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ASSESSMENT OF TRANSPORT-RELATED POLLUTION IN THE ESCWA REGION

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Introduction

Transport plays a major role in the development of the countries in the ESCWA region. It is well established now that no economic activity can take place without reliance on a form of transportation. The prevailing modes of transport have changed in their significance over the years. For instance in the early years of the twentieth century more emphasis was given to the rail transport which came to an end in the early 1930's with the depression. The motor vehicle started to become the major mode of transport by the middle of this century. Motor vehicles have become indispensable part of modern life. It was established that most of the countries in the region are witnessing a greater increase in transport demand than their respective GDP. The main reason for this is due to both the continuing movements of people from their rural areas to the newly developing urban areas. There seems to be no alternative to roads that can accomplish the functions of supplying relatively fast, cheap land transportation. The number of vehicles in the world in 1950 was about 53 million. In 1990 this figure has jumped to more than 430 million indicating an average annual increase of about 9.5 million vehicles. Worldwide, the transport sector accounts for more than 60 percent of oil products, which constitute about 98 percent of transport energy. The figure was 92 percent for the year 1960, which indicates there is a continuous more dependence on oil in the transport sector. Because the trend worldwide is towards more frequent use of personal automobiles it becomes evident there should be effective steps taken in order to reduce the current detrimental impact otherwise the cumulative effect will be multiplying.

The status of legislation in selected member countries in the ESCWA region with regards to the pollution control from mobile sources are reviewed in this study. The emphasis is directed towards the steps being undertaken with respect to the issues dealing with maximum limits imposed for some pollutants, the specifications imposed on the quality for the fuels used and the specifications for importation of new vehicles. Finally the inspection schemes and enforcement measures with regards to the mechanics of vehicles are explained with emphasis on their role in mitigating the harmful impact on the environment.

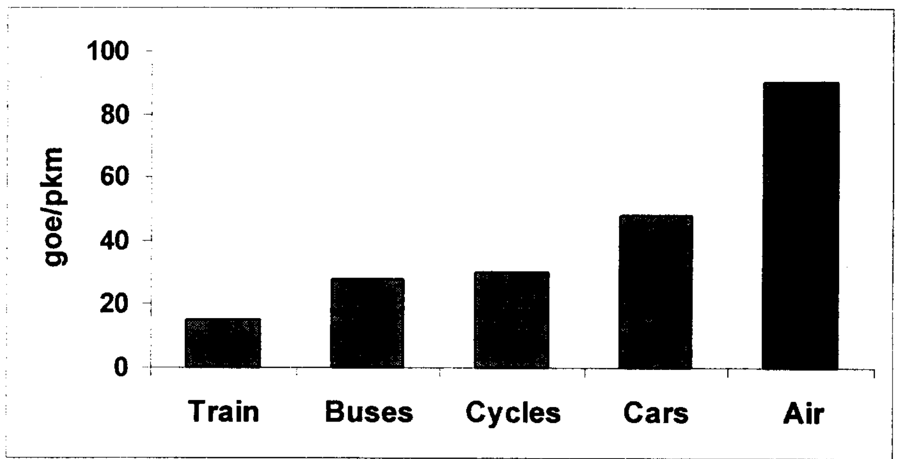
This paper presents a very brief review of the environmental impact of land transport and the current situation in some ESCWA countries. It presents a scheme for mitigating the harmful effect of land transport on the environment and recommends specific procedures that may lead to improved environmental condition.

A. Nature of the Problem

Transport is never environmentally neutral since all modes of transport consume one kind or other of fuel, which results in varying degrees of pollution. It is estimated that the transport sector accounts for more than half of world oil consumption and that there is a constant increase in energy consumption in this vital sector. In urban areas of developing countries, motorization has been more concentrated than 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 public health guidelines and standards.

Petroleum products mainly supply energy needs in the transport sector. Internal combustion engines (ICEs) power the vast majority of vehicles. Almost all of these engines are fuelled with distillates of petroleum-gasoline, diesel, LPG or kerosene. This is mainly attributed to many reasons among which are the ICEs' high efficiency, high power-to-weight and power –to-volume ratios, and low cost compared with alternative prime movers. Another factor peculiar to road transport is the predominant role of car transport, which has the lowest intrinsic energy efficiency, especially with the low quality of roads in many developing countries. In all countries, the transport sector is over 95 per cent dependent on hydrocarbons. This is especially the case in developing countries, which have even 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) countries alone accounts for half of world fuel product consumption. Figure 1 shows clearly that the unit of energy consumption by cars (expressed as goe/person-km) is very high compared to other modes of transport and only exceeded by air transport.

