DEVELOPING A CONCEPT FOR REDUCING TRANSPORT-RELATED GHG EMISSIONS, EGYPT AS A CASE STUDY

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The world community has many needs for reliable measures to reduce the greenhouse gas emissions, as it discusses climate change. To evaluate the effectiveness of possible abatement measures, the paper firstly presents a "minimum data" emission estimation method. This method was based on the assumption that the greenhouse gas emissions depend on fuel consumption, fuel quality, and transport activities. This assumption may be probable as a starting point for countries which have limited experience with emission estimations. Then, a catalogue of abatement measures was prepared and an evaluation process was developed to investigate the effects of each individual measure and measure combinations. The paper demonstrates also an application to Egypt, as a case study. Three abatement scenarios were proposed and compared with a reference scenario which was established on the basis of "business as usual" travel demand.

تلعب نظم النقل دورا أساسيا فى إقتصاديات الدول وفى إسلوب الحياة اليومية للمواطنين. ولما كان النقل والإقتصاد عاملين متلازمين، فإن أحجام النقليات للركاب والبضائع تزداد زيادة مضطردة مع إرتفاع مستوى المعيشة، سواء فى الدول المتقدمة أو الدول النامية. ولكن زيادة أحجام النقليات على نفس مرافق النقل المتاحة يؤثر سلبا على البيئة فى كامل صورها، نتيجة للضوضاء والعوادم والحوادث، وينتج عنها أيضا الإختناقات المرورية والتلوث البصرى وتمزق خريطة إستخدامات الأراضى. بالإضافة إلى ذلك فإن قطاع النقل يعتبر المستهلك الأساسى للطاقة وللأرض وللموارد الطبيعية. كما أن إحتراق الوقود بمحركات وسائل النقل يؤدى الى زيادة كميات غازات الصوبة المسببة لتغير درجات حرارة الجو وللأمطار الحمضية ولإرتفاع مستوى مياه البحار. إن الهدف الأول من هذا البحث هو تطوير نموذج رياضى يمكن عن طريقه تقدير كميات غازات الصوبة الناتجة عن قطاع النقل بأى منطقة، أخذا فى الإعتبار حجم النقليات وطبيعتها، ونوع الوقود المستخدم وخصائصه، ومعدل إستهلاك الطاقة لوسائل النقل المختلفة وفقا لحالتها الفنية بالمنطقة موضوع الدراسة. كما يهدف البحث أيضا إلى تطوير إسلوب جديد لإعداد البدائل المختلفة التى يمكن إستخدامها لتقليل كميات غازات الصوبة.

هذا وقد تم تجهيز مجموعة من النماذج الرياضية اللأزمة للتنبؤ بالتاثيرات الإيجابية لكل بديل على حدة ولمجموعات من البدائل فى صورة تصورات مستقبلية. وفى البحث تم إعداد البدائل المختلفة على أساس الإستراتيجيات النقلية الأتية: (١) خفض الحاجة للتنقل عن طريق إعادة تخطيط إستخدامات الأراضى وفقا لنظرية توزيع المركزية، (٢) الإعتماد على نظم نقل أفضل للبيئة وبديلة للسيارة الخاصة واللورى. هذا وقد تم تطبيق النماذج المقترحة على مثال جمهورية مصر العربية بهدف التحقق من إمكانيات التطبيق العملى لها.

Keywords: Greenhouse gases, Global warming, Air pollution, Energy consumption, Transport-related emissions.

INTRODUCTION

The transportation systems play a major role in the economic life of each country and in the daily lives of its citizens. The movement of people and goods increases significantly with the rapid economic growth in both developed and developing countries. The increase in mobility is generally considered to be a positive aspect. However, too much traffic on a given transportation infrastructure leads often to negative effects. These negative effects include congestion, accidents, noise, and pollution. Furthermore, The transport sector is a major consumer of fossil fuels and therefore contributes a significant share of "greenhouse gases" (GHGs), which play a crucial role in determining the earth's climate. The earth receives energy continuously from the sun. It must get rid of this energy at the same rate by sending it back out to space. The GHGs affect the ability of this outgoing energy to pass through the atmosphere. As the concentrations of the GHGs rise, the climate must somehow change to keep the energy budget in balance. One probable change (among others) is a warming of the earth's surface [1].

The most prevalent GHGs emitted from the mobile sources are the carbon dioxide

(CO_2), nitrous oxide (N_2O), and methane (CH_4). Some minor atmospheric constituents, such as the nitrogen oxides (NO_x) and carbon monoxide (CO), although not important GHGs in their own right, can influence the concentration of the GHGs through atmospheric chemistry. These Emissions can be estimated by the major transport activities; road, rail, water, and air [2]. Several fuel types need to be considered; gasoline, gas oil, fuel oil, and jet-fuel. If the fuel (mostly composed of hydrocarbons) are completely combusted, the only products emitted are CO_2 and water. However, under actual conditions, not all the fuel is combusted completely [3]. As one example of combustion-related emissions, the motors release large portions of N_2O emissions. These emissions are closely related to air-fuel mixes and combustion temperatures. CH_4 emissions from the motors are a function of the methane content of the fuel, the amount of hydrocarbons passing unburnt through the engine. The emissions of unburned CH_4 are lowest when the quantity of hydrogen, carbon, and oxygen are present in exactly the right combination for complete combustion. Thus, CH_4 emissions will be determined by the air-fuel ratio. They are generally highest in low speed and engine idle conditions.

