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# Energy and its Impact on the Environment

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## Abstract

Transportation is the major source of air pollution in the West Bank. Gasoline and diesel are used for transportation. Three factors make pollution from vehicles in the West Bank more serious. First, most of the used vehicles are in poor condition and of old models. Second, low quality fuels are used. Third, the road networks in the West Bank are in poor conditions. Pollutants in air are not measured. Air pollution is growing with the increase in population and developing in industry. In this paper, the annual amount of pollutants emitted to air as a result of gasoline vehicles in the West Bank will be estimated. The estimates are based on the WHO Transportation Air Emission Inventories.

Gas stations in the West Bank are responsible for selling the gasoline in addition to changing the motor oil. From an environmental point view, practices in these gas stations are threatening to the environment as they give little consideration to the safety of individuals or to the natural environment. Oil storage tanks and the used motor oil at these stations are threatening the air and the water resources in the area. The paper also focuses on environmental problems at the gas stations in the West Bank.

## Introduction

The central role of energy in economic and social development has long been recognized in the world. Currently, most industrialized countries depend on fossil fuels for their energy needs. Palestine, like other developing countries, is following in the footsteps of industrialized countries, whose dependence on oil is their main source of energy. Palestine has no cheap or easily exploitable energy resources. Today, Palestinians import their primary energy requirements from Israel. Although the generation of energy through fuel is critical for life, it is also one of the most environmentally damaging if air emissions are not controlled.

In Palestine, energy consumption is increasing rapidly. This reflects upon population growth, as well as the level of development in all aspects of life. Transportation is the largest energy consumer sector in Palestine reaching approximately 60% of the total

energy used in Palestine. Burning of fuel in internal combustion engines releases different pollutant to air such as nitrogen oxides (NO<sub>x</sub>), hydrocarbons (HC), carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), particulate matters and lead (Pb).

## **Air Pollution from Vehicles**

The only mode of transport in the West Bank is road transportation. Presently, the West Bank lacks any functional train, underground or air systems of transportation. The impact of road transport on the environment depends on the total number of vehicles, type of vehicle, engine capacity, year of production of vehicles in use, fuel quality and road conditions.

The road network in the West Bank is in poor condition where it is not expanded or maintained for many years. The poor conditions of the road increase the congestion and emissions from vehicles. Based on the total length of paved roads in the West Bank, the density of paved roads is 0.51 kilometer per square kilometer and the length of paved roads is 1.86 km per 1000 inhabitants. In Israel, the density of paved roads is 0.7 kilometer per square kilometer and the length of paved roads per 1000 inhabitants is 2.5 km. These figures indicate that the existing road network in the West Bank is underdeveloped and below the level required for economic development. Traffic congestion, fumes, noise and parking are problems common to all West Bank urban areas. Added to this, traffic congestion is regularly created by the Israeli check points which are placed at the entrance of all Palestinian cities and towns in the West Bank. These checkpoints are also a major inducer of vehicle pollution.

Over the last two decades, the number of cars in the West Bank has increased dramatically. The annual increasing rates of private cars and other vehicles in the West Bank are estimated at 12% and 6% respectively (ICBS, 1995). Between 1975 and 1996, the number of vehicles increased ten times from about 12,964 in 1975 to an estimated 133,386 in 1996. The increasing rate is estimated to be higher than 12% after receiving authority by the PNA in the Palestinians major cities. It is estimated that approximately 24,000 new cars entered the Palestinian Authority area since that time. However, even with this high increase in vehicles number, it is still much lower than that in Israel. According to the Israeli Central Bureau of Statistics (ICBS), 1996, the total number of vehicles in Israel was 1,459,018 in 1995. This number shows that pollution caused by emissions from vehicle exhaust in Israel is much higher than that in the West Bank.

There are approximately 97 thousands private cars (73% of the total vehicles) in the West Bank (Table 1). The motorization level in the West Bank (total number of private vehicles per thousand of people) is around 64 for privately owned vehicles, which is very low compared to 198 in Israel at the end of 1995 (ICBS, 1996).

Although the number of vehicles in the West Bank is low, a large percentage of these, approximately 30%, were made in the 1970s. Around 60% of the cars were made between 1980-1990 and only 10% between 1990-1996 (ARIJ survey, 1996). The fuel burning efficiency is less in older vehicles than new models which lead to higher emissions of pollutants.