Fig 1. Unit of energy consumption by mode of passenger transport



Source: UNEP, *Energy Savings in the Transport Sector*, Technical Report No. 25.

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 contributing factors to this is the continuous increase in the population in the various countries, with the inevitable growth in travel frequency and transport volume. 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 the year 1990. ESCWA member countries have experienced similar trends. Table 1 shows that the increase in the number of registered vehicles has more than doubled, or tripled, in all ESCWA member countries in a short span of time.

Table 1. Motor vehicles in use in the ESCWA region

Country	1983	1985	1987	1989	1991	1993	1995	1997
Bahrain	85998	102030	108337	117653	125942	145922	160600	...
Egypt	...	1012045	1115219	1175499	1265064	1557403	1819530	1987493
Iraq ([illegible]	...	684080	807552	944351	955165	981664	...	...
[illegible]	...	191190	207635	213221	217583	235589	253960	283821
[illegible]	...	536500	544588	598573	683371	724259	791696	...
[illegible]	...	...	...	...	...	1115918	1282257	1391473
[illegible]	...	...	170248	190116	236299	272843	295384	352184
[illegible]	...	...	139938	153751	179875	198801	212921	247003
[illegible]	3560698	4131846	4415219	4950466	5328455	5580000	6111137	...
[illegible]	235982	229272	242574	242792	245907	312173	387008	...
[illegible]	206915	232431	234746	286629	284727	369952	...	...
[illegible]	...	...	...	276347	326571	432717	528746	740189

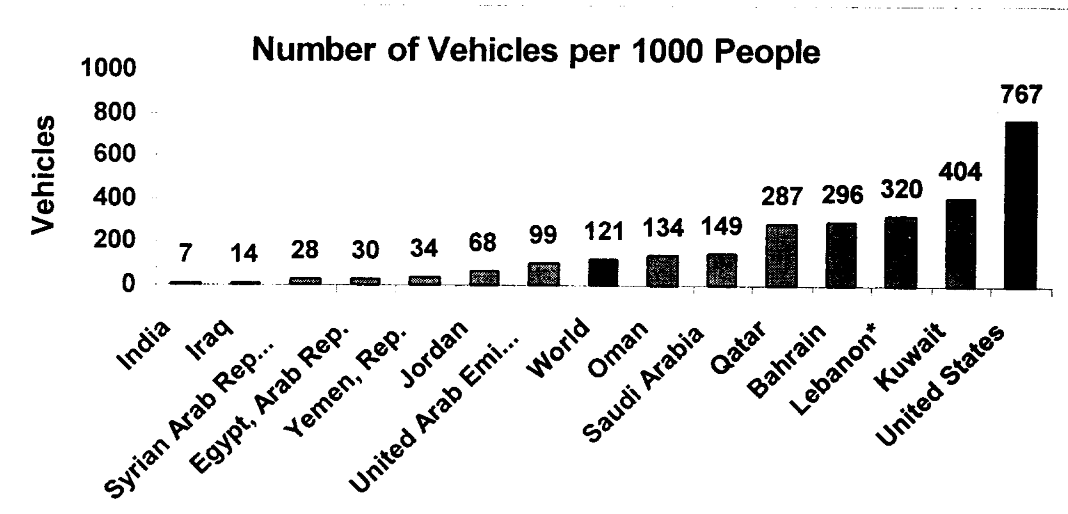
Source: Data compiled by the Statistics Division of ESCWA.

Figure 2 shows the number of vehicles per 1000 capita in the ESCWA member states. The figure clearly indicates a large variation in the ownership of vehicles. The world average for the year 1998 was 121 vehicles per 1000 people. Definitely a major factor that affects this ratio is the average income per capita. However other factors contribute also such as the tax laws and the limitation on the number of vehicles that one person can own. It is to be noted also here that the amount of pollution that is experienced in one country can hardly be based on this indicator alone. For instance it is well recognized that air pollution in Egypt, where the average number of vehicles per 1000 people is 30, is much more than that of Bahrain where the corresponding number is 296. It is more appropriate to measure the traffic volumes at a certain location and other related factors such as the volume to capacity ratio, the operating speeds, the average distance of a trip, and other related factors.

One major problem associated with the efforts to control the amount of pollution emitted from vehicles is that the number of vehicles in any place is continuously increasing.

In ECWA region, as shown in Table 3, the rate of growth of number of vehicles indicates clearly that there is a continuous rise with various rates. Some countries like Yemen are still witnessing very high increasing rates. On the average the rate of increase is higher than the world average indicating that more environmental impact will be encountered with time which call for appropriate strategies to be formulated.

