Transportation

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I. INTRODUCTION

Transportation is fundamental to the functioning of a modern society and a necessary requirement for a growing economy`
. An efficient transport sector will contribute significantly to economic opportunities and social integration by linking rural with urban areas, enabling trade, and providing access to markets and services. To meet these challenges, access to transportation services must be reliable, affordable, and safe. Therefore, government investment in transportation must be seen not as an end in itself, but as a conduit to achieving social development and economic integration. In addition to contributing to the competitiveness of any modern economy, the transport sector by itself is a large employer. In fact, "transportation is globally considered to be the largest sector in the world in terms of financial turnover, resource consumption, and workforce," according to a report on transportation in the Arab region by the United Nations Economic and Social Commission for Western Asia (ESCWA, 2009a).

This chapter will highlight existing policies, practices, and major trends in the transport sector in Arab countries, emphasizing the benefits and costs of current policies on economic development, social integration, and the environment. We will argue for the adoption of transportation strategies that promote sustainable development and reduce poverty.

The chapter will propose alternative policies and strategies to promote green mobility, and articulate the implications of green transport on economic growth, social cohesion, and environmental sustainability. We define green transportation in broad terms to mean the provision of safe, affordable, and reliable mobility options that are energy efficient, while minimizing pollution, congestion, and random urban sprawl.

II. CURRENT PRACTICES IN THE TRANSPORTATION SECTOR

The urban population in Arab countries makes up 57.5% of the total population, compared to a world average of 49.1% (Croitoru and Sarraf, 2010). Increased urbanization and population growth have contributed to a rapid rise in the demand for urban transport and hence to a high rate of private car use and high traffic densities, particularly as mass public transit remains underdeveloped for the most part. These dynamics are contributing to high emission rates, noise pollution, and land degradation. A transport sector brief by the World Bank (2010) has thus concluded that "many of the [Arab] region's large urban areas, where the bulk of [gross domestic product] GDP is produced, face increasingly difficult transport problems with a high degree of traffic congestion, reduced mobility, and deteriorating air quality."

Transportation trends in Arab countries are characterized by:

- Rapid sprawling in the region's major urban centers such as Amman, Baghdad, Beirut, Cairo, and Damascus, whose populations exceed one million inhabitants.
- Government-subsidized gasoline and diesel fuel in many Arab states.
- An ageing vehicle fleet in most of the region's cities, where the average age of cars is 15 years, with countries of the Gulf Cooperation Council (GCC) being an exception. Cars are generally not well maintained, which contributes to high fuel consumption and elevated levels of emission rates.
- Inefficient and inadequate public transport systems and excessive reliance on private

cars.

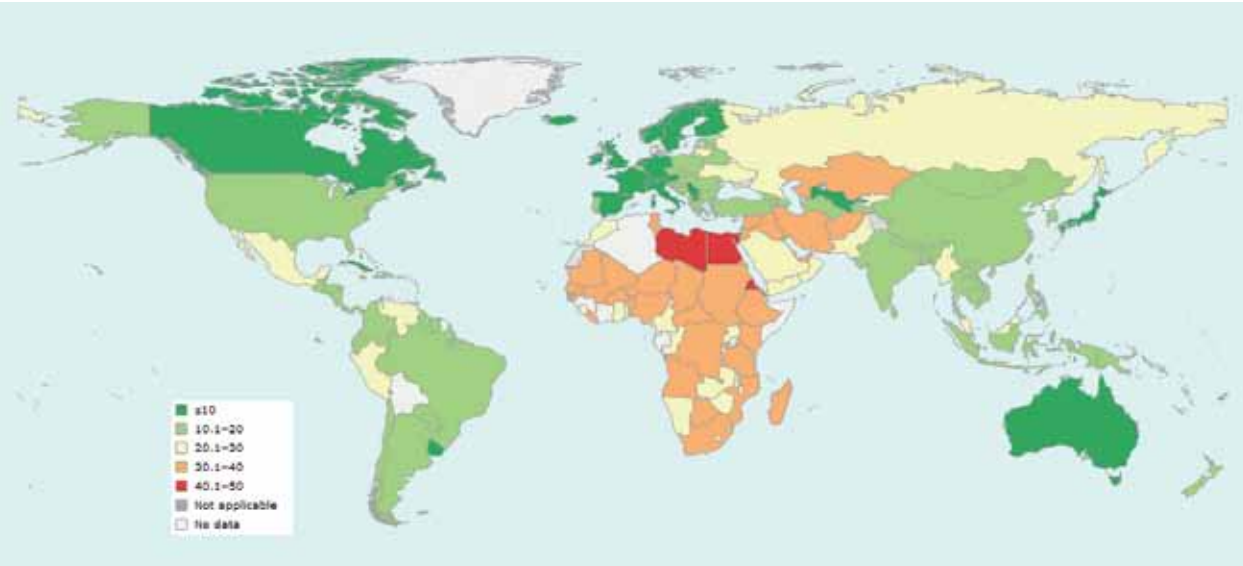
- The existence of government policies that encourage private car ownership as opposed to other modes of transport such as public transport, cycling, and walking.
- Inefficient traffic management systems and insufficient public awareness.
- Poor urban and physical planning resulting in long travel distances between residential and service center areas and places of work.
- Inadequate governance setup to adequately manage the transportation sector manifested by weak and insufficiently enforced environmental policies and regulations.
- For most Arab countries, "especially those with a large rural population such as Morocco, Egypt, and Yemen, all-weather access in rural areas is limited by the poor condition of road networks and the inadequacy of basic transport services" (World Bank, 2010).
- High road traffic mortality rates relative to other regions of the world. Table 1 shows that estimated death rates (per 100,000 population) in Arab countries are the highest compared with other regions of the world. In fact, the period from 1990 to 2000 has seen a 20% increase in road

TABLE 1 **ESTIMATED ROAD TRAFFIC DEATHS (PER 100,000 POPULATION) IN 2006-2007**

Country	Death Rate
Bahrain	12.1
Egypt	41.6
Iraq	38.1
Jordan	34.2
Kuwait	16.9
Lebanon	28.5
Libya	40.5
Mauritania	35.5
Morocco	28.3
Oman	21.3
Qatar	23.7
Saudi Arabia	29
Sudan	34.7
Syria	32.9
Tunisia	34.5
United Arab Emirates	37.1
Yemen	29.3
Regional rate	**32.2**
African region	**32.2**
Region of the Americas	**15.8**
South-east Asia region	**16.6**
European region	**13.4**
Global	**18.8**

Source: WHO, 2009; WHO, 2010

FIGURE 1 **ROAD TRAFFIC MORTALITY RATES (PER 100,000 POPULATION), 2006-2007**



Source: WHO, 2010

accident deaths in the Middle East, whereas in Australia, Europe, and Japan, mortality decreased by 10% during the same period (ESCWA, 2009a). Figure 1 shows that some countries in the Arab region have the highest road traffic mortality rates (per 100,000 population) in the world.

Although policies and measures envisioned by Arab countries aim to some extent at creating sustainable transportation systems (AFED, 2009), deficiencies