noise pollution.

The effects of transport noise are not yet well understood. There are no fully satisfactory measurements of noise and the nuisance it causes. Several regulations and standards have been established in the ESCWA region. Egypt and Lebanon have noise intensity limits for different zones, as indicated in tables 17 and 18.

TABLE 17. AMBIENT NOISE INTENSITY LIMITS FOR DIFFERENT LAND-USE ZONES IN LEBANON

| Receptor | Daytime dB(A) | Evening dB(A) | Night-time dB(A) |
|---|---|---|---|
| Industrial areas (heavy industries) | 60-70 | 55-65 | 50-60 |
| Commercial, administrative and “downtown” areas | 55-65 | 50-60 | 54-55 |
| Residential areas including some workshops or commercial businesses or on public roads | 50-60 | 45-55 | 40-50 |
| Residential areas in the city | 45-55 | 40-50 | 35-45 |
| Residential suburbs with low traffic | 40-50 | 35-45 | 30-40 |
| Rural residential areas (hospitals and gardens) | 35-45 | 30-40 | 25-35 |

*Source*: Lebanon, Ministry of Environment, Resolution No. 1/52, *Official Gazette*, No. 45 (12 September 1996).

TABLE 18. AMBIENT NOISE INTENSITY LIMITS FOR DIFFERENT LAND-USE ZONES IN EGYPT

| Receptor | Daytime dB(A) | Evening dB(A) | Night-time dB(A) |
|---|---|---|---|
| Industrial areas (heavy industries) | 60-70 | 55-65 | 50-60 |
| Commercial, administrative and "downtown" areas | 55-65 | 50-60 | 45-55 |
| Residential areas including some workshops or commercial businesses or on public roads | 50-60 | 45-55 | 40-50 |
| Residential areas in the city | 45-55 | 40-50 | 35-45 |
| Residential suburbs with low traffic | 40-50 | 35-45 | 30-40 |
| Rural residential areas (hospitals and gardens) | 35-45 | 30-40 | 25-35 |

*Source*: ESCWA, "The Egyptian experience in applying environmental norms and standards in the areas of electricity generation, transmission and distribution", E/ESCWA/ENR/1999/WG.3/3.

## F. ACCIDENTS

There is growing concern in the ESCWA region about the impact of accidents and increased recognition of the need to address this problem in order to reduce human suffering and the drastic economic loss to national economies. Total costs of accidents are usually not tallied since the loss of working power and the costs related to human suffering are not determined.

Table 19, which shows the number of car accidents and fatalities that occurred in various ESCWA member countries from 1992 to 1997. Some countries, such as Oman and Bahrain, have witnessed positive trends; the number of fatalities is decreasing with time, indicating their safety schemes are satisfactory. However, Jordan is witnessing a dismal situation with respect to accidents; from 1994 until 1997 (about four years), there was an increase of approximately 40 per cent in the number of fatalities.

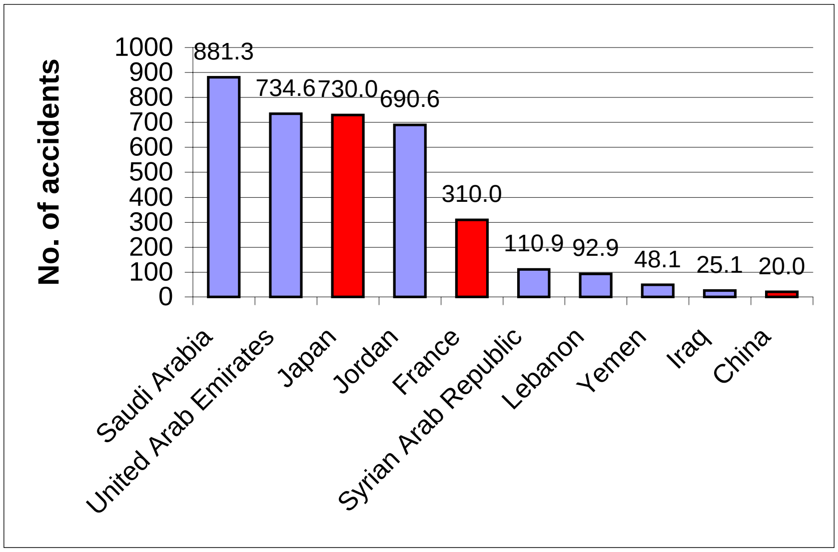
TABLE 19. NUMBER OF CAR ACCIDENTS AND FATALITIES IN SELECTED ESCWA MEMBER COUNTRIES

| | 1992 | | 1993 | | 1994 | | 1995 | | 1996 | | 1997 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No of acc | No. of fat | No. of acc | No. of fat | No. of acc | No. of fat | No. of acc | No. of fat | No. of acc | No. of fat | No. of acc | No. of fat |
| Bahrain | 28 073 | 69 | 32 004 | 56 | 31 019 | 63 | 29 083 | 53 | 27 899 | 57 | .. | .. |
| Jordan | .. | .. | 24 799 | 440 | 26 837 | 443 | 28 970 | 469 | 33 784 | 552 | 39 005 | 577 |
| Kuwait | .. | .. | 19 820 | 289 | 21 697 | 289 | 24 045 | 294 | 24 912 | 285 | 26 322 | 356 |
| Lebanon | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3 315 | 357 |
| Oman | 13 617 | 218 | 11 754 | 372 | 11 754 | 372 | 11 025 | 399 | 9 456 | 413 | 8 444 | 549 |
| Qatar | 41 100 | 116 | 41 615 | 84 | 39 719 | 52 | 41 691 | 99 | 43 263 | 89 | 49 943 | 96 |
| Saudi Arabia | .. | .. | .. | .. | .. | .. | .. | .. | 167 265 | 3 123 | .. | .. |
| Syrian Arab Republic | .. | .. | 17 407 | 1 198 | 16 692 | 1 297 | 15 649 | 1 524 | 14 297 | 1 386 | 14 694 | 1 256 |
| United Arab Emirates | .. | .. | .. | .. | 19 397 | 600 | 18 071 | 563 | 16 610 | 358 | .. | .. |
| Yemen | .. | .. | .. | .. | .. | .. | 7 346 | 1 369 | 7 303 | 1 267 | 8 332 | 1 223 |

*Source*: Data compiled from the Statistical Abstracts of each Country.
*Note*: No. of acc = number of accidents.
No. of fat = number of fatalities.

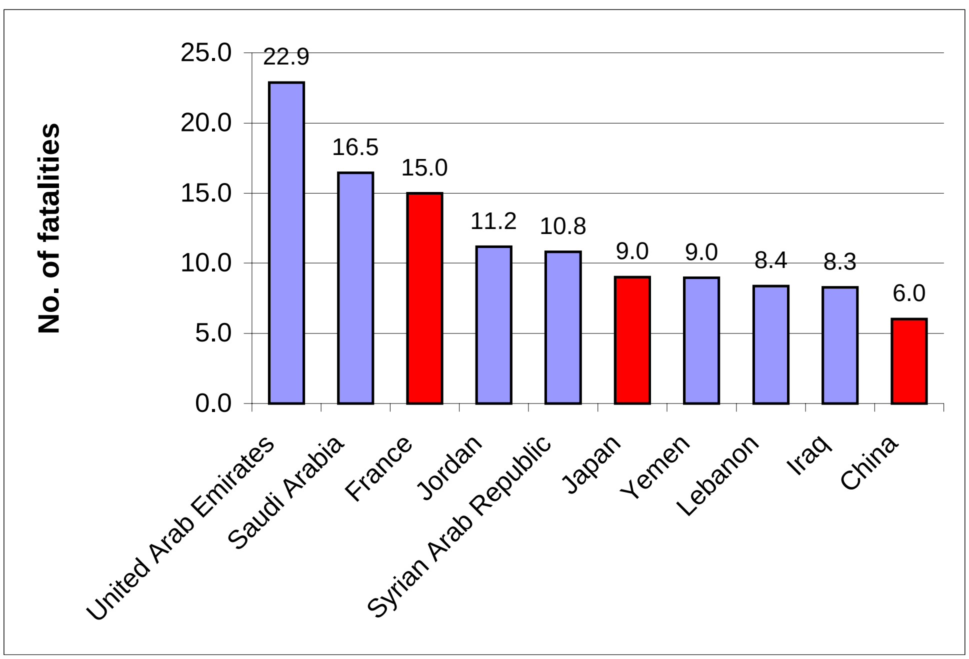
Accident statistics are usually expressed in terms of is the number of accidents per 100,000 inhabitants. Figures IV and V show this indicator for ESCWA member countries compared with some other countries in the world. The data might be misleading, since accidents figures for developing countries are neither comprehensive and nor accurate. Some of the accidents that do not involve fatalities or serious injuries are not recorded in the region. The data for some countries might therefore be greatly underestimated. Statistics are not available to indicate the number and types of accidents that may be fully or partially attributed to loss of control owing to the effects of traffic pollution, but they are believed to be insignificant. In any case, there is a need to put more emphasis on traffic safety in the region.