The main objectives of this paper are: (a) to present the amount of GHGs emitted from the transportation sector in Egypt taking into consideration the transport activities and the local specific energy consumption, (b) to define and identify abatement policies and programs of transport-related GHGs, and (c) to develop a recommendation catalogue for needed actions in Egypt to reduce the GHGs generated from mobile sources in the target year 2015. This catalogue is to be evaluated to investigate the effects of each individual action and combinations of actions in the form of scenarios. For this evaluation, the different scenarios are compared with a reference scenario which is based on the authorized transport policies and "business as usual" travel behavior.

ESTIMATION METHOD FOR TRANSPORT-RELATED GHG EMISSIONS

GHG Emission Estimation

The estimation of mobile sources emissions is a very complex problem that requires consideration of many parameters such as: engine type, fuel quality, vehicle age, maintenance level, and the operating characteristics.

The wide variety of parameters that can affect the GHG emission estimates makes it very difficult to generalize an emission inventory procedure. In fact, the complexity of this issue makes it difficult even for countries with extensive experience to develop highly-precise emission inventories [4]. As such, it is appropriate to avoid excessive complexity with any starting emission estimation methodology.

A minimum emission estimation methodology will be suitable as a starting point, particularly for countries which have limited experience with estimation of emissions from mobile sources.

In order to develop a "minimum estimation" method for GHG emissions from mobile sources, the minimum data required are the fuel consumption of the individual transport modes, the average carbon content for each fuel type, and the transport activities. Thus, as a first approximation, GHG emissions should be adjusted in direct relationship to fuel economy. The basic approach for estimating the emissions is:

$$\text{Emissions} = \Sigma\ (EF_{a.b.c} \times \text{Activity}_{abc})$$

where,

EF = Emission factor (e.g. gram emission per vehicle-km)

Activity = total transport activity (e.g. vehicle-Km)

a = transport mode (road, rail, water, air)

b = fuel type (gasoline, gas oil, fuel oil, jet oil)

c = vehicle type (car, taxi, bus, truck, train, etc.)

The fuel economy can be used to calculate the emission factor (EF) as follows:

$$EF = SEC \times ESER$$

Where

SEC = Specific energy consumption (e.g. MJ per vehicle-km)

ESER = Energy-specific emission rate (e.g. gram emission per MJ)

Other units may also be the basis for the calculations: Emission factor in gram emission per passenger-km (g/pkm) or per ton-km (g/tkm), and the transport activities in total passenger-km and in ton-km.

The use of energy-specific rates (gram emission/MJ), instead of fuel-specific rates (gram emission/liter fuel), is always recommended to avoid the differences of carbon content anticipated in the fuel used in the various countries (i.e., fuel quality) [5].

It is important to remember that there is a substantial amount of uncertainty surrounding emission estimation. The calculations ignore several parameters, such as:

- The operating characteristics (e.g., percent of driving in cold start or in hot start, as well as average speed and ambient temperatures).
- The maintenance level (e.g., air-fuel ratio).

Some procedures should be developed to improve the data quality and to resolve uncertainties affecting emission estimates. This may involve the use of standard deviations, ranges of uncertainties, or some other means of indicating the reliability of the data. This issue must receive additional attention in any follow-up process.

The Emission Procedure

The following basic steps are required to estimate mobile source emissions:

(1) Determine the amount of fuel consumed by type for all transport modes using national data (gram or liter fuel/ veh.-km).

(2) Calculate the specific energy consumption for all transport modes by fuel type (e.g., MJ/veh.-km).

(3) For each fuel type, determine the energy-specific emission rates (e.g., gram emission/ MJ).

(4) Multiply the specific energy consumed by each transport mode by the energy-specific emission rate to determine the emission factor for all modes (e.g., gram emission/veh.-km).

(5) Determine the total distance traveled for each transport mode (e.g., Veh.-km).

(6) Multiply the emission factor for each transport mode by its total transport activity to compute the total emissions by mode.

(7) Emissions can then be summed across all fuel and transport mode categories to determine total emissions from mobile source-related activities.

Specific energy consumption and energy-specific emission rates should be country-specific whenever possible. If these specific data are available, they should be used, otherwise international data can be used as default assumptions.

GHG ABATEMENT TECHNIQUES

As traffic continues to grow on a given transportation infrastructure, two basic strategies are needed: (a) changing the planning concepts to combat the large-scale environmental problems, and (b) introducing technical solutions to reduce transport-related energy consumption and environmental damages.

Changing the transportation planning concepts

The objective of changing the transportation planning concepts is not to improve the environmental performance of an existing transport system but to change the transport system itself with a view to the environmental constraints. Two planning concepts are recommended: (1) Reducing the transport demand, and (2) Modal shift from less to more environmentally friendly transport modes.