Fig 2. Number of vehicles per 1000 capita in the ERSCWA region



* Actual number is probably higher since not all cars are registered
Source: World Development Indicators 1998, World Bank .

Table 3. rate of annual growth in vehicles in the ESCWA region

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	[illegible]	[illegible]	[illegible]	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	...
Syria	1	-4	5	1	3	-3	1	1	6	16	9	11	8	...
U.A.E.	5	6	-3	3	6	13	-3	2	11	14	...	...	...	...
Yemen Republic	...	...	...	...	...	...	3	13	11	15	7	12	13	18

Source: Based on Table 2 above.

B. Motor Vehicle Pollution

It is well known that burning fossil fuels will result in producing pollutants that are not only harmful to human beings but also to plants and infrastructures. Motor vehicle emissions into the air are a critical class of pollutants. The most important environmental problems related to land transport are climate change and depletion of the ozone layer, spread of acidifying and oxidant-forming substances, spread of organic compounds. It is not to be forgotten that other important aspects that are related to noise and accidents can also be termed as environmental impacts. It is noted that the environmental impact of motor vehicles can have local, regional and even global impact. Definitely the pollution caused by traffic is most felt in urban areas.

The most important transport-borne pollutants are the Nitrogen oxides (NO_x), Carbon monoxide (CO), Carbon Dioxide (CO_2), Hydrocarbons (HC), Sulphur oxides (SOx), and numerous gaseous organic carbon compounds- mainly hydrocarbons (HC)- referred to collectively as volatile organic compounds (VOCs). Lead and suspended particulate matter are also considered as major pollutants.

More than one third and up to on half of the NO_x emitted in the atmosphere is attributed to mobile sources. The most pronounced effect of the nitrogen oxides is attributed to their combination with other air pollutants to form various oxidants. Most important is the formation of the ozone (O_3) that results from the reaction between nitrogen oxides and hydrocarbons in the sunlight. In addition another product associated with the reaction of nitrogen and sulphur oxides with unburned hydrocarbons is the acid rain.

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

Carbon dioxide from mobile sources is estimated as 15 percent of the all carbon dioxides emitted into the atmosphere. Definitely with the expected increase in the number of vehicles that this percentage will be increased. It is expected that global warming will result from the increasing concentration of this gas. The energy policy (volume 22, Number 6, June 1994) estimates that burning 1 ton of petrol gives 3.21 tons of CO2 whereas 1 ton of diesel gives 3.17 tons of CO_2. Table 4 shows the total amount of motor gasoline consumed in the various countries of ESCWA and the average consumption expressed in kg of gasoline per capita.

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

Lead has been 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 cause major effects on human health and the introduction of the unleaded gasoline is finding worldwide acceptance and implementation. Table 5 summarizes the effects of the various pollutants on human beings.

Table 4. Total motor gasoline consumption in the ESCWA region

Country	Production 1000 t	Import 1000 t	Export 1000 t	Consumption	
				Total 1000 t	Kg / Capita
India	4362			4362	[illegible]
Egypt	4520	0	2590	1930	31
Syria	1342	0	339	1023	72
Yemen	990	150	0	1140	76
Jordan	483	0	0	486	90
World	797863	75206	90127	[illegible]	[illegible]
Iraq	2990	0	0	2990	149
Oman	555	76	0	631	286
Lebanon	-	1279	0	1279	425
UAE	1498	0	340	1158	524
Saudi Arabia	9971	0	156	9805	537
Bahrain	1050	0	746	301	540
Qatar	558	0	120	438	799
Kuwait	1902	0	429	1473	871
USA	325854	11378	4486	[illegible]	[illegible]

Source: Energy Statistics Yearbook 1995, United Nations.

C. Status of Environmental legislation in selected member states of ESCWA

It is important to mention at the beginning that there might be no real lack of laws and legislation that if effected, could lead to a much- improved situation than what is currently now in practice. For instance almost all member states in the ESCWA region have in their Traffic Laws articles that call for stopping any vehicle that produces unacceptable smoke. In Syria, for example, Traffic Law issued in 1991 specifically calls for imposing fines on vehicles that remove exhaust filters or emit polluted exhaust in the air. In addition all imported vehicles have to be inspected once after delivery and once after 5 years for privately owned vehicles and 3 years for other vehicles. In Jordan vehicles have to be inspected once every year during renewal of vehicles. Steps in order to reinstate the motor vehicle inspection program in Saudi Arabia are underway. The then centralized system for inspection encountered some problems related to the large delays at the stations due to their very limited numbers (only two stations in each of Riyadh and Jeddah). The system then only checked for the concentration of smoke from the exhaust and no elaborate checking for concentration of pollutants was undertaken. The new proposed system will allow the private sector to undertake the responsibility of establishing the stations that will follow specifications and guidelines. A special Ministerial Committee on Environment (MCE) that includes representatives from the various governmental and other institutions has already been set formulate these guidelines. There is currently no specific date a when this system will be operative. In Lebanon currently there is no inspection required from vehicles and the registration of the vehicles is done through banks.