**Figure IV. Number of accidents per 100,000 inhabitants, 1995**




*Source*: Yusifalbakri, Ala' Abdulrahman, "Traffic accidents: facts and solutions", *Traffic Safety* (in Arabic), 1997.

**Figure V. Number of fatalities per 100,000 inhabitants, 1995**




*Source*: Yusifalbakri, Ala' Abdulrahman, "Traffic accidents: facts and solutions", *Traffic Safety* (in Arabic), 1997.

# III. MEASURES TO ABATE THE ENVIRONMENTAL IMPACT OF LAND TRANSPORT

Environmental problems are usually dealt with when a “crisis” situation develops. Crisis-oriented policies usually involve very high costs in comparison with preventive policies, and often result in unrecoverable damages. Air quality measurements undertaken in some cities in the region, including Damascus, indicate that the percentages of some pollutants have exceeded the maximum allowable limits. Fortunately, however, the situation has not yet become as serious as the motor-vehicle-related environmental crisis that occurred in the early 1990s in Athens, where city traffic pollution exceeded maximum allowable limits and necessitated banning all vehicle movement for a few days in order to reduce pollution to acceptable levels.

There are measures aimed directly at reducing the impact of transport-related pollution. It is worth mentioning here that some of these measures require international cooperation for implementation to achieve tangible results. They include:

(a) Using alternative fuels;
(b) Imposing specifications for imported vehicles;
(c) Setting up proper inspection schemes for checking vehicle emissions.

Most of the measures adopted to reduce the amount of vehicle emissions will have a limited impact, so further actions must be to control the amount of pollution. The major measures needed in this regard involve the following:

(a) Avoiding unnecessary transport;

(b) Encouraging the use of public transit;

(c) Promoting environmentally friendly rail and other means of travel that have a less damaging impact on the environment.

The main courses to follow in order to achieve tangible results in controlling pollution include reducing the emissions from each mode of transport through technical improvements in the vehicle industry, switching to more environmentally friendly modes of transport that have less harmful environmental repercussions, and reducing overall transport activities, as illustrated below.

## A. IMPROVING VEHICLE TECHNOLOGY

Minimizing congestion and the number of vehicles on the roads is just one way of limiting air and noise pollution. There is also a need to control pollution at the source. Vehicles contribute heavily to total air pollution. There are some intrinsic constraints, however, which may limit the extent to which pollution can be reduced. Road users continuously demand more powerful vehicles, which means more energy-consuming cars with new accessories that reduce efficiency (such as catalytic chambers) or consume energy (such as air-conditioning and radios). Paradoxically, the demand for traffic safety implies an increase in vehicle weight, which in turn means higher energy consumption and pollution. Considerable attention has been devoted to the engine, the crucial element for fuel economy and emission limitations. In many countries, the potential efficiency gains that could have been achieved over the last decade have not been realized, owing to the shift towards more powerful engines. Some experts note that marketing efforts by many manufacturers now emphasize power, speed and acceleration in contrast with the emphasis on fuel economy in the 1970s. This situation undermines efforts to improve fuel economy and emission levels. Efforts are required from national and international authorities to counter this trend.

Different options are available to increase engine efficiency and flexibility and decrease fuel consumption, weight and maximum power while maintaining adequate performance in accordance with agreed limits prevalent in the industrialized countries. For example, combining the use of high-power-density engines, turbocharging and supercharging, and electronically controlled fuel injection, engine regulation, and continuously variable transmissions can maximize engine power where needed while retaining the fuel economy characteristics of lighter and less powerful engines. Some of these options can be implemented now; others may require additional development. The option of electrical systems (if electricity production is based mostly on hydraulic or nuclear power) is infeasible in developing countries owing to the lack of the required infrastructure.

Diesel vehicles are usually the major source of sulphates and a significant source of carbonaceous particulates. Passenger cars are the largest contributors to carbon monoxide and lead pollution. They also contribute significantly to the total amount of nitrogen oxides and hydrocarbons. Different categories of vehicles must be assessed in order to address different aspects of the overall vehicle pollution problem.

Other interesting developments include the manufacture of compact and efficient two-stroke engines with electronic fuel injection, efficient and clean "lean burn" engines, through which problems of catalyst durability under poor maintenance conditions may be overcome. It is estimated that in the next few years, significant gains in the fuel efficiency of new models will be achievable with today's techniques and fuels, and that these gains can satisfy environmental regulations. Beyond the year 2000, the experts believe that the implementation of the best available technologies, together with increased consumer demand for highly efficient and clean automobiles, could lead to further improvement in the fuel efficiency of cars on the order of 50 to 60 per cent above today's levels.

New vehicles should be required to meet defined emission standards before they can be registered in order to eliminate urban transport pollution. It is essential to upgrade emission standards for new vehicles as soon as improvements in vehicle technology allow. Since the ESCWA member countries import all of their vehicles, it will be necessary to modify specifications in order to accommodate any new emission standards and to enforce policies that guarantee the required specifications are met.

Vehicles become more polluting and less roadworthy over time owing to wear and tear. Older vehicles are more likely to break down on the road, causing congestion and posing a danger to other road users. It is recommended that Governments discourage people from keeping old vehicles and encourage the early replacement of such vehicles. However, this would have a major economic impact on developing countries, which would find a replacement programme very difficult to implement. Table 20 shows the age distribution of vehicles operating in the Syrian Arab Republic. Close to a quarter of the passenger cars on the streets are at least 24 years old. In Egypt about 65 per cent of the vehicles are 10 years old or more, and around 25 per cent of those are more than 20 years old. Jordan has taken a positive step towards replacing the old fleet of taxis operating in the major cities and causing high levels of air pollution. The Government has granted taxi owners an exclusive tax exemption if they opt to replace their old vehicles with new ones. With a high turnover rate, better quality vehicles with cleaner engines can be introduced quickly to replace older ones with inferior technology so that the effects of the improved vehicle technology can benefit the environment.

TABLE 20. AGE DISTRIBUTION FOR VEHICLES IN THE SYRIAN ARAB REPUBLIC

| | Percentage of fleet more than | |
|---|---|---|
| | 13 years old | 24 years old |
| Passenger cars | 60.5 | 24 |
| Buses and microbuses | 40.4 | 9.4 |
| Pick-ups | 57.4 | 6.5 |
| Trucks | 68.2 | 19.2 |

*Source*: Syrian Arab Republic, "United Nations Development Programme Project for Environmental Capacity Building; investigating air quality" (in Arabic), prepared by Fuad Abusamra and others (Damascus, 1995).

## B. USING ALTERNATIVE FUELS

The use of alternative fuels including natural gas, methanol, ethanol, electricity, and different qualities of petroleum-based fuels should be considered. Most recently, hydrogen fuel cells have shown promise as the potential alternative fuel in the future. Gasoline and diesel fuels are likely to continue to cover most fuel demand over the next several years as they represent the only low-priced transport fuels available in sufficient quantities. However, important improvements in current gasoline and diesel fuel formulations could be implemented that would help increase efficiency while decreasing vehicle emissions.