Reducing Travel Demand

For reducing travel demand, proposals should be made on the basis of an integrated land use/transportation planning. The need to integrated planning is especially acute in the main cities of most developing countries where almost uncontrolled population growth and motorization generate long trips and congested traffic.

In many cases urban development have induced the spatial segregation of working, residential, shopping, service and recreational functions. In contrast, development patterns remain highly centralized in the city center which often contains most of the local administration offices, financial houses, and warehousing activities.

This development must be stopped. Reversing the spatial segregation of the urban functions will not be possible in the future. Measures have to be taken to halt this trend and to facilitate the changes in the medium and long terms.

In addition, effective use of telecommunication systems may also represent reliable opportunities for reducing travel demands.

Modal Shift to environmentally more friendly Transport Modes

The financial charges imposed on travelling by car and shipping goods by trucks are simply too low to reflect the real social cost incurred (environmental damages).

The concept of road pricing in cities as a planning tool for modal shift from road to other transport systems attracts recently more and more attentions [7]. Singapore, Hong Kong, and Oslo are already following this path. Cars entering certain roads are charged with a road user fee, and these charges may be varied between peak and off-peak hours. The general philosophy of road pricing in cities is to penalize the use of car, if public transport systems are available. The income generated by the road user fees may be invested in improving public transport.

A more encompassing way of "setting prices right" lies in the taxation of road transport. Annual registration taxes have little effect on actual driving patterns as they are fixed costs to the motor vehicle owner [8]. The variation of registration fees according to the car's fuel consumption or the emission behavior may influence at least the distribution of a country's car fleet between more and less fuel consuming.

People have to be lured out of private car into railways and public transport modes. Criteria for the attraction of railway and public transport system are multiple. Certainly, their speed, comfort, reliability, schedule and network design are crucial factors. Permanent right-of-way for light railways, separate bus lanes, park-and-ride facilities, an extended night service and the improvement of the public transport image are also items in a whole catalogue of possible actions.

Additional measures which have other planning objectives, such as traffic calming, can support the emission abatement techniques. Traffic calming measures, for example, can reduce the convenience of private car use, make it less attractive, and may thus indirectly contribute to modal change.

For freight transport, service quality factors such as frequency, regularity, flexibility, safety, customer delivery conditions, and transport cost are the decision-making parameters of the transport user. A modal shift strategy for goods transport must be based on the complementarily between rail, waterways and the road.

The introduction of a sea-waterway or a sea-railway combined system is a far-reaching objective, not only for reducing the heavy traffic in overcrowded urban areas but also for minimizing the overall transport costs.

Technical Solutions

In the last few years, technical solutions, such as maintenance of vehicles to the manufacturer's specifications, catalytic converter, and improving the fuel efficiency, achieved a great success in reducing the amount of emissions emitted from mobile sources.

Today, some hopes are put in the introduction of alternative fuels (e.g., methanol, ethanol, natural gas and hydrogen) as well as in the electric vehicles. However, in calculating the overall effect of these options, certain trade-offs have to be taken into account. The pollution costs at the stage of producing the alternative fuel or electricity have to be considered [9].

In view of the fact that cars, buses and trucks will remain important pillars of the transport system, technical solutions are undoubtedly important element in a concept to make transportation more environmentally sustainable. Ultimately, a true "zero emission car" propelled by renewable energy is unlikely to be put on the road in the foreseeable future. While the industry is stepping up its efforts to develop new technical solutions, many technical problems still have to be overcome. Time would be needed for the conversion of car fleet to new technologies and for the creation of new fuel distribution systems.

Abatement Measures Catalogue

Table 1 presents different measures that may be needed by preparing an abatement program for reducing the petroleum energy needed for the transport sector and consequently the GHG emissions. The table also shows the objectives of the individual measures.

EVALUATION PROCESS FOR GHG EMISSION ABATEMENT TECHNIQUES

Figure 1 shows the multi-stepped process proposed to evaluate abatement techniques. Based on the transport activities (in the base year) and the national fuel economy, the GHG emissions can be calculated. Then, different scenarios for reducing the GHG emissions (in the target year) are prepared and analyzed. Each Scenario may contain an abatement measure or a set of measures (i.e., combination of measures from the catalogue in Table 1). The scenarios should be compared with each other as well as with the so-called "reference scenario". The reference scenario is defined as the solution which is based on the authorized transportation master plan, if available, and/or "business as usual" travel behavior.

For the calculation of the transport activities, travel demand models are needed. The models can also be applied to predict the effects of measures with "modal shift and travel demand reduction" objectives.

It is very difficult to predict the effects of the measures with other objectives, such as fuel switching, energy saving, public education of vehicle drivers, and vehicle maintenance. In this case, the measure effects can roughly be estimated by applying limited experiments or by investigating the results obtained from countries which already carried out such measures [10].