Table 5. Sources, impacts, and exceedances of the principal motor-vehicle-related air pollutants

Pollutant	Type of impact						Source of emission	Health effects of pollutant
	Local	Regional		Global				
	High concen-tration	Acidifi-cation	Photo-chemical oxidants	Indirect Green-house Effect	Direct Green-house Effect	Strato-spheric Ozone Depletion		
Suspended particulate matter (SPM)	x		x				Products of incomplete combustion of fuels; also from wear of brakes and tires	Irritates mucous membranes; increased 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	Reduced 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 immunities
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	
Nitrous oxide (N_2O)					x	x	Combustion product of fuel and biomass; also formed in catalytic converters	
Chlorofluorocarbons (CFCs)				x	x	x	Leakage of coolant from air conditioning systems	

Specifications for the quality of gasoline (premium and regular) are in existence in all member states and indicate various limits. The Saudi standard for standard fuel for vehicles call for sulfur content not to exceed 0.03 (with maximum deviation of 0,015) by weight and for lead to have 0.57 (with a deviation of 0.03) gm/lit. In Syria on the other hand the total maximum content of sulfur by weight for both regular and premium gasoline is not to exceed 0.15 and to be lead free. In fact the use of non- leaded fuel has been implemented since 1997 in the capital city of Damascus only. In 1999 the non-leaded fuel has become available at all gas stations in Damascus. Currently about 30 percent of the gasoline used in Damascus are unleaded. Plans are underway to spread the use to all other cities. However the use of a catalytic converter is not obligatory. In Egypt the use of unleaded gasoline has seen big application. Of the 2.1 million tons of gasoline currently annually consumed in Egypt, about 90 percent of it are unleaded. The average content of lead in the other gasoline is about 0.2 grams per liter, which is far below international requirements.

The existing legislation for the maximum allowable concentrations of air pollutants is shown for three member states in the following tables. Since the concentrations are for residential areas then it can be assumed that transport will account for the major percentages specifies.

When comparing the allowed concentration limits of the above mentioned countries with other countries and WHO standards some variance in concentration was observed. Carbon monoxide limits of Saudi Arabia and Lebanon as compared to USA.EPA, WHO and Canada were found to be approximately similar where as Syria's were found to be much lower. As for Nitrogen dioxide, Saudi's concentration in the 1hour exposure was found to be the highest, the Lebanese the lowest while Syria, USA.EPA, Canada and WHO had the same limits. However in the annual exposure to Nitrogen dioxide all the countries had the same limits. As for the Sulfur Dioxide the concentration in the various above mentioned countries for the 1 hour exposure varied between 0.497 PPM (USA.EPA) and 0.134 PPM (Syria & WHO), whereas the annual exposure varied between 0.015 (WHO) and 0.04 (Lebanon). Saudi Arabia and the USA.EPA allowed the highest concentration of total suspended particles in the 24 hours, 340 $\mu g/m^3$ respectively, while the other countries and WHO allowed a limit of 120 $\mu g/m^3$.

There is in fact a need to establish specific limits for the concentration of pollutants that are permitted from any vehicle. This is important to be imposed during the inspection of vehicles. Guidelines such as those developed in Europe can be used as a starting point for formulating the standards.

Table 6. Maximum allowable concentration of air pollutants in major cities in Syria

Pollutant	Formula	Allowed Concentration Limit *	Time Rate	Frequency Rate	Remarks
Carbon Monoxide	CO	6 PPM * *	1 hr		
Ozone	O_3	0.12 PPM	1hr		These concentrations are for the ozone due to the breakdown of Photochemical Oxidants during the day
		0.05-0.08 PPM	8hr		
Nitrogen Dioxide	NO_x	0.21PPM	1hr	Not to exceed twice a month at any location	There are 5 Nitrogen Oxides known as Nitrogen Oxide Gases, and the stable form is NO_2
	NO_2	0.079 PPM	24hr		
		0.054 PPM	Annual Rate		
Sulfur Dioxide	SO_x	0.134 PPM	1Hr	Not to exceed 3 times a month	There are many Sulfur Oxides and the stable form is SO_2
	SO_2	0.047PPM	24 hr		
		0.03 PPM	Annual Rate		
Total Suspended Particles	TSP.	150 g/m^3	24 hr		Mineral suspended particles are the total suspended particles
		90 g/m^3			
Lead	Pb	1.5 g/m^3	3 Months		

Source: Syrian Arab Standardization and Meteorology Organization (SASMO).
* Concentrations are according to the WHO standards.
** The previous limits were 24 PPM for 1 hr, and 9 PPM for 8 hrs.