The use of compressed natural gas and liquefied natural gas has become much more widespread in recent years; it is estimated that the total number of vehicles using this fuel exceeds 1 million. In Egypt, the use of natural gas has increased significantly. Natural gas is non-polluting and its use has proven economically feasible; currently, there are more than 14,000 vehicles that have been converted to use natural gas and there are at least 20 fueling stations available. In the Syrian Arab Republic the use of natural gas as a fuel is under serious consideration. Natural gas still poses distribution problems because of the limitations on its direct use on a large scale. In addition, the possible leakage of methane into the atmosphere during transport, distribution and use might introduce a higher warming effect than the corresponding $CO_2$ reduction. However, some researchers believe that natural gas has a promising future as a transport fuel if the leakage problems are solved.

Methanol presents a complex problem: it produces lower quantities of some pollutants and higher quantities of others. Its use is being encouraged in some very polluted urban areas in the United States and Scandinavia, where it can be produced as a renewable fuel from biomass. However, its uses are viewed as rather limited in the short term because the supply sources for its production are limited; wood products are too expensive, natural gas is remote, and coal is environmentally unacceptable. While methanol produced from natural gas is competitively priced, it can only be used in a very marginal manner; it may be mixed with petrol up to a proportion of 10 per cent or may be used in specially adapted cars.

Ethanol, produced from agricultural raw materials, shows promise for use in fuel cells, but its development as a fuel is expected to be limited in the near future if oil prices remain relatively low. The introduction of substitute fuels such as alcohol or plant-based fuels would require the technological adaptation of the vehicle fleet; this would not be easy in developing countries, which rely heavily on imports for their supply of vehicles. The use of ethanol (85 per cent ethanol mixed with 15 per cent gasoline) in the United States has increased dramatically in the last few years; the number of vehicles using this fuel increased from 172 vehicles in 1992 to about 11,750 vehicles in 1998, representing average annual growth of 102 per cent, the highest rate for any alternative fuel. One drawback associated with the use of ethanol and methanol is the raised emission of aldehydes.

The use of hydrogen also poses a number of technological problems that are not likely to be solved in the immediate future. Hydrogen production and storage require the availability of low-cost electricity. Problems related to leakage and safety limit its use as an alternative fuel. One new technology is a cell fueled by hydrogen and atmospheric oxygen; its waste is distilled water. Fuel cell technology can be used to produce cleaner and more efficient power plants.

Electricity as a means of vehicle propulsion is still unavailable owing to the lack of light, compact, powerful and low-cost batteries. However, even in the absence of breakthroughs in battery technology, promising solutions are being developed. The hybrid car, for example, combines an electric motor that is more efficient and less polluting in urban conditions and a conventional engine for highway traffic (which also permits battery recharging). Some experts feel that such cars may soon appear on the market. Electric vehicles are generally believed to have very promising medium- and long-term potential, especially in urban areas, where future policies might progressively exclude the use of polluting vehicles. Compact, ultra-low-emission and noiseless light urban vehicles fill a real need in many polluted cities worldwide, particularly in developing countries. The number of electric vehicles in the United States increased from 1,607 in 1992 to around 5,820 in 1998, representing an average annual growth rate of about 24 per cent.

In general, it has been found that fuels offering the greatest emission reductions are also the most expensive. Among the alternative fuels, the greatest emission reduction is obtained with hydrogen, followed by compressed natural gas and LPG. Electric vehicles have zero emissions at the point of use; however, the emissions of $NO_x$ and $SO_2$ associated with power generation for electric vehicles can exceed those from gasoline-powered vehicle. The use of alternative fuel vehicles in the United States is promoted mainly through vehicle emission standards, direct subsidies and tax exemptions. In Europe, high gasoline and diesel tax rates have made it easier to use tax exemptions to encourage the use of alternative fuels.

## C. IMPROVING TRAFFIC MANAGEMENT AND URBAN PLANNING

### 1. *Improving traffic conditions*

An energy-saving policy in the land transport sector cannot be successful if it is based on technological improvements alone, as such improvements cannot compensate for growing demand. Improving traffic flow and circulation and providing better facilities and road infrastructures can solve some problems. Improving access to, and mobility within, a central area, while at the same time relieving the adverse impact of heavy automobile use and enhancing the pedestrian environment are only a few possible solutions for achieving better traffic conditions. In every urban area in the world, smoother traffic flow is the key factor in promoting fuel economy and limiting noise and pollutant emissions. The environmental advantages provided by improved urban traffic conditions were illustrated through a simulation of urban traffic conditions on a dynamometer bench. Smooth flow conditions in the early morning (5 a.m.) were compared with highly congested flow conditions (5 p.m. rush hour) along the same urban route. The result: under the smoother conditions, fuel economy was 31 per cent higher and hydrocarbon, CO and $NO_x$ emission levels were 54, 52 and 2 per cent lower, respectively, for a hot start. When the surface of a road is smooth and a constant speed can be maintained, the consumption of fuel drops noticeably. Table 21 shows the approximate effect of vehicle speed on the emission of various pollutants.

TABLE 21. EFFECT OF VEHICLE VELOCITY ON EXHAUST EMISSIONS

| Mode of operation | Hydrocarbons (ppm) | CO (percentage volume) | $NO_x$ (ppm) | $H_2O$ (percentage) | $CO_2$ (percentage) | $H_2$ (percentage volume) |
|---|---|---|---|---|---|---|
| Idle | 750 | 5.2 | 30 | 1.7 | 9.5 | 13.0 |
| Cruise | 300 | 0.8 | 1 500 | 0.2 | 12.5 | 13.1 |
| Acceleration | 400 | 5.2 | 3 000 | 1.2 | 10.2 | 13.2 |
| Deceleration | 4 000 | 4.2 | 60 | 1.7 | 9.5 | 13.0 |

Uncontrolled urban growth and the consequent increase in traffic can constitute an impediment to any plans for traffic improvements. It has been observed that the movement of people in some cities in the region tends to occur during the same few hours in the day, because of either weather conditions or social habits. In Damascus, for instance, it has been estimated that about 90 per cent of activities take place between 8 a.m. and 2 p.m. Control of urban growth is therefore necessary to facilitate transportation activity and make the best use of limited resources through improved collective management. In some countries, including most developing countries, it may be necessary to reverse the present trend of rural-urban migration, in particular by improving conditions in rural areas.

The geometric design of urban roads and highways can be best utilized to introduce improvements in traffic operations within certain urban areas. Use may be made, as appropriate, of separated traffic distribution, flyovers (both temporary and mobile) or underpasses at congested crossroads, traffic diversion, computerized traffic signals, off-street parking and licensing access to specific inner-city areas. Junction interchanges, flyovers and underpasses can be incorporated into major roads to facilitate traffic flow. In the city centre, traffic junctions can be fully computerized to give “green waves” to major traffic flow. Such intelligent infrastructure traffic management techniques have enhanced the carrying capacity of many major roads.

Improved traffic management in urban areas constitutes the most cost-effective technique for reducing transport-related air pollution. It has been observed in many large cities that simple changes such as changing two-way streets into one-way streets and changing the direction of traffic on certain major roads during peak hours to provide more lanes in the direction of heavy traffic have resulted in substantively smoother traffic flows. In those areas where urban traffic becomes extremely heavy, such as Beirut or Cairo, the use of stricter measures might be called for.

### 2. *Integrating land-use planning*

Urban planning can best be utilized to aid in abating the detrimental effects of traffic on air quality. Land-use and transport are closely related parts of the human activity system. An increase in activity calls for a corresponding increase in public transportation capacity. Systematic town planning can play a major role in minimizing the number of daily vehicle trips. Bringing schools, factories, offices, shops, and recreational and other facilities into or near activity centres minimizes the need to travel far or frequently for work and other activities. Development schemes should be carefully and progressively implemented. Alternative sites should be sought for new activities such as office development or for the relocation of existing activities with mobile characteristics such as wholesaling or warehousing. Developing countries have an advantage over developed countries in the sense that they are in the process of building or completing their infrastructures. They are therefore given a unique opportunity to carry out their urban expansion with appropriate incentives for more efficient and environmentally sound patterns.

### 3. *Promoting public transport*

Public transit can play a major role in combating urban air pollution. Public transit is an efficient people-mover compared with cars, as public transit vehicles occupy less road space for the same number of passengers. Buses and other means of public transport such as the metro are also more energy-efficient and less polluting than cars for each passenger carried.