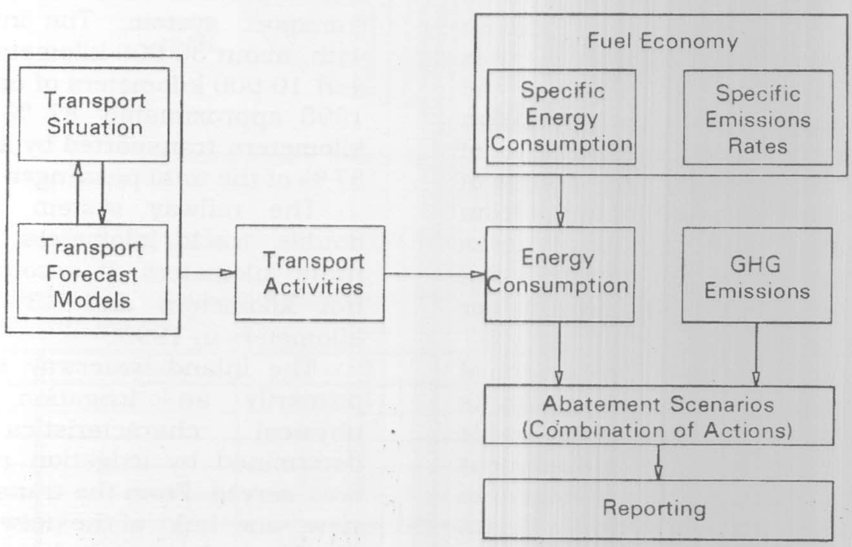

Figure 1 A Multi-stepped process for the evaluation of abatement techniques

Table 1 Abatement measures for the Reduction of transport-related GHG Emissions

Measures		Objectives
Measures for Short distance Transport		
M1	Integrated land use/transportation planning	Reduction of travel demand
M2	Upgrading public transport systems	Modal shift
M3	Creation of Pedestrian facilities	Modal shift
M4	Environment-oriented improvement of road network and the introduction of automatic traffic Signalling	Reduction of traffic delays, as well as energy consumption and GHG emissions
M5	Road pricing / road licensing / parking restrictions / traffic calming	Reduction of car use in sensitive areas, modal shift
M6	Traffic priorities for bus and taxi	Modal shift
M7	The introduction of freight transport centers	Minimizing truck movements in urban areas, and reducing GHG emissions
Measures for Intercity Transport		
M8	Electrification of main railway lines	Reduction of GHG emissions
M9	Increasing the attractivity of the railway system (high speed, comfort, safety, schedule, etc.)	Modal shift from road to railways for both passenger and freight transport
M10	Improving inland waterways	Modal shift
M11	The introduction of Sea/rail and Sea /water combined freight transport	Modal shift from road to both railways and inland waterways
M12	Highway user fees	Modal shift
General Measures		
M13	Maintenance of vehicles to the manufacturer's specifications	Reduction of fuel consumption and GHG emissions
M14	Higher registration fees	Modal shift
M15	Higher fuel price	Modal shift
M16	Monthly fix-rate of fuel per vehicle	Modal shift
M17	Public education of vehicle drivers	Improving traffic behavior, reduction of energy consumption and GHG emissions
M18	Effective use of telecommunications	Reduction of travel demand
Measures for the far Future (Fuel Switching)		
M19	Road Vehicle with alternative fuels	Reduction of GHG-emissions
M20	Electric car / Electric bus	Reduction of GHG-emissions

CASE STUDY: EGYPT

General

The Arab Republic of Egypt has an area of about one million square kilometers with a total population of about 60.0 million inhabitants (census 1996). Although Egypt is essentially rectangular in shape, the predominant feature from the transportation point of view is the linear configuration of economic activities, following the course of the river Nile over the length of Egypt from south to north. The inhabited area represents about 4% of the country total area, giving an average of 1500 persons per square kilometer.

The topographical and geographical conditions in Egypt in combination with its very high population densities in the arable areas present a highly favorable environment for the transport of goods and passengers in the Delta and along the Nile in Upper Egypt. It is therefore not surprising that an extensive multi-mode intercity transportation systems have been developed.

Highways are the most important mode of transport system. The intercity highways, with about 30 000 kilometers of paved roads and 10 000 kilometers of unpaved, carried in 1995 approximately 87 % of the total ton kilometers transported by all modes and also 57 % of the total passenger- kilometers.

The railway system consists of 1287 double track kilometers and 2973 single route kilometers. It accounted for 9.3 % of ton kilometers and 43 % of passenger-kilometers in 1995.

The inland waterway system in Egypt is primarily an irrigation system and its physical characteristics are basically determined by irrigation requirement of the area served. From the transportation point of view, one link of the network (from the port of Alexandria to Aswan) is the most important axis. The rest of the network is occasionally used for transporting relatively small quantities of goods. The inland waterway system carried approximately 3.3 % of the total ton-kilometers.

The Egyptian port system consists of five major ports (Alexandria, Damietta, Port Said, Red Sea, and Suez) and a three smaller ports. These ports handled approximately 51.0 million tons in 1995.

The civil aviation system consists of 15 airports with approximately 77 000 aircraft and about 10 million passengers in 1995, from which Cairo airport handled approximately 6.7 million passengers.

Energy Consumption of the Transport Sector

According to the official published statistics and our calculations for the transport sector, the prime energy consumed by the transport sector (including the fuel consumption at ports and airports) in the year 1995 was about 37.4 % of the total energy consumption of the different economic sectors. Thus, the transport sector in Egypt is the largest prime energy consumer, also before electricity production and industry (Figure 2).