*Table 7. Maximum allowable concentration of air pollutants in major cities in Saudi Arabia**

Pollutant	Formula	Allowed Concentration Limit	Time Rate	Frequency Rate	Remarks
Carbon Monoxide	CO	35 PPM	I hr	Not to exceed twice a month at any location	
		9 PPM	8 hrs	Not to exceed twice a month at any location	
Ozone	O_3	0.15 PPM	1hr	Not to exceed twice a month at any location	
Nitrogen Dioxide	NO_2	0.35PPM	1hr	Not to exceed twice a month at any location	
		100 g/m^3	Annual Rate		
Sulfur Dioxide	SO_2	0.28 PPM	1Hr	Not to exceed twice a month at any location	
		0.14PPM	24 hr	Not to exceed once a location	
		0.03 PPM	Annual Rate		
Total Suspended Particles	TSP.	340 g/m^3	24 hr	Not to exceed once a location	Unusual excess in the TSP concentration (for 24 hrs or 1year) due to natural causes may not be considered as a reason for deviating from abiding by the set measures.
		80 g/m^3	Annual Rate		

Source: Standards for Protection of the environment Meteorology and Environmental Protection Agency, (MEPA), Document # 01/1409

EU Emissions Limits for Cars (gm/kilometer)

Standard	CO	VOC_s and NO_x	Particulates
Stage I (1993) Gasoline and diesel	3.16	1.13	0.18
Stage II (1997)			
Gasoline	2.2	0.50	-
Diesel, indirect injection	1.00	0.70	0.08
Diesel, direct injection	1.00	0.90	0.10

Table 8. Maximum allowable concentration of air pollutants in major cities in Lebanon

Pollutant	Formula	Allowed Concentration Limit	Time Rate	Frequency Rate	Remarks
Carbon Monoxide	CO	26 PPM	1 hr		
		9 PPM	8 hrs		
Ozone	O_3	0.08 PPM	1hr		
		0.05 PPM	8 hrs		
Nitrogen Dioxide	NO_2	0.10 PPM	1hr		
		0.08 PPM	24 hrs		
		100 g/m^3	Annual Rate		
Sulfur Dioxide	SO_2	0.18 PPM	1hr		
		0.16PPM	24 hrs		
		0.04 PPM	Annual Rate		
Total Suspended Particles	TSP.	120 g/m^3	24 hrs		
Suspended Particles < 10 microns		80 g/m^3	24 hrs		
Benzene		5 PPB*	Annual Rate		
Lead	Pb	1.0 g/m^3	Annual Rate		

Source: Ministry of Health, Resolution # 1/52, Official Gazette issue # 45, 12/9/1996.
* PPB: Parts per billions.

D. Measures to abate the environmental impact of land transport

Environmental problems are usually dealt with when a "crisis" situation develops. Crisis-oriented policies usually result in very high costs compared to preventive policies, which often result in unrecoverable damages. Air quality measurements undertaken in some cities in the region, like those in Damascus, have indicated that the percentages of some pollutants have exceeded in some cases the maximum allowable limits. Fortunately, however, not very serious situations have yet surfaced like the motor vehicle related environmental crisis that occurred early in the 90's in the city of Athens.

There are direct measures that directly aim at reducing the impact of the transport related pollution. It is worth mentioning here that some of these measures require that international cooperation be implemented in order that tangible results can be attained. These include:

a. Use of alternate fuels.
b. Imposing obligatory specifications for imported vehicles.
c. Installing proper inspection schemes for checking emissions of vehicles.

It is well established that all measures to reduce the amount of emissions from vehicles will be limited in their impact and there is a need to control the amount of pollution. The major measures needed in this regard involve the following steps:

a. Avoidance of unnecessary transport.
b. Encouraging the use of public transit means.
c. Promotion of environmentally friendly rail and other means that have a less damaging impact on the environment.
d. Reducing the impact of transit traffic, which is an important issue in some countries in the region, like Syria and Jordan, which have to deal with large transit truck volumes.

In the following the three main courses to follow in order to achieve tangible results are illustrated. These include reduction of the emissions from each transport mode through technical improvements in the vehicle industry, switching to more environment- friendly transport modes which cause less harmful environmental repercussions, and finally reduction of overall transport activities.