Public transport should be the key element of a well-planned and integrated transportation system adapted to local needs and conditions. In order to promote the use of public transit, countries in the region should start to develop public transit systems that are efficient, comfortable, affordable and reliable. The use of such a system has two major advantages: it encourages car owners to use public transport (at least during peak hours), and it provides the commuting masses with an inexpensive and efficient means of transportation. Major steps have already been taken or are under serious consideration in some major cities in the region to establish better public transport facilities. For instance, the construction of the underground (metro) system in the city of Cairo has eased traffic congestion considerably. In addition, Damascus and Amman are considering constructing light rail systems. Studies undertaken as early as 1985 and in 1997 call for the construction of a 45-km line (one circumferential and three diagonal routes) with a total of 36 stations in Damascus.

It is imperative that Governments in the ESCWA region take measures to ensure the efficiency of public transit systems. Governments should provide infrastructure services such as bus interchanges and bus stop lanes, especially during peak hours; this will help bus operators to keep fares low. Priority should be given to public transport, and incentives should be provided, including reduced transport fees for the elderly, the less privileged, and weekly or monthly public transport subscribers.

Parking policies should enhance public transport activity by reducing access and the use of private cars in the city centre. Because most cities in the world have some form of public or private bus service, bus service improvement is essential. In most countries in the world, public transit does not generate revenue. Governments might opt to provide operating subsidies to encourage operators to offer good and efficient service. Public transit operators should be encouraged to upgrade their services in order to attract users. Continuous modernization of the bus fleets is required to ensure improvements in safety, comfort, noise and pollution emissions.

### 4. *Managing vehicle ownership*

No traffic management plan will be successful unless it includes provisions for controlling the number of registered vehicles. To minimize congestion, Governments should regulate both the ownership and the use of vehicles. First, the vehicle population must be maintained at levels that will not result in general congestion across the entire road network. Usage management measures can then be applied to relieve localized congestion and optimize the use of roads by distributing and controlling traffic more effectively over time and space. One measure would be to impose higher vehicle taxes, with rates based on the fuel consumption of the vehicle under consideration.

## IV. STATUS OF ENVIRONMENTAL LEGISLATION IN SELECTED ESCWA MEMBER COUNTRIES

### A. BACKGROUND INFORMATION

The impact of transportation, and mainly road transport, on the environment has long been established. California was the first State to regulate emissions from autos, as early as 1963. The United States Environmental Protection Agency (EPA) has played a very influential role in auto manufacturing. The auto industry has had to develop new technologies in order to meet emission regulations. Table 22 illustrates the history of these regulations, which have resulted in substantial reductions in auto emissions. The regulations delineate the maximum allowable emissions from automobiles at the production sites.

TABLE 22. SELECTED HISTORY OF UNITED STATES AUTOMOBILE AIR POLLUTANT EMISSION REGULATIONS

| | Permitted tailpipe emissions (grams per mile) | | |
|---|---|---|---|
| Year | CO | $NO_x$ | Hydrocarbons |
| 1960 (pre-control) | 87 | 3.6 | 8.8 |
| 1970 | 23 | .. | 2.2 |
| 1971 | .. | .. | .. |
| 1972 | 39 | .. | 3.4 |
| 1973 | .. | 3 | .. |
| 1975 | 15 | 3.1 | 1.5 |
| 1978 | .. | 2 | .. |
| 1980 | 7 | .. | 0.41 |
| 1981 | 3.4 | 1 | .. |
| 1993 | .. | 0.4 | 0.25 |
| 1996 (clean fuel vehicles) | .. | 0.4 | 0.125 |
| 2001 (clean fuel vehicles) | .. | 0.2 | 0.075 |

*Source*: Noel de Nevers, *Air Pollution Control Engineering*, (Singapore: McGraw-Hill, 1994), p. 405.

It is important to mention that appropriate legislation may already be in place in the countries of the ESCWA region. If enforced, the relevant laws could lead to a much-improved situation. Governments of the region are aware of the environmental damage caused by the various transport activities, and mainly by road transport. In response, some Governments have enacted and enforced legislation that requires the inclusion of new technology in imported vehicles in order to mitigate the harmful environmental effects of transport activities. Almost all ESCWA member States have in their traffic laws articles that call for stopping any vehicle that produces an unacceptable level of smoke. In the Syrian Arab Republic, the traffic law issued in 1991 specifically calls for imposing fines on vehicles that remove exhaust filters or emit polluted exhaust. In addition, all imported vehicles have to be inspected once after delivery and once after five years for privately owned vehicles and three years for commercial vehicles. In Jordan, vehicles are to be inspected once every year upon renewal of vehicle registration. Jordan has specified the maximum allowable limits for gaseous pollutants emitted into the atmosphere from vehicle exhausts. In addition, the Government has established some requirements for vehicles, effective by the year 2002. These include, among other things, the availability of unleaded gasoline of satisfactory quality and the installation of catalytic converters.

Steps to reinstate the motor vehicle inspection programme in Saudi Arabia are being taken. The centralized inspection system used in the past involved long delays owing to the limited number of stations (there were only four: two in Riyadh and two in Jeddah). The system only checked for the concentration of smoke from the exhaust but not for the concentration of pollutants. The new system being proposed will allow the private sector to undertake responsibility for establishing the stations that will ensure specifications and guidelines are being met. The Ministerial Committee on Environment, which includes representatives from various government sectoral and other institutions, has been established to formulate these guidelines. There is no specific date set to indicate when this system will become operative. In Lebanon, no vehicle inspection is required, and vehicle registration is done through banks. In Egypt, articles 36 and 37 of the executive regulation for Law No. 4 of 1994 set the standards and rules: establishments subject to the law's provisions must avoid emissions or leakage of air pollutants at or above the maximum limits allowed and must not exceed the limits determined by regulations; in addition, these pollutants must not change the composition and characteristics of natural air to the extent that it endangers human health and the environment.

## B. FUEL SPECIFICATIONS

Specifications relating to the quality of gasoline (premium and regular) are in existence in all member States of ESCWA and include various requirements. For example, the Saudi Arabia's standards for vehicle fuel call for sulphur content not to exceed 0.03 per cent (with maximum deviation of 0.015 per cent) by weight and for lead not to exceed 0.57 grams (with a maximum deviation of 0.03 grams per litre). In the Syrian Arab Republic the total maximum sulphur content by weight for both regular and premium gasoline is not to exceed 0.15 per cent and the fuel must be free of lead. The specifications for premium gasoline in the Syrian Arab Republic are shown in table 23.

TABLE 23. SPECIFICATIONS FOR PREMIUM GASOLINE IN THE SYRIAN ARAB REPUBLIC

| Characteristics | Requirements | Test methods |
|---|---|---|
| Specific gravity at 60° F or 15.6° C | 0.720-0.770 | ASTM-D1298/90 |
| Colour | Yellowish | Visual |
| Tetra ethyl lead g/l maximum | 0.4[a/] | ASTM - D3237/90 |
| Octane (research), minimum | 90 | ASTM - D2699/88 |
| Vapour pressure (Reid method) kg/cm$^2$ maximum | 0.7 | ASTM - D323/90 |
| Total sulphur weight maximum percentage | 0.15 | ASTM - D1266/87 |
| Gum content mg/100 ml maximum | 4 | ASTM - D381/86 |
| Oxidation stability in minutes, minimum | 420 | ASTM - D525/88 |
| Copper test 3 hours at 50° C | No. 1 | SNS 174/1981 |
| Water and sediments percentage | Nil[b/] | ASTM -D2709/88 |
| Distillation: | | ASTM - D86/1990 |
| 10 per cent distilled over, not higher than | 70° C | |
| 50 per cent distilled over, not higher than | 130° C | |
| 90 per cent distilled over, not higher than | 180° C | |
| Final boiling point not higher than | 200° C | |
| Residue volume percentage more than | 1.5 | |

*Source*: Syrian Arab Standardization and Metrology Organization, *SN.S* 67/1992 (Damascus, 15 December 1992).

a/ This will be changed to 0.

b/ No sediment.