Table 2 illustrates the Distribution of Fuel consumption according to Fuel Type and Transport Modes in Egypt 1995. The roadways are the first major consumer of fossil fuels, followed by the ports.

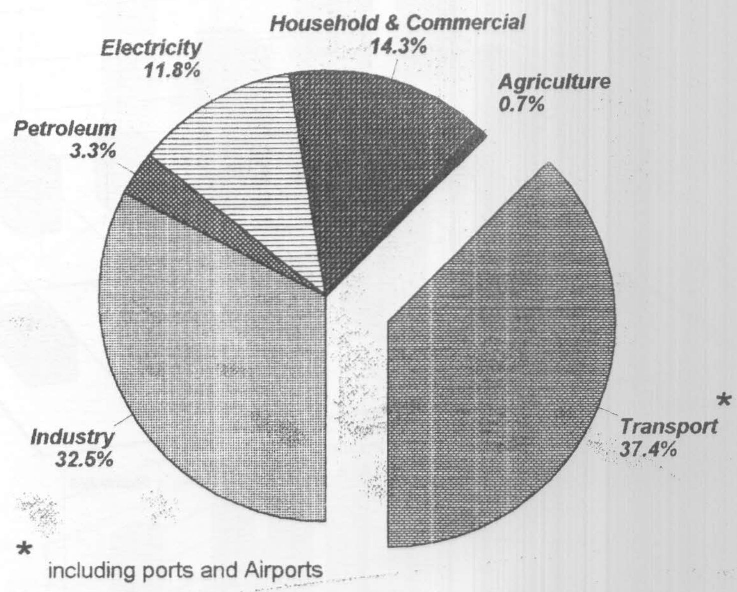

Figure 2 Energy Consumption of the different Economic Sectors in Egypt 1995

Table 2 Distribution of Fuel consumption according to Fuel Type and Transport Modes in thousand tons, Egypt 1995

	Gasoline	Gas oil	Fuel oil	Jet-Fuel	Total
Roads	1865.062	1862.411	-	-	3727.473
Railways	-	243.817	-	-	243.817
Waterways	-	81.186	-	-	81.186
Ports	-	324.683	2164.869	-	2489.552
Airports	-	-	-	429	429
Total	1865.062	2512.097	2164.869	429	6971.028

Sources: Organization for Energy Planning

Specific Energy Consumption of the different Transport Modes in Egypt

The determination of the specific energy consumption for different transport modes in Egypt is based on data collected from the statistics of different sources, taking into consideration vehicle occupancy rates [11,12,13]. The specific energy consumption is calculated in terms mega joule per passenger-kilometer (MJ/pkm) for passenger transport or per ton-kilometers (MJ/tkm) for freight transport. Figure 3 presents the specific energy consumption for various transport modes under different operating conditions.