<b>District</b>	<b>Private</b>	<b>Commercial</b>	<b>Bus</b>	<b>Taxi</b>	<b>Truck</b>	<b>Motorcycle</b>	<b>Others</b>
Bethlehem	14,909	1,865	144	179	181	147	1,204
Hebron	21,027	3,138	210	245	1,449	147	2,097
Jericho	1,962	556	34	58	315	39	282
Ramallah	17,012	3,413	190	402	529	191	1,694
Jenin	10,321	2,998	81	196	2,138	55	1,330
Nablus	17,954	3,036	151	279	590	93	1,427
Tulkarm	13,792	3,124	62	199	674	109	1,158
<b>Total</b>	<b>96,977</b>	<b>18,130</b>	<b>872</b>	<b>1,558</b>	<b>5,876</b>	<b>781</b>	<b>9,192</b>

Based on the WHO transportation air emission inventories (Table 2) (Economopoulos, 1993), it is possible to estimate the annual emission of air pollutants due to vehicle gasoline. Calculations are for private cars only and based on estimates that the average year production is 1981-1984, average engine capacity is between 1400-2000 and the total yearly distance traveled by car is 20,000 kilometer. Thus, at least 45,385 tons of CO, 3,258 tons of SO<sub>x</sub>, 3,723 tons of NO<sub>x</sub>, 5,500 tons of hydrocarbons (HC) volatile organic compounds, and 212 tons of lead were emitted to the West Bank's atmosphere in 1996, considering the number of registered cars only. Added to this, the 36,500 settlers' cars in the West Bank which are estimated to emit around 11,483 tons of CO, 1,183 tons of SO<sub>x</sub>, 1,299 tons of NO<sub>x</sub>, 1,628 tons of HC, and 80 tons of lead to the West Bank atmosphere. The calculations for the settlers cars are estimated based on average year production of 1985-1992. Table 3 shows the estimated quantities of Palestinian car emissions in the West Bank districts.

<b>Year of Production</b>	<b>Engine Capacity</b>	<b>CO kg/1000km</b>	<b>SO<sub>x</sub> Kg/1000km</b>	<b>NO<sub>x</sub> Kg/1000km</b>	<b>HC Kg/1000km</b>	<b>Pb Kg/1000km</b>
Up to 1971	< 1400	45.6	1.9	1.64	3.86	0.13
	1400-2000	45.6	2.22	1.87	3.86	0.15
	> 2000	45.6	2.74	2.25	3.86	0.19
	1972-1977	< 1400	33.42	1.66	1.64	3.07

	1400-2000	33.42	1.92	1.87	3.07	0.13
	>2000	33.42	2.2	2.25	3.07	0.15
1978-1980	< 1400	28.44	1.39	1.5	2.84	0.09
	1400-2000	28.44	1.68	1.72	2.84	0.11
	>2000	28.44	2.13	1.97	2.84	0.14
1981-1984	< 1400	23.4	1.39	1.58	2.84	0.09
	1400-2000	23.4	1.68	1.92	2.84	0.11
	>2000	23.4	2.13	2.57	2.84	0.14
1985-1992	< 1400	15.73	1.27	1.5	2.23	0.09
	1400-2000	15.73	1.62	1.78	2.23	0.11
	>2000	15.73	1.85	2.51	2.23	0.14

([Figure1](#)) Estimated emissions from private cars at different districts in the West Bank

Particulate emissions arising from incomplete combustion of diesel-powered vehicles such as trucks, buses and taxis are causing serious air pollution in urban areas. Diesel vehicles emit respirable particulate matter at a rate of approximately 100 times greater than the rate of particulate emitted from gasoline vehicles (Whitman, 1988). Diesel fuel also contains roughly 10 times as much sulfur as does gasoline, so the SO<sub>2</sub> emissions in diesel-powered vehicles are much greater than from gasoline vehicles (Watkins, 1991).

Palestinians in the West Bank are still use leaded gasoline. The content of lead has serious impact on the health. In addition lead increases maintenance costs in cars since lead and its chemical compounds act as contaminants and corrosive agents in the engine and exhaust system. During the last few years, Palestinians have introduced unleaded gasoline in the West Bank. Using unleaded fuel reduces air pollution and the potential danger of exposing to lead. A program to encourage the use of unleaded fuel should however, be undertaken by the Palestinian National Authority.

Fuel consumption and vehicle emissions have been also affected by the current political conflict in Palestine. With the closure of Jerusalem for Palestinians, those Palestinians who travel between the southern and northern parts of the West Bank are required to drive through a steep road which by-pass Jerusalem from the East. This road adds approximately 45 km to the regular trip and causes great emissions and depreciation of vehicles due to the harsh topography over which the road is laid.