In Damascus, the use of unleaded fuel has been encouraged since 1997. Unleaded fuel became available at all gas stations in the city in 1999. Currently about 30 per cent of the gasoline used in Damascus is unleaded, and plans are under way to extend its use to all other cities in the country. However, the use of a catalytic converter is not obligatory. In Egypt, the use of unleaded gasoline has increased; of the 2.1 million tons of gasoline consumed annually, about 90 per cent is unleaded. The average content of lead in regular gasoline is about 0.2 grams per litre, which is far below international requirements. In Kuwait, the Wahim Petroleum Company produces approximately 35,000 barrels of leaded gasoline and 34,000 barrels of unleaded gasoline every day. Kuwait was the first Gulf Cooperation Council (GCC) country to produce unleaded fuel (beginning in October 1998). In order to encourage the use of this fuel, its price was set equal to that of leaded gasoline. Currently, 80 per cent of the gasoline used in Kuwait is unleaded. Jordan will restrict the percentage of sulphur in diesel to a maximum of 0.5 per cent as of the year 2002. The specifications for premium gasoline in Jordan are shown in table 24. They indicate that the maximum sulphur content (by weight) should not exceed 0.2 per cent.

TABLE 24. SPECIFICATIONS FOR PREMIUM GASOLINE IN JORDAN

| Characteristics | Requirements | Test methods |
|---|---|---|
| Specific gravity at 60° F or 15.6° C | 0.7-0.76 | ASTM-D1298 |
| Colour | Yellow | Visual |
| Tetra ethyl lead g/l maximum | 0.83 | ASTM-D3341, D3116 |
| Octane (research), minimum | 96 | |
| Vapour pressure (Reid method) kg/cm$^2$ maximum | 0.7 | ASTM-D323 |
| Total sulphur weight, maximum percentage | 0.2 | ASTM-D1266, D2622 |
| Gum content mg/100 ml maximum | 5 | ASTM-D381 |
| Oxidation stability in minutes, minimum | 240 | ASTM-D525 |
| Copper test 3 hours at 50° C | No. 1 | ASTM-D130 |
| Distillation: | | ASTM-D86 |
| 10 per cent distilled over, not higher than | 70° C | |
| 50 per cent distilled over, not higher than | 120° C | |
| 90 per cent distilled over, not higher than | 180° C | |
| Final boiling point not higher than | 225° C | |
| Residue volume percentage more than | 2 | |

*Source*: Jordan Institution for Standards and Metrology, *"Petroleum products—gasoline"*, JS 164: 1998 (Amman, 1998).

In Lebanon, the specifications for both regular and premium gasoline (the latter shown in table 25) were developed in the early 1960s. These specifications are under revision, and a new set of specifications will soon be adopted. It is of prime importance that the content of lead and sulphur be revised owing to the heavy congestion in the urban areas of Lebanon.

TABLE 25. SPECIFICATIONS FOR PREMIUM GASOLINE IN LEBANON

| Characteristics | Requirements |
|---|---|
| Tetra ethyl lead g/l maximum | 0.8 |
| Octane (research), minimum | 92 |
| Vapour pressure (Reid method) kg/cm$^2$ maximum | 0.7 |
| Total sulphur weight, maximum percentage | 0.1 |
| Gum content mg/100 ml maximum | 10 |
| Cooper test 3 hours at 50° C | No. 1 strip |
| Distillation: | |
| 10 per cent distilled over, not higher than | 65° C |
| 50 per cent distilled over, not higher than | 125° C |
| 90 per cent distilled over, not higher than | 196° C |

*Source*: Lebanese Standards Institution, L.S.16: 1965 (Beirut, 1965).
*Note*: Revised specifications are currently being established.

Vehicle lead emissions must be controlled. Many incentives are being offered to reduce the amount of lead emitted into the air, as lead can cause serious health problems. The variations in the lead content of gasoline in selected ESCWA member States are indicated in table 26. In 1993, the lead content was 0.24 grams per litre in the Syrian Arab Republic, while it was approximately 0.53 grams per litre in Kuwait. Efforts are being made in the Gulf States to produce unleaded gasoline. This constitute a step towards harmonization of one characteristic of the fuel.

TABLE 26. ESTIMATED USE OF LEADED GASOLINE IN SELECTED ESCWA MEMBER COUNTRIES, 1993

| Country | Motor gasoline consumption (millions of litres per year) | Lead content of leaded gasoline (grams per litre) | Total added lead (tons per year) | Leaded gasoline share (percentage) |
|---|---|---|---|---|
| Egypt | 2 | 0.35 | 700 | 100 |
| Iraq | 4.4 | 0.4 | 1 700 | 100 |
| Kuwait | 1.2 | 0.53 | 620 | 100 |
| Qatar | 0.4 | 0.4 | 75 | 47 (1992) |
| Saudi Arabia | 9.3 | 0.4 | 3 700 | 100 |
| Syrian Arab Republic | 1.5 | 0.24 | 360 | 100 |
| United Arab Emirates | 1.3 | 0.4 | 530 | 100 |

*Source*: Asif Faiaz, Christopher Weaver and Michael Walsh, *Air Pollution from Motor Vehicles: Standards and Technologies for Controlling Emissions* (Washington D.C., 1996), p. 225.

## C. AIR POLLUTION STANDARDS

This section includes a review of existing legislation determining the maximum allowable concentrations of air pollutants in selected ESCWA member States. Since the concentration limits are for residential areas, it can be assumed that transport accounts for most of the emissions specified.

Ambient air quality standards are meant to define the limits above which the effects of pollutants will become harmful to human beings. These standards are generally established for various sample-averaging periods because the effects are dependent upon pollutant exposure time and concentration. There is a need to establish pollutant concentration limits for specified time periods (yearly, daily and hourly concentrations of the specified pollutants). When observations relating to air quality indicate that the standard maximum limits of some pollutants have been exceeded, prompt and strict correction programmes should be undertaken. Measures such as regulations to control fuel quality or emission control standards should be implemented. In urban areas, the major reason for air quality violations is traffic congestion.

Most ESCWA member States have established ambient standards, particularly for air. Most of these standards were not developed by the countries themselves but were taken from other sources, including WHO, the EPA in the United States, the World Bank, and the European Union (EU). Priority in the ESCWA region has been given to establishing primary ambient standards; little, if any, attention has been given to developing secondary ambient air standards. Tables 27 through 33 show the current ambient air quality standards (main pollutant limits) for various ESCWA member countries.

In a comparison of the allowed concentration limits of some ESCWA member countries with those of selected developed countries and WHO standards, some differences were observed. For instance, the carbon monoxide limits in Lebanon and Saudi Arabia were comparable with those of EPA, WHO and Canada, while those for the Syrian Arab Republic were found to be much lower and those for Iraq much higher than EPA, WHO and Canadian standards. As for nitrogen dioxide, Saudi Arabia's concentration after one hour's exposure was found to be the highest and that of Lebanon the lowest while the Syrian Arab Republic, Jordan, Iraq, the EPA, Canada and WHO had the same limits. However, for annual exposure to nitrogen dioxide, all countries and concerned organizations had the same limits. As for sulphur dioxide, the concentration limits in the above-mentioned countries for the one-hour exposure ranged from 0.134 parts per million (ppm) for the Syrian Arab Republic and WHO to 0.497 ppm for the EPA, whereas the annual exposure limits ranged from 0.015 ppm for WHO to 0.04 ppm for Lebanon and Jordan. Saudi Arabia and the EPA allowed the highest TSP concentration in 24 hours, with their limits set at 340 and 260 $\mu g/m^3$ respectively, while the other countries and WHO allowed a limit of 120 $\mu g/m^3$.