1. Improved vehicle performance

Minimizing congestion and the number of vehicles on the roads is just one aspect of limiting air and noise pollution. There is also a need to control pollution at the source_the vehicles. Vehicles play a major role in the quantity of air pollutants. Unfortunately, there are some intrinsic constraints, which may prohibit a reduction in their pollution. Road-users continuously demand more powerful cars, which means more energy-consuming cars with new accessories, which reduce efficiency (catalytic chambers) or consume energy (such as air-conditioning and radios). Paradoxically, the demand for traffic safety implies an increase in vehicle weight, and thus more energy consumption and resulting 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 accomplished over the last decade have not been realized, owing to a shift towards more powerful engines. Some experts noted that marketing efforts by many manufacturers now emphasize power, speed and acceleration in contrast to the emphasis on fuel economy in the 1970s. This situation undermines improved levels of fuel economy and emissions, and efforts are required from national and international authorities to counter this trend.

One factor associated with the use of large-sized and very powerful vehicles in some countries, and especially in the Gulf States, was the very low price of fuel. As shown in Table 9 which gives the development of gasoline prices in the region. Recently many countries in the region have adjusted their gasoline prices that are now very close to the market prices. In Saudi Arabia the price has been adjusted twice lately and the current price of SR1.0/liter (about US$). It is expected as a result that a progressive shift towards smaller and more compact cars will take place.

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

Table 9. Development of Premium Gasoline prices in the ESCWA countries (cent/liter)*

	UAE	Bahrain	Saudi Arabia	Syria	Iraq	Qatar	Kuwait	Egypt
1970	8.4		7	1.1		7.4		1.8
1971							8.4	
1972							5.8	
1973							8.4	
1974	11.4			1.6	0.5		8.4	
1975	12.6		3.9	1.5	0.6		8.4	2.1
1976	11.4			2.4			8.4	
1977				2.4			8.4	
1978		16	5.7	2.6		9.6	8.4	
1979	19.8	16					8.4	
1980	19.2		5.7	5.7			8.4	3.8
1981	19.2	16		5.7			8.4	3.8
1982	22.2	19.9		6.3	0.8		16.7	
1983	29.8				1	16.5	16.7	
1984					1		16.7	4.4
1985	29.4			8	1			
1986	27			10.9				7.4
1987	23.7		14.3	18.6				7.4
1988				28.6			16.7	
1989				42.9				10.3
1990	23.7				1.3			
1991	23.7			50.1	1			20.7
1992	23.7		8.8	50.8	1			
1993					1			26.6
1994				58.1	2.8			
1995			16					
1996	23.7	26.6			20.9			

Source: Annual Statistics Report 1998, OAPEC
* Based on 1996 Exchange Rates

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

Other interesting engine developments include manufacturing compact and efficient two-stroke engines with electronic fuel injection, and efficient and clean "lean burn" engines, for which problems of catalyst durability under poor maintenance conditions could be overcome. It is estimated that in the next few years, significant gains in the fuel efficiency of new models are achievable with today's techniques and fuels, and that these gains can satisfy environmental regulations. Beyond the year 2000, the experts considered 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 50-60% above today's levels.

New vehicles have to meet defined emission standards before their registration is allowed if attempts to eliminate urban transport pollution are to succeed. It is therefore essential to upgrade emission standards for new vehicles as soon as improvement in vehicle technology allows. Since ESCWA member countries import all of their vehicles, it will be necessary to modify their specifications in order to accommodate any new emission standards and to enforce policies that guarantee that the required specifications are satisfied.

It is inevitable that 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, thereby causing congestion and posing a danger to other road users. It is recommended that countries discourage people from keeping old vehicles and encourage the early replacement of such vehicles. However, this would have a major economic cost for developing countries, which would find this very difficult to implement. Table 10 gives an example of the problem associated with the age of the operating vehicle fleet. In Egypt about 65 percent of the vehicles are 10 years old or more and about 25 percent of these vehicles are more than 20 years old. Jordan has taken a positive step to replace the old fleet of taxis operating in its major cities which, it has been demonstrated, introduce high levels of air pollutants. The Government has granted taxi owners an exclusive exemption from taxes if they opt to replace their old vehicles with new ones. With a high turnover rate, vehicles of better quality and 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 10. Age distribution for vehicles in Syria

	% Of fleet older than	
	13 years	24 years
Passenger cars	60.5	24
Buses and microbuses	40.4	9.4
Pickups	57.4	6.5
Trucks	68.2	19.2

2. *Use of alternate fuels*

The use of alternative fuels including natural gas, methanol, ethanol, electricity, and differing qualities of petroleum-based fuels should be considered. Most recently the hydrogen fuel cells have indications that it has the potential to become the alternate fuel in the future. Gasoline and diesel fuels however are likely to continue to cover the great majority of fuel demand till the turn of the century. They represent the only low-priced transport fuels available in sufficient volume. However, important improvements in current gasoline and diesel fuel formulations could be implemented, and would result in increased efficiency while decreasing vehicle emissions.