# Jerusalem-Ramallah Road as a Case Study

Transportation emissions can be calculated for specific roads if the transportation flow is counted. Pollutants emission have been estimated for the Jerusalem-Ramallah Road based on the WHO Transportation Air Emission Inventories. The length of the road is approximately 10 km. Transportation flow at this road has been counted for one week. Number of vehicles passes through this road are shown in table 4.

<b>Table 4</b>		
<b>Transportation flow at Jerusalem- Ramallah road for one week</b>		
<b>Day</b>	<b>To Ramallah</b>	<b>To Jerusalem</b>
	<b>Total no. of vehicles</b>	<b>Total no. of vehicles</b>
Thursday	12,618	11,979
Friday	9,181	836
Saturday	12,695	11,790
Sunday	11,939	11,453
Monday	12,494	12,283
Tuesday	12,244	12,024
Wednesday	12,541	11,595

Source: Al-Malki, R., 1997

The collected data shows that the annual number of vehicles pass through this road is estimated at 8,486,504. Table 5 shows the annual estimate of air pollution as a result of transportation in the Jerusalem-Ramallah Road.

<b>Table 5</b>			
<b>Estimated annual air pollutants emitted due to transportation flow in the Jerusalem-Ramallah Road</b>			
<b>Emission</b>	<b>Estimated annual quantity of pollutants emitted to air (Tons)</b>		
	<b>To Ramallah</b>	<b>To Jerusalem</b>	<b>Total</b>
CO	1019	967	1986
SOx	73	69	142
NOx	84	74	158
VOC	124	117	241
Lead (Pb)	4.7	4.5	9.2

## Effect of air pollutants on health:

Each of the emitted gases has its special side effect as follows:

1. Nitrogen oxides (NO<sub>x</sub>) affects human respiration and induce acid rain.
2. Hydrocarbons (HC), include a wide variety of organic chemical substances, has multiple effects on both human health and environment. It is toxic, an irritant, carcinogenic and mutagenic.
3. Carbon monoxide (CO) combines with blood and prevents it from conveying oxygen. Also it causes headaches, vertigo, sensory disorder and asphyxiation.
4. Sulfur dioxide (SO<sub>2</sub>) aggravates respiratory problems and its acidity attacks plants (acid rain), aquatic life and material.
5. Particulate matter can impact human health through eye and respiratory irritation and fibrotic, allergenic, carcinogenic or mutagenic effects.
6. Lead (Pb) can cause nervous disorders, especially for children and animals. Lead emitted into the air can be breathed in directly or consumed through drinking water and vegetables that are contaminated or through digesting contaminated meat of animal polluted with lead.

## **Environmental Problems at Gas Stations**

There are approximately 127 gasoline stations in the West Bank. The Applied Research Institute-Jerusalem has conducted a survey for 64 gas stations in the Bethlehem, Ramallah, Hebron and Jenin districts. Operating practices inside the gas stations give little consideration to the safety of natural environment. For example, the underground storage tanks are not monitored or checked for leakage, and above ground tanks often have small leaks that are not repaired. Up to date, no gasoline station has double liner tanks nor sensors for monitoring any leakage. Most, if not all, the underground storage tanks are made of steel with no lining. Moreover, many gas stations are located in shops in residential areas where fuel tanks are located inside the buildings which threatens the safety and the health of residents.

### **Used motor oil**

The use of motor oil in vehicles is important to protect the engine from friction in addition to the increase of its life. The lifetime of the motor oil is limited and has to be changed periodically. Vehicles motor oil is changed in the gas stations and in the car garages. In the West Bank, there is no regulations to organize the disposal of the used motor oil. Large amounts of motor oil are disposed annually. The largest amount of these used oil are sold to bakeries where it is used as fuel for the oven. It is also used as fuel for some industries as in pottery or glass making industries. The remaining amount of the used motor oil are disposed in cesspits. Both methods are environmentally unsound where they pollute the air and water resources.

ARIJ survey shows that at least 15 stations include centers that change the vehicle motor oil. Twelve of them keep the used oil in special tanks to be sold for bakeries, pottery and glass making industries while the other three stations dispose the used motor oil into cesspits. Both methods are threatening the environment.