TABLE 27. MAXIMUM ALLOWABLE CONCENTRATIONS OF AIR POLLUTANTS IN MAJOR CITIES IN THE SYRIAN ARAB REPUBLIC

| Pollutant | Formula | Allowed concentration limit[a/] | Time rate | Frequency rate | Remarks |
|---|---|---|---|---|---|
| Carbon monoxide | CO | 26 ppm[b/] | 1 hour | | |
| Ozone | $O_3$ | 0.12 ppm<br>0.05-0.08 ppm | 1 hour<br>8 hours | | These concentrations are for ozone due to the breakdown of photochemical oxidants during the day. |
| Nitrogen oxides | $NO_x$ | 0.21 ppm | 1 hour | Not to exceed twice a month at any location | There are five nitrogen oxides known as nitrogen oxide gases, and the stable form is $NO_2$. |
| Nitrogen dioxide | $NO_2$ | 0.079 ppm<br>0.054 ppm | 24 hours<br>Annual rate | | |
| Sulphur oxides | $SO_x$ | 0.134 ppm | 1 hour | Not to exceed three times a month | There are many sulphur oxides, and the stable form is $SO_2$. |
| Sulphur dioxide | $SO_2$ | 0.047 ppm<br>0.03 ppm | 24 hours<br>Annual rate | | |
| Total suspended particulates | TSP | 150 µg/m$^3$<br>90 µg/m$^3$ | 24 hours<br>Annual rate | | Mineral suspended particulates are the total suspended particulates |
| Lead | Pb | 1.5 µg/m$^3$ | 3 months | | |

*Source*: Syrian Arab Standardization and Metrology Organization, SNS 67/1992 (Damascus, 1992).

a/ Concentrations are set according to World Health Organization standards.

b/ The previous limits were 24 ppm for 1 hour and 9 ppm for 8 hours.

TABLE 28. MAXIMUM ALLOWABLE CONCENTRATIONS OF AIR POLLUTANTS IN MAJOR CITIES IN SAUDI ARABIA

| Pollutant | Formula | Allowed concentration limit | Time rate | Frequency rate | Remarks |
|---|---|---|---|---|---|
| Carbon monoxide | CO | 35 ppm<br>9 ppm | 1 hour<br>8 hours | Not to exceed twice a month at any location<br>Not to exceed twice a month at any location | |
| Ozone | $O_3$ | 0.15 ppm | 1 hour | Not to exceed twice a month at any location | |
| Nitrogen dioxide | $NO_2$ | 0.35 ppm<br>100 µg/m$^3$ | 1 hour<br>Annual rate | Not to exceed twice a month at any location | |
| Sulphur dioxide | $SO_2$ | 0.28 ppm<br>0.14 ppm<br>0.03 ppm | 1 hour<br>24 hours<br>Annual rate | Not to exceed twice a month at any location<br>Not to exceed once per location | |

TABLE 28 (*continued*)

| Pollutant | Formula | Allowed concentration limit | Time rate | Frequency rate | Remarks |
|---|---|---|---|---|---|
| Total suspended particulates | TSP | 340 µg/$m^3$<br><br>80 µg/$m^3$ | 24 hours<br><br>Annual rate | Not to exceed once per location | Unusual excess in the TSP concentration (for 24 hours or 1 year) owing to natural causes may not be considered a reason for deviating from the set limits. |

*Source*: Meteorology and Environmental Protection Administration, "Standards for protection of the environment" (in Arabic), Document No. 01/1409 (Riyadh, 1989).

TABLE 29. MAXIMUM ALLOWABLE CONCENTRATIONS OF AIR POLLUTANTS IN MAJOR CITIES IN LEBANON

| Pollutant | Formula | Allowed concentration limit | Time rate | Frequency rate | Remarks |
|---|---|---|---|---|---|
| Carbon monoxide | CO | 26 ppm<br>9 ppm | 1 hour<br>8 hours | | |
| Ozone | $O_3$ | 0.08 ppm<br>0.05 ppm | 1 hour<br>8 hours | | |
| Nitrogen dioxide | $NO_2$ | 0.10 ppm<br>0.08 ppm<br>100 µg/$m^3$ | 1 hour<br>24 hours<br>Annual rate | | |
| Sulphur dioxide | $SO_2$ | 0.18 ppm<br>0.16 ppm<br>0.04 ppm | 1 hour<br>24 hours<br>Annual rate | | |
| Total suspended particulates | TSP | 120 µg/$m^3$ | 24 hours | | |
| Suspended particulates < 10 microns | | 80 µg/$m^3$ | 24 hours | | |
| Benzene | | 5 ppb | Annual rate | | |
| Lead | Pb | 1.0 µg/$m^3$ | Annual rate | | |

*Source*: Lebanon, Ministry of Health, Resolution No. 1/52, *Official Gazette*, No. 45 (Beirut, 12 September 1996).

TABLE 30. MAXIMUM ALLOWABLE CONCENTRATIONS OF AIR POLLUTANTS IN MAJOR CITIES IN IRAQ

| Pollutant | Formula | Allowed concentration limit | Time rate | Frequency rate | Remarks |
|---|---|---|---|---|---|
| Nitrogen dioxide | $NO_2$ | 0.25 ppm<br>0.5 ppm | 1 hour<br>Annual rate | | |
| Sulphur dioxide | $SO_2$ | 0.15 ppm<br>0.1 ppm<br>0.03 ppm | 1 hour<br>24 hours<br>Annual rate | | |
| Carbon monoxide | CO | 35 ppm<br>9 ppm | 1 hour<br>8 hours | | |

*Source*: ESCWA, " Country paper: Iraq" (in Arabic), E/ESCWA/ENR/1999/WG.3/CP.8.

TABLE 31. MAXIMUM ALLOWABLE CONCENTRATIONS OF AIR POLLUTANTS IN MAJOR CITIES IN EGYPT

| Pollutant | Formula | Allowed concentration limit | Time rate | Frequency rate | Remarks |
|---|---|---|---|---|---|
| Nitrogen dioxide | $NO_2$ | 400 μg/m$^3$<br>150 μg/m$^3$<br>60 μg/m$^3$ | 1 hour<br>24 hours<br>Annual rate | | |
| Sulphur dioxide | $SO_2$ | 350 μg/m$^3$<br>150 μg/m$^3$<br>60 μg/m$^3$ | 1 hour<br>24 hours<br>Annual rate | | |
| Total suspended particulates | TSP | 230 μg/m$^3$<br>90 μg/m$^3$ | 24 hours<br>Annual rate | | |
| Suspended particles < 10 microns | | 70 μg/m$^3$ | 24 hours | | |

*Source*: ESCWA, "The Egyptian experience in allying environmental norms and standards in the areas of electricity generation, transmission and distribution" (E/ESCWA/ENR/1999/WG.3/3).

TABLE 32. MAXIMUM ALLOWABLE CONCENTRATIONS OF AIR POLLUTANTS IN MAJOR CITIES IN JORDAN

| Pollutant | Formula | Allowed concentration limit | Time rate | Frequency rate |
|---|---|---|---|---|
| Carbon monoxide | CO | 26 ppm<br>9 ppm | 1 hour<br>8 hours | Not to exceed three times a month |
| Nitrogen dioxide | $NO_2$ | 0.21 ppm<br>0.08 ppm<br>0.05 ppm | 1 hour<br>24 hours<br>Annual rate | Not to exceed three times a month |
| Sulphur dioxide | $SO_2$ | 0.30 ppm<br>0.14 ppm<br>0.04 ppm | 1 hour<br>24 hours<br>Annual rate | Not to exceed three times a month<br>Not to exceed once per year |
| Total suspended particulates | TSP | 260 μg/m$^3$<br>75 μg/m$^3$ | 24 hours<br>Annual rate | Not to exceed three times a year |
| Suspended particulates < 10 microns | | 120 μg/m$^3$ | 24 hours | Not to exceed three times a month |
| | | 70 μg/m$^3$ | Annual rate | |
| Sulphuric acid | $H_2S$ | 0.03 ppm<br>0.01 ppm | 1 hour<br>24 hours | Not to exceed three times a month<br>Not to exceed three times a month |
| Lead | Pb | 1.0 μg/m$^3$<br>0.5 μg/m$^3$ | Seasonal<br>Annual rate | |

*Source*: Jordanian Institute of Standards and Metrology, "Pollutants: maximum allowable limits of air pollutants emitted from mobile sources", JS 1140/1999 (Amman, 1999).