Natural gas has witnesses a very large use recently and it is estimated that the total number of vehicles using this fuel exceeds one million. In Egypt the use of natural gas has witnessed a big stride. Beside its free pollution advantage it has proven to be economically feasible. Currently there are more than 14000 vehicles that have been converted to use natural gas and the existing number of fueling stations have exceeded 20. In Syria serious considerations are being directed towards use of natural gas fuel. Natural gas still poses problems of distribution and there are 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 CO2 reduction. However, it was thought by some researchers to have a promising future as a transport fuel if the leakage problems could be solved.

Methanol poses complex problems: it diminishes some pollutants and increases others. Its use is being encouraged for some very polluted urban areas in the United States and in 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), too expensive or remote (natural gas), or environmentally unacceptable (coal). While methanol produced from natural gas is competitive, it can only be used in a very marginal manner (mixed with petrol up to a proportiort of 10 per cent) or in specially adapted cars.

Ethanol, which is produced from agricultural raw materials, holds 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's or plant-based fuels, poses the problem of the technological adaptation of the vehicle fleet. This will certainly not be easy in developing countries that are currently for the most part dependent on imports for their supply of vehicles.

Hydrogen also poses a number of technological problems that are not likely to be solved before the end of the century. Storage and production of hydrogen are dependent on the availability of low-cost electricity. Problems related to leakage and safety limit its use as an alternative fuel.

Electricity as a means of vehicle propulsion still suffers from 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 (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 in general were thought to have very promising medium and long-term potential, especially in urban areas where future policies might progressively exclude their vehicles. Such compact, ultra-low-emission and noiseless light urban vehicles are a real need in many polluted cities worldwide, particularly in the developing countries.

3. Improved traffic management and urban planning

(a) Improved traffic conditions

For developing countries in specific, and for others in general, it must be first recognized that, for an energy-saving policy in the land transport sector to be successful, it is imperative that it not be based on technological improvements alone as they cannot compensate for growing demand. Improving traffic flows and circulation and providing facilities and road infrastructures can result in smooth traffic flows. Improving access to, and mobility within, a central area, but at the same time relieving the adverse impacts of heavy automobile use and enhancing the pedestrian environment are only a few examples of improved traffic conditions. In every urban area in the world, the achievement of a smoother traffic flow is the key factor in promoting fuel economy and, at the same time, limiting pollutant and noise emissions. To illustrate the environmental advantages provided by smoother urban traffic conditions, it has been reported' on the basis of simulated urban traffic conditions on a dynamometer bench, that the smooth flow conditions of the early morning (5 a.m.) compared with the same urban route during highly congested flow periods (5 p.m. rush hour) resulted simultaneously in a fuel economy improvement of 31 per cent and a reduction of HC, CO and NOx emission levels of 54, 52 and 2 per cent respectively for hot start. It has been established that when the surface of a road is smooth and constant speeds can be maintained, the consumption of fuel becomes noticeably less. Table 11 shows the approximate effect of the vehicle speed on the emission of various pollutants.

Table 11. Effect of the vehicle velocity on the exhaust emissions

Mode of operation	HC PPM	CO% vol.	NO_x PPM	H_2O %	CO_2 %	H_2 %vol.
Idle	750	5.2	30	1.7	9.5	13.0
Cruise	300	0.8	1500	0.2	12.5	13.1
Acceleration	400	5.2	3000	1.2	10.2	13.2
Deceleration	4000	4.2	60	1.7	9.5	13.0

It is needless to mention here that a major factor to be considered is urban growth. It is observed almost everywhere that this uncontrolled urban growth, as well as the related increasing need for mobility and communication, can constitute an impediment to any plans for traffic improvements. In addition it is very common that the concentration of people movement is some cities in the region is restricted to few hours in the day either for weather conditions or due to social habits. In Damascus, for instance, it was estimated that about 90 percent of activities take place between 8 a.m. and 2 p.m. Control of urban growth is therefore necessary, with a view to facilitating transportation activity and making the best use of limited resources, including available space and facilities, through improved collective management. Moreover, in some regions, as is the case for most developing countries, it may be necessary to reverse the present trend of rural-urban migration, in particular by improving conditions in rural areas. It should always be borne in mind that when an urban area attains the size of a large metropolitan zone, and especially where this metropolitan zone has spread from a historical city center, the very dimension, complexity, and the organizational pattern of the urban area make the accessibility issue a critical one for the majority of the inhabitants.