**Table 6**

**Methods of disposal of used motor oil in the gas stations in the Bethlehem, Hebron, Jenin and Ramallah Districts**

District	No. of stations surveyed	No. of gas stations which replace motor oil	Methods of disposal	
			Cesspits	Special tanks for sale
Bethlehem	10	6	20	4
Hebron	29	8	1	7
Jenin	19	1		1
Ramallah	6	-	-	-

Source: ARIJ, Gas Station Data base, 1996

## Composition of Used Motor Oil

The composition of pollutants in the motor oil depends largely on the type of fuel used. While the primary pollutant found in the oil is the oxidants such as the Aldehydes and Ketones and other compounds which contain Nitrogen and Oxygen (Nitro-Compounds) in addition to the organic compounds of the motor oil. The used motor oil also contains lead resulted from the gasoline. It is estimated that the used oil contains 0.5% by weight lead.

## Hazards resulted from oil disposal

The reuse of the used motor oil as energy source in the pottery or bakery oven emits different pollutant to the atmosphere such as the leaded compounds and carbon oxides. When disposed in cesspits, the used motor oil endangers and pollutes the water resources in the area. It increases the organic compounds concentration to a level which makes it difficult to treat.

## Conclusions and Recommendations

Transportation in the West Bank is a major source of air pollution. The old models of vehicles, poor road networks, road congestion and low quality fuel used are the major factors that make the air pollution from transportation more serious. The problem of air pollution from transportation will increase with the population growth and traffic expansion. The number of private cars in the West Bank is expected to increase to five times the existing number by the year 2010. This will make the problem of air pollution more serious if measures and actions are not followed to reduce vehicle emissions.

The use of unleaded gasoline should be encouraged to reduce the amount of lead emitted to the air. To switch from regular to lead-free gasoline, the price of unleaded gasoline should be reduced, making it less expensive to the consumer than regular gasoline, thus providing an incentive for increasing its use.

In Palestine, there is no specific emission standards for air pollutants (amount per time and maximum concentration). Emission standards are the main instrument in any air pollution control program. To start a control program in Palestine, the PNA should

install air pollution monitoring stations at different locations. Recently, the Applied Research Institute (ARIJ) has brought two air monitoring stations. One of the stations is installed at ARIJ building, while the other is used at different locations.

Methods of disposal of used motor oil are threatening the air, groundwater and soil in the West Bank. Using the used motor oil as an energy source is emitting toxic substances into air. Furthermore, the disposal of the used motor oil through cesspits is polluting the groundwater. The disposal of used motor oil has to be conducted in an organized procedure. There is a great need to study the quantities generated and disposal of such material. This type of hazardous waste should be collected and treated for reuse. In many parts of the world, waste motor oil has been successfully recycled for reuse.

There should be a continuous inspection and monitoring of the gas stations. Environmental inspection should be done continuously to protect groundwater from the hazard materials that might reach groundwater. Moreover, to protect the surface water in winter from being mixed with fuel and oil in the gas stations.

Also, there should be a continuous inspection and monitoring of underground storage tanks used at gas stations. Environmental inspection should be done continuously to protect groundwater from the hazard materials that might reach groundwater. In addition, any leaking oil products can produce VOCs which are dangerous air emissions. Many of these fuel shops are located in residential areas and pose hazardous threats to people.

Economic tools such as fines, fees, taxes and subsidies should be designed to punish organizations and vehicle owners who misuse or pollute natural sources, so as to impose the costs of use on the user.

## References

1. A'qel N. *Used Motor Oil, Its hazards and methods of treatment*" Al-Reem Journal, Royal Society for Nature Protection, vol 13, 1983. (In Arabic)
2. ARIJ, GIS Database, 1995.
3. ARIJ, Gas Stations Database, 1996.
4. Economopoulos, A., **Assessment of Sources of Air, Water and Land Pollution, A guide to Rapid Source Inventory, Techniques and Their Use in Formulating Environmental Control Strategies**, Part one, WHO, Geneva, 1993.
5. ICBS (Israel Central Bureau of Statistics), **Statistical Abstract of Israel 1995**, no. 46, Jerusalem, 1995.
6. ICBS (Israel Central Bureau of Statistics), **Statistical Abstract of Israel 1996**, no. 47, Jerusalem, 1996.
7. PEC (Palestinian Energy Center),. **The Present Status of Electricity Services in the West Bank**, Jerusalem, 1995.
8. Al-Malki, R.,et al, Transportation and Air Quality, ARIJ
9. Watkins, L. H., **Air Pollution From Road Vehicles**, Transport and Road Research Laboratory, HMSO Publications, London, U.K., 1991.
10. Whitman, J., **The Environment in Israel**, Environmental protection service, Ministry of interior, Jerusalem, 1988.