## D. CONTROLS FOR EXHAUST GASES FROM MOTOR VEHICLES

Regulations to control gaseous emissions from vehicles are much needed in order to control pollution levels. Regulations of this sort adopted in the EU provide a good example and can perhaps serve as a model for the possible harmonization of such standards. Table 33 summarizes the EU directives that have been issued, together with their possible amendments.

TABLE 33. EUROPEAN UNION DIRECTIVES FOR ENVIRONMENTAL STANDARDS AND REGULATIONS FOR THE TRANSPORT SECTOR

| Directive No. | Subject of directive |
|---|---|
| Directive 70/220/EEC (1970) | Established technical standards for emissions of carbon monoxide (CO) and unburned hydrocarbons from petrol-driven vehicles (with the exception of tractors and public works vehicles) |
| Directive 88/436/EEC | Sets value limits for particulate pollutant emissions from diesel engines |
| Directive 89/458/EEC | Sets stringent European standards for emissions of gaseous pollutants from motor vehicles with engines smaller than 1,400 $cm^3$ |
| Directive 91/441/EEC | Covers all passenger cars regardless of their engine capacity; includes requirements relating to evaporative emissions and to the durability of emission-related vehicle components as well as more stringent particulate pollutant standards for motor vehicles equipped with diesel engines |
| Directive 94/12/EC | Introduced value limits for all pollutants and a modification of the control of conformity of the production applied to passenger cars designed to carry more than six passengers and having a maximum mass of more than 2,500 kg (light commercial vehicles) |
| (i) Applied since January 1996 for new vehicles and since January 1997 for all vehicles | Modified directive 70/220 in that it aimed to reduce carbon monoxide emissions to 2.2 grams per km for petrol and by 1 gram per km for diesel. The directive also aimed at reducing hydrocarbons and nitrous oxide output to 0.5 grams per km for petrol and 0.7 grams per km for diesel |
| (j) Replaced directive 93/59/EEC and directive 96/69/EC | Requires that the Commission propose standards to be enforced after the year 2000, according to a new multi-faceted approach, which includes (1) assessment of costs and efficiency of all measures aimed at reducing road transport pollution; (2) tighter car emission standards; (3) complementary measures for improving fuel quality and car fleet inspection and maintenance programmes; (4) the establishment of air quality criteria and associated emission reduction objectives; and (5) an evaluation of the cost-effectiveness of each package of measures |
| Directive 77/143/EEC on testing vehicle emissions (amended by directive 92/55/EEC) | Requires testing vehicle emissions in regular roadworthiness tests for the control of CO and the air-fuel ratio for petrol-fueled vehicles, and of the opacity of the exhausts from diesel vehicles |
| Directive 94/63/EC on emissions of volatile organic compounds | Controls volatile organic compound (VOC) emissions resulting from the storage of petrol and its transportation from terminals to service stations. The provisions of this directive are currently being revised |
| Directive 85/210/EEC on the lead content of petrol (to be replaced by the year 2000 by directive COM/96/0164 [COD]) | Allows member States to reduce the permitted lead content to 0.15 grams of lead per litre as soon as they consider it appropriate; they must ensure the availability and balanced distribution of unleaded petrol having a lead content below 0.013. The benzene content of both leaded and unleaded petrol may not exceed 5 per cent. Unleaded petrol must be clearly labelled at the pump |
| Directive 93/12/EEC on the sulphur content of liquid fuels (to be replaced by COM/96/0164 [COD] with regard to diesel fuel, gas oil and heavy fuel oil) | Limits the sulphur content of certain liquid fuels including diesel fuel and other gas oils. With regard to gas oil and heavy fuel oil, the Commission recently made a proposal to revise the provisions of directive 93/12/EEC. In order to reduce sulphur dioxide pollution, in particular ground-level concentrations in urban areas, the directive imposes maximum sulphur limits (by weight) for gas and diesel oils. Further reductions in sulphur limits (by weight) and related emission standards for diesel engines are anticipated through the introduction of a generalized 1 per cent ceiling on sulphur content from the start of 2000. The directive does not apply to gas oil intended for further processing or contained in the fuel tanks of vehicles crossing the frontiers of the EU. New limits on the sulphur content of diesel fuel will be introduced under the auto-oil programme |

TABLE 33 (*continued*)

| Directive No. | Subject of directive |
|---|---|
| Directive 82/884/EEC on lead emissions | Sets a maximum value limit for lead concentrations in the air of 2 micrograms per cubic metre, expressed as an annual mean concentration |
| Directive 75/716/EEC on the sulphur content of fuel oils | Limits the concentration of sulphur in oil for heating and cooking and for motor vehicles powered by diesel engines (gas oil) |
| Directive 87/212/EEC on the sulphur content of fuel oils | Sets a series of maximum sulphur content limits starting with 0.3 per cent as of January 1989. The limit dropped to a maximum of 0.2 per cent for all gas oils by 1994 and a limit of 0.05 per cent for automotive diesel fuel by October 1996 |
| Directive 88/77/EEC (amended by 91/542/EEC; to be modified by directive COM/95/350 [COD]) | Establishes emission requirements for carbon monoxide, hydrocarbons and nitrogen oxides; modification introduces requirements for particulate emissions |

*Source:* ESCWA, "Towards harmonization of environmental standards in the energy sector of ESCWA member States", (E/ESCWA/ENR/1999/WG.3/12/Add.1).

Egyptian regulations for pollutant emissions specify that certain maximum limits are to be imposed. For vehicles currently in use, CO should not exceed 7 per cent in volume at a running speed of 600-900 revolution per minute (rpm). No more than 100 ppm of unburned hydrocarbons should be allowed at the same speed (600-900 rpm). Smoke must not exceed 65 per cent in terms of degree of darkness, or the equivalent in other units, at minimum acceleration.

The limits adopted by Saudi Arabia and other GCC countries for maximum gaseous exhaust emissions are presented in table 34.

TABLE 34. MAXIMUM LIMITS FOR VEHICLE EXHAUST GAS EMISSIONS IN SAUDI ARABIA

| Vehicle reference weight (kg) | CO weight (g) | | Hydrocarbon weight (g) | | $NO_2$ weight (g) | |
|---|---|---|---|---|---|---|
| | Type test | Acceptance test | Type test | Acceptance test | Type test | Acceptance test |
| <750 | 65 | 78 | 6 | 7.8 | 8.5 | 10.2 |
| 750-850 | 71 | 85 | 6.3 | 8.2 | 8.5 | 10.2 |
| 850 -1020 | 76 | 91 | 6.5 | .. | 8.5 | 10.2 |
| 1020-1250 | 87 | 104 | 7.1 | 9.2 | 10.2 | 12.2 |
| 1250-1470 | 99 | 119 | 7.6 | .. | 11.9 | 14.3 |
| 1470-1700 | 110 | 132 | 8.1 | 10.5 | 12.3 | 14.8 |
| 1700-1930 | 121 | 145 | 8.6 | 11.2 | 12.8 | 15.4 |
| 1930-2150 | 132 | 158 | 9.1 | 11.8 | 13.2 | 15.8 |
| 2150-3500 | 143 | 172 | 9.6 | 12.5 | 13.6 | 16.3 |

*Source*: Saudi Arabian Standards Organization, "Maximum allowable concentration limits of air pollutants emitted from vehicles" (in Arabic), Document No. 01-1409 (Riyadh, 1994).

The value limits expressed in table 34 are those collected within 13 minutes. Certain procedures must be followed in accordance with Saudi Arabia's specification No. 367/1984 (equivalent to GCC specification 47/1984) to determine whether vehicles pass or fail. For instance, a vehicle will pass the test if the measured weight of each pollutant is equal to or less than 0.7 per cent of the maximum values given in the table above. If the weight of any pollutant is more than 1.1 per cent of the maximum values specified, then the vehicle will fail the test and measures have to be taken to reduce the concentration of the pollutant in question.

Jordanian limits for emissions from gasoline engines are shown in table 35.