The geometric design of urban roads and highways can be best utilized to introduce improvements in traffic operations within a certain urban area. In this respect, use may be made, as appropriate, of separated traffic distribution, flyovers (e.g. of the temporary, mobile type) or underpasses at congested cross-roads, by means of traffic diversion, computerized traffic signals operation, off-street parking and licensing access to specific inner city areas. Junction interchanges flyovers and underpasses are incorporated into major roads to facilitate traffic flow. In the city center, 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.

It is to be stressed here that improved traffic management in urban areas will provide 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 direction of traffic of certain major roads during peak hours to provide more lanes in the direction of heavy traffic, has resulted in substantive smoother traffic flows. In some extreme cases where the urban traffic becomes extremely heavy, such as Beirut or Cairo, use stricter measures might be called for.

(b) 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, recreational and other facilities into or near activity centers will minimize the need to travel far or frequently for work and other activities. Development schemes should be carefully and progressively implemented. Alternative sites for new activities such as office development, or for the relocation of existing activities, with mobile characteristics such as wholesaling or warehousing, should be sought. Developing countries have an advantage over developed countries in the sense that they are in the process of building or completing their infrastructures. They therefore have the unique advantage of their urban expansion with appropriate incentives for more efficient and environmentally sound patterns.

(c) 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 much 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 point within 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 and affordable. The use of such a reliable system has a twofold advantage: it encourages car-owners to use public transport (at least during peak hours) and it provides the commuting masses with an affordable and efficient means of transportation. Major steps have been taking place or under serious considerations in some major cities in the region to promote public transport facilities. For instance the construction of the underground (metro) system in the city of Cairo has eased traffic congestion considerably. In addition the cities of Damascus and Amman are considering constructing light rail systems. Studies were undertaken as early as 1985 and updated studies were completed in 1997 calls for the construction of a 45 km line (three diagonal routes and one circumferential) with a total of 36 stations.

It is imperative that Governments take certain measures to ensure an efficient public transit systems. Governments should provide infrastructure 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, such as reduced transport fees for the elderly, the less privileged and the weekly or monthly public transport subscribers.

Parking policies should enhance public transport activity through reducing access and use of private cars in the city center. Because most cities in the world have some form of public or private bus service, bus service improvement is essential. Public transit in most countries in the world is not revenue generating: Governments might opt to give operating subsidies to spur operators to provide 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 to provide improvement in safety, comfort, noise and pollution emissions is required.

(d) Management of vehicle ownership

No traffic management plan will be successful unless it tackles the problem of controlling the number of registered vehicles. To minimize congestion, Governments should regulate both the ownership and use of vehicles. First, the vehicle population must be contained within 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 through smoothing out traffic over time and space. One measure would be to impose higher vehicle taxes, which would be a function of the fuel consumption of the vehicle under consideration.

CONCLUSIONS

This paper presents the effects of transport on the environment and the measures available to minimize them. It is shown that, 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 management and control. Currently, the issue of land transport pollution is not receiving the attention it deserves in the region, mainly because there is not enough awareness with regard to the magnitude of the future 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 will present 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 which are concentrated in the already congested urban areas will ultimately result in pollution crises in the major cities in the region. In order to avoid the occurrence or at least to mitigate the effects of such a crisis, the following recommendations are proposed:

1. National or regional air quality standards should be formulated and the types of pollutants emanating from transport activities should be defined. It is important that sufficient resources be allocated to carry out the required programmes for measuring air quality and/or enforcing regulations relating to relevant standards.

2. Measures aimed at reducing air pollution from urban traffic should be implemented. For example, incentives should be provided for public transport systems, and measures should be undertaken to control the importation of vehicles and encourage the use of public transit. It is imperative that public transport systems save users both time and money; otherwise, they will not constitute a reasonable alternative to private transport.

3. National specifications on the standards of imported vehicles should be amended in order to allow the importation of more environment-friendly vehicles. In this regard the use of such systems as the International Conformity Certification Program should be encouraged to ensure the compliance of imported vehicles with the required specifications.

4. Because the proper maintenance of vehicles plays a major role in determining pollution emissions, more vigorous vehicle inspection programmes should be implemented, especially for commercial vehicles. It may be necessary in order to guarantee a smoothly running programme to authorize the private sector to undertake this task, but only after regulatory instruments that guarantee the proper implementation of the system have been authored.

5. 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 the operations.

6. Traffic management regulations in urban areas should be improved, as they could provide the most cost-effective technique for reducing transport-related air pollution.

7. There is a need to enforce already existing laws and procedures rather than attempting to propose new laws and specifications that will not be implemented.