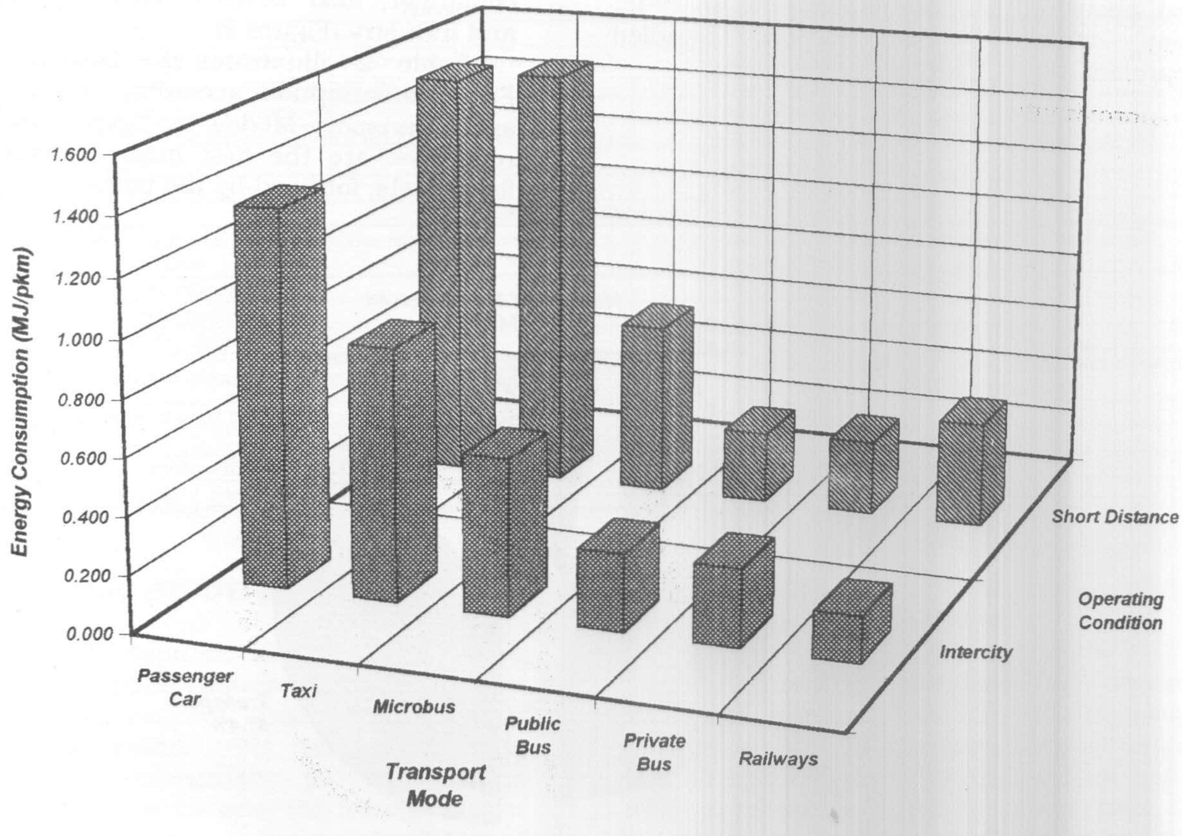

Figure 3 Specific Energy Consumption of different Transport Modes

As might be expected private cars have the highest specific energy consumption in MJ/pkm, particularly for short distance transport. Intercity trains and buses are the most efficient energy consumers. In case of freight transport, intercity trains and boats are again the most efficient energy consumers in terms of MJ/tkm. Semi-trucks (Figure 4-b) represent, on the other hand, the least efficient mode for freight transport.

GHG-Emission Rates

The GHG-emission rates (for CO_2, CH_4, and N_2O) are calculated in gram emission per passenger-kilometer or per ton-kilometer, based on data collected about the quality of different types of fuel used in Egypt [14]. Figure 4 (a and b) illustrates the specific GHG-emission rates of different transport modes (passenger and freight). It is almost a mirror of Figure 3 which shows the specific energy consumption.