TABLE 35. MAXIMUM LIMITS FOR GASEOUS POLLUTANTS EMITTED FROM GASOLINE AND DIESEL ENGINES IN JORDAN

| Fuel | Pollutants | | | | | |
|---|---|---|---|---|---|---|
| *Gasoline* | | | | | | |
| Vehicle type | CO (percentage volume) | Hydrocarbon (ppm) | $NO_x$ (ppm) | $O_3$ (percentage) | $CO_2$ (percentage) | $SO_x$ (ppm) |
| Old | 4.5 | 600 | 2500 | 3 | 13-16 | .. |
| New | 3 | 300 | 200 | 2 | 13-16 | .. |
| *Diesel* | | | | | | |
| Vehicle type | CO (percentage volume) | Hydrocarbon (ppm) | $NO_x$ (ppm) | Smoke (percentage volume) | $CO_2$ (percentage) | $SO_x$ (ppm) |
| Old | 1 500 | 1 000 | 1 000 | 65 | .. | 250 |
| New | 1 000 | 700 | 600 | 50 | .. | .. |

*Source*: ESCWA, "Towards harmonization of environmental standards in the energy sector of ESCWA member States", (E/ESCWA/ENR/1999/WG.3/12/Add.1).

Jordan has adopted the EU standards for motor vehicle emissions without any modifications, as these specifications are considered appropriate for Jordan's geographical and meteorological conditions.

## E. TOWARDS HARMONIZATION OF ENVIRONMENTAL STANDARDS IN THE TRANSPORT SECTOR

The importance of harmonization to the overall economy points to the necessity of issuing, implementing and maintaining standards that can serve as an effective tool for raising the competitiveness of the products and services of a nation.[8] These standards should have a strong technical basis and should be developed by consensus and tested in practice. Moreover, these standards should be well-referenced and should specify levels that are compatible with other proven standards. Above all, the standards should be well-balanced and economically justifiable and feasible.

Standards bodies exist at various levels (national, regional and international). Most of the national standards bodies in the ESCWA region are governmental. Standardization at the regional level has become important only recently, with the formation of trade blocs. In ESCWA member countries the benefits of standardization at the regional level were recognized by the formation of the Arab Standardization and Metrology Organization (ASMO) in 1968. It should be emphasized that standardization is a dynamic process and therefore requires the monitoring of advances in science and technology.

The preceding sections have provided some information on existing standards associated with the various components of vehicle transport, mainly standards for emission control, fuel types, and ambient air quality. There are some general differences in these standards owing to the fact that they were derived from various sources.

As a first step, before national standards are harmonized in the ESCWA region, thorough and critical assessments of such standards should be carried out. National standards must comply with other national regulatory systems in order to avoid conflicts and inconsistencies. Problems can arise when two different sets of standards are applicable to the same kinds of emissions. One obstacle to the regional harmonization of standards is that some national standards are too rigid. As observed with the standards listed for ambient air, some national standards in the ESCWA region are more rigid than those applied in developed countries. For instance, the American limit for small particulates (PM10) is 150 $\mu g/m^3$ while the Egyptian limit is as low as

[8] ESCWA, "Survey of national institutes of standards in the ESCWA region" (E/ESCWA/ID/1997/10).

70 µg/$m^3$ 24-hour average. This indicates that a comprehensive revision of national standards is worth considering, with the view of making them more realistic and easier to implement.

Another difficulty that may preclude the harmonization of standards for motor gasoline relates to economic considerations. For instance, in harmonizing sulphur content standards for premium gasoline, countries producing fuel with a high sulphur content would incur high costs.

For the enforcement of environmental standards in the transport sector, two issues should be considered. One is the availability of the manpower and equipment to apply those standards, and the second is the availability of a licensing authority to implement them. In most ESCWA member States experience has shown that in efforts to apply exhaust emission standards, it has been difficult to establish regular testing programmes to check the concentration of pollutants. Some countries (including Saudi Arabia) are delegating this authority to the private sector. The more practical approach would be to limit regular checking to public transport and heavy commercial vehicles; however, all vehicles that emit smoke should be checked.

# V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## A. SUMMARY

This study constitutes a basic but essential step in the long process of harmonizing environmental standards in land transport: it defines the major effects of land transport on the environment. Major issues related to environmental pollution from land transport are considered both from a global and a regional perspective. Statistics from the region related to such relevant issues as population growth and increases in vehicle ownership, as well as specific figures for energy consumption and pollutant emissions associated with transport activities and the measures available to minimize them, are presented. The current national standards for vehicle emissions, fuels and ambient air quality for selected countries in the ESCWA region are reviewed. Finally, information is presented on noise pollution and its impact and the status of legislation with respect to noise standards in selected ESCWA member countries.

## B. CONCLUSIONS

The main conclusions of this study can be summarized as follows:

1. The standards in the ESCWA region with respect to land transport pollution derive from various sources. Insufficient effort has been exerted to determine their applicability to national conditions. Major steps must be undertaken before the harmonization of environmental standards in the land transport sector can be attempted or achieved.

2. While some effective technological measures are available to address the problem of transport-related air pollution, developing countries will have to concentrate their efforts on traffic control and management.

3. The issue of land transport pollution has not received the attention it deserves in the region, mainly because there is not enough awareness about the future magnitude of the problem, and also because of the absence of reliable data on air pollution. It would be more effective and appropriate in this context to take steps that address the major catastrophic problems related to city pollution from vehicle operation. The high rates of population increase in the region and the consequent increase in the number of vehicles, concentrated in already congested urban areas, will ultimately result in pollution crises in the major cities in the region.

4. Average gasoline consumption in the ESCWA region ranges between 31 and 871 kg per capita, in comparison with 140 kg per capita worldwide. Gasoline consumption is very high, indicating heavy dependence on auto transport, which is known to be the worst polluter among all modes of transport.

5. The road transport sector in the region is not considered a major contributor to $NO_x$ emissions, and emissions of $CO_2$ in the region are being gradually controlled and reduced to low levels.

6. There is growing interest in the region, especially in Egypt, in utilizing natural gas as an alternative fuel for vehicles. So far, environmentally friendly alternative fuels are not being used in the ESCWA region.

## C. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

(a) Air pollution from urban traffic should be reduced:

(i) Traffic management regulations for urban areas should be improved, as they could provide a cost-effective means of reducing transport-related air pollution. In some cities, including Beirut and Damascus, very effective remedies for vehicle-related pollution can be introduced through the adoption of schemes to improve public transit systems and the adoption of measures to control the importation of vehicles and reduce fuel consumption. Fuel prices reflecting the high social costs linked to fuel use could both restrain the growing demand for fuel and stimulate demand for more fuel-efficient technologies. Reducing road traffic by these means offers the added advantage of meeting other objectives besides pollution reduction, including noise and congestion reduction, traffic safety and improvement of the quality of life in general. It is imperative that public transport systems save users both time and money; otherwise, they will not constitute a reasonable alternative to private transport;

(ii) The use of natural gas as a fuel should be encouraged, especially for vehicles operating in congested areas. It is important that national plans be established to ensure the proper monitoring of traffic flow. The use of alternative fuels that cause less pollution should be considered, especially for public transit, in urban areas where traffic pollution is observed to be high;

(b) Standards should be formulated:

(i) National or regional air quality standards should be established and the types of pollutants emanating from transport activities should be defined. Sufficient resources should be allocated to carry out the required programmes for measuring air quality and/or enforcing regulations relating to relevant standards. In addition, efforts should be exerted to review current national specifications to identify those areas in which their application is difficult owing to either the extreme rigidity of certain limits or their conflict with other regulatory instruments;

(ii) National specifications for imported vehicles should be amended to allow the importation of more environment-friendly vehicles. The use of such systems as the International Conformity Certification Programme should be encouraged to ensure the compliance of imported vehicles with required specifications;

(iii) No major improvement in air quality can be achieved if only standards for new vehicles are targeted and no action is taken to address emissions from old vehicles. A related issue to consider is the maintenance of vehicles. Without proper maintenance and checking for pollutant emissions, all new technological solutions adopted in manufacturing new vehicles become ineffective. Because the proper maintenance of vehicles plays a major role in determining pollution emissions, especially for commercial vehicles, more vigorous vehicle inspection programmes should be implemented. In order to guarantee a smoothly running programme, it may be necessary to authorize the private sector to perform this task. This can be done only after regulatory instruments that guarantee the proper implementation of the system have been authorized.

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