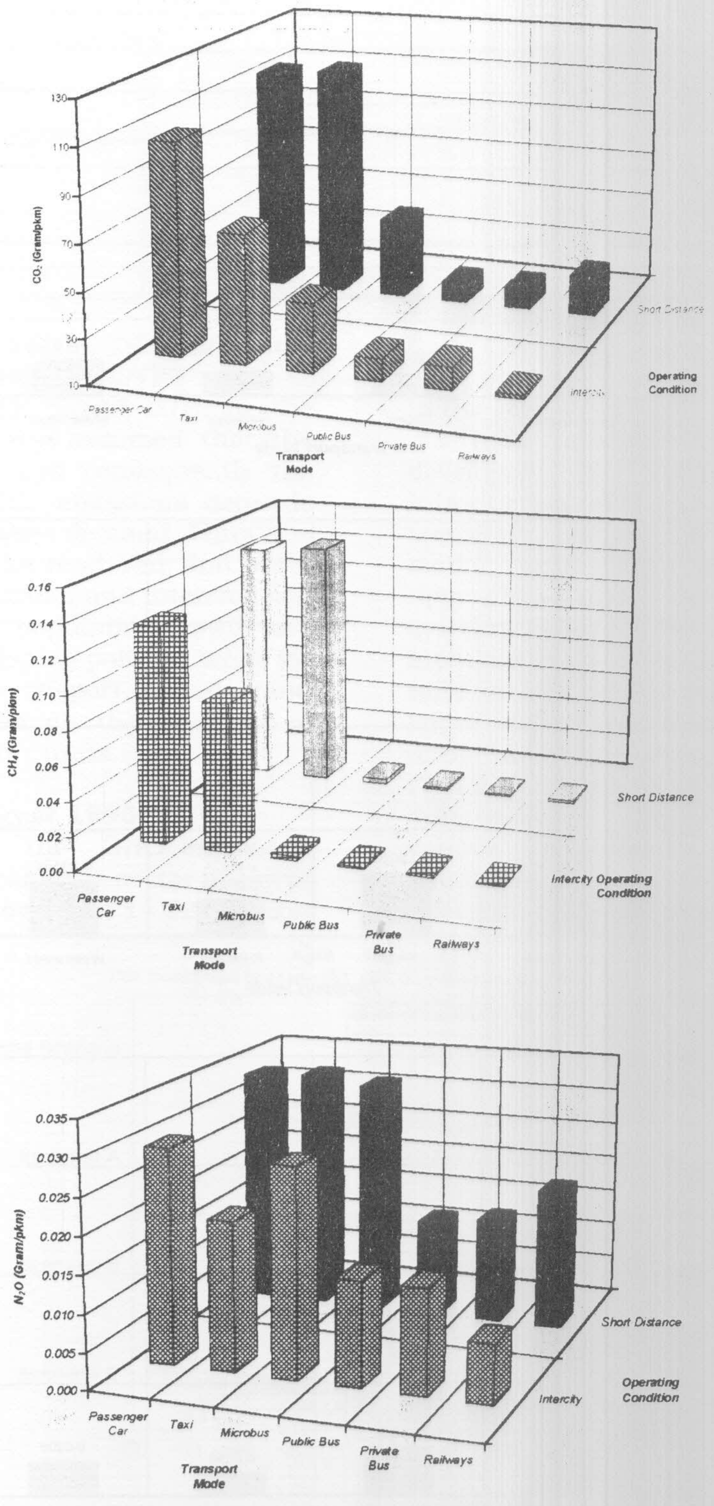

Figure 4-a Specific GHG-Emission Rates of Passenger Transport Modes

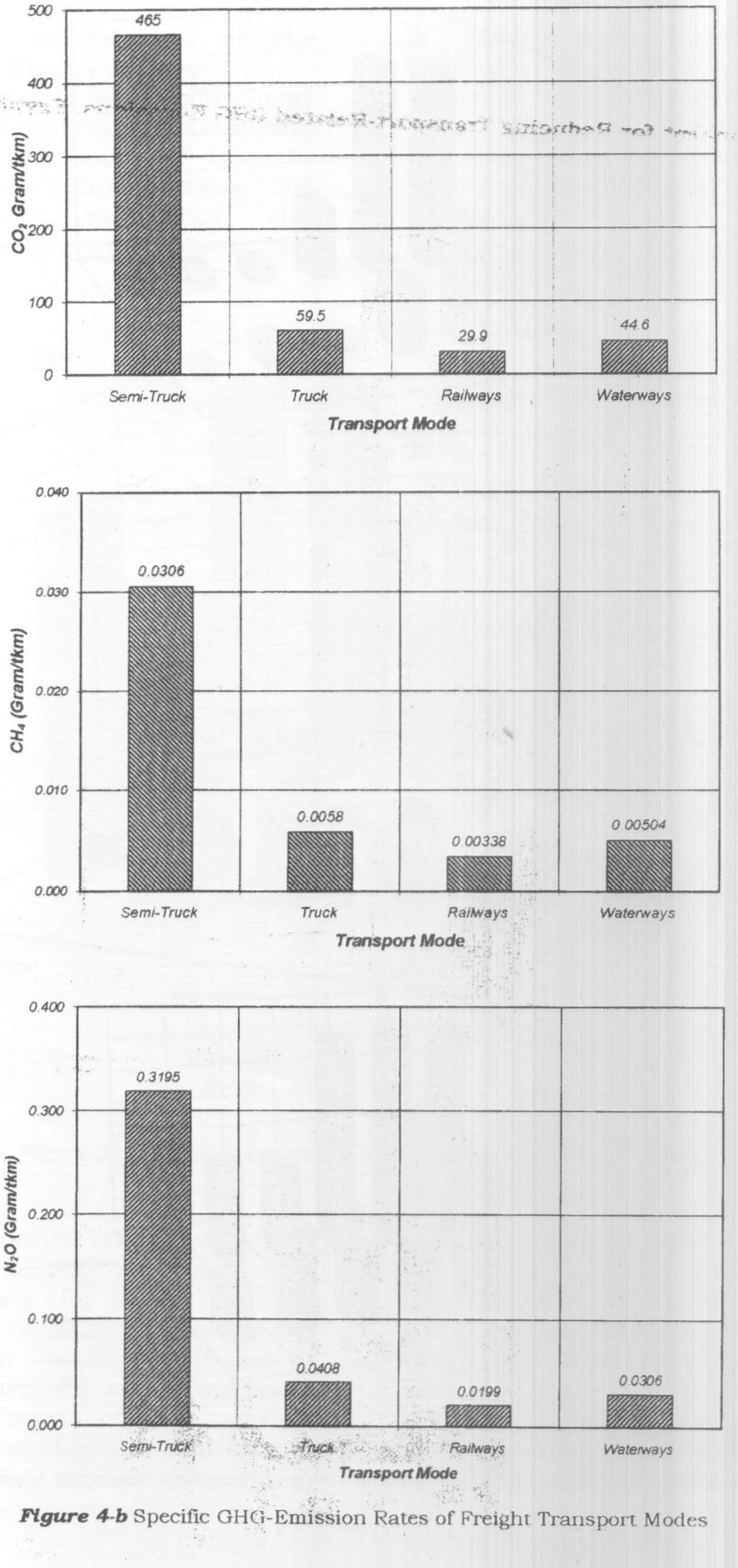

Figure 4-b Specific GHG-Emission Rates of Freight Transport Modes

Table 3 GHG Emissions in Egypt 1995

Transport Mode	Energy Consumption	GHG-Emissions		
	PJ	CO_2 (kt)	CH_4 (t)	N_2O (t)
Urban Transport				
• Fossil Oil Modes	85.650	6410	5275	2856
• Electric Modes	2.007	151	16	102
Intercity Transport	85.678	6391	3068	3579
Air and Maritime	18.31	1375	171	772
Total	191.645	14327	8530	7309

ACTIONS FOR THE REDUCTION OF GHG-EMISSIONS IN EGYPT

For the year 2015 (Trend 2015 or the Reference Scenario), it is assumed that the energy consumption and consequently the transport-related GHG emissions depends mainly on the transport demand. Thus, the increase of demands for road, rail, and water transport in Egypt (urban and intercity) will match the projected population growth and the authorized developing policies, while for air and maritime transport, the demand increase will be based on the expansion of the number of transport units.

GHG Emissions in Egypt 1995

Table 3 Present the GHG emissions generated from the transport sector in Egypt in 1995. The table shows that 14.327 Million tons Co_2, 8530 toms CH_4, and 7309 tons N_2O were emitted from the transport sector in the year 1995

Three abatement scenarios are then developed: (i) Scenario A includes the introduction of the natural gas in the mobile transport modes, (ii) Scenario B aims a modal shift with limited measures for upgrading the existing transportation systems, and (iii) Scenario C contains the intensive use of waterways and electrified rails in lieu of the highways, as well as the large scale operation of taxis, buses and mini- and microbuses with natural gas. Figure 5 presents the GHG-emission differences in the year 2015 under the various abatement scenarios from the situation in the year 1995 and from the reference scenario (trend 2015).

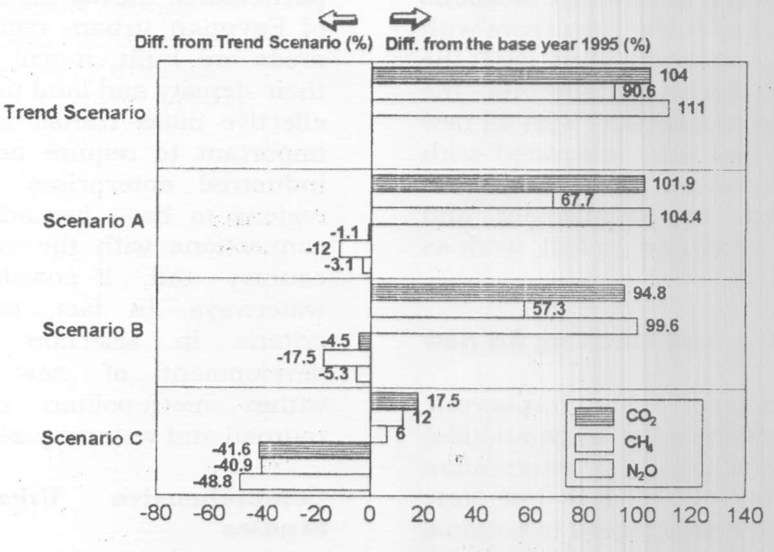

Figure 5 GHG-Emissions Differences (in %) under the different Scenarios from the Situation of the Base year 1995 and the Trend Scenario

RECOMMENDATIONS

During the study, an option was developed which might reduce the energy demand of the transportation sector and the corresponding GHG-emissions. In summary, the option emphasises the intensive use of waterways and electrified rails in lieu of the highways. This option includes the following policies:

Transport Policies

There is a need for transport policy initiatives and investment priorities that foster improvements in urban public transport, intercity personal travel, and intercity freight movement by inland waterways and railroad systems. Only when these systems are able to provide, on a regional and national scale, the transportation services that the country crucially needs, would it be prudent to initiate measures for reducing relatively the use of the intercity truck fleet and the passenger car.

Several things could be done to improve the railroads and the inland waterways other than increasing fleets and the size of the current network. First, the serviceability of the Nile river waterway can be improved by establishing and equipping frequent depots (ports) at strategic locations along the river and by integrating them with the local highway network and with the railroad system of the region. Second, the rail system can be connected with all new industrial enterprises and integrated with the inland waterways. The two systems must be planned to supplement and complement each other and, in fact, work as one integrated system.

Urbanisation Policy and Planning for New Cities

Egyptian urbanisation policy has several explicit objectives with regard to population, industrial decentralisation, and conservation of agricultural land, but it does not state clearly any objectives with regard to national transportation efficiency and energy effectiveness. As a result, several new cities are placed outside the networks of inland waterways and the railroad.

Industrialisation Policy

In integrating industrial and transportation activities, it is important to review all major new enterprises to see if they could be serviced primarily and effectively by either the inland waterways or the railroad system; wherever possible, by both systems. It would be advantageous for all major and long distance industrial freight to be carried by the waterways or the railroads. The present situation of heavy dependence on trucks for intercity transport should be reversed. It is economically important to an exporting industry to minimise switches from one mode of movement to another (transhipment) of any commodity between its origin and its destination. A single transhipment usually costs as much as all the other transport costs of the commodity, and involves added risks and losses. Such cost factors may make a commodity non-competitive in the international market.

Land Use Policy Planning

Land use planning should take into account two major transport related considerations. First, it is extremely important to promote, within urban regions, a developmental pattern serviceable by public transport, particularly during the developmental stages of Egyptian urban regions. Once the urban areas are built, it will be difficult to alter their density and land use patterns to permit effective mass transit service. Second, it is important to require and plan for the major industrial enterprises within metropolitan regions to have immediate and high quality connections with the railroad system of the country and, if possible, with the inland waterways. In fact, one of the primary criteria in selection of sites and the development of new industrial districts within metropolitan regions should be railroad and waterway serviceability.

Comprehensive Urban Transportation Studies

A series of comprehensive urban transportation studies should be undertaken for the urban areas of the country. It is understood that studies have been carried out for Greater Cairo and Alexandria only. These should be reviewed and completed with environment-oriented policies. In the future, People have to be lured out of private car into public transport modes. Possible actions for improving the attraction of public transport systems are speed, comfort, reliability, schedule, permanent right-of-way for light railways, and separate bus lanes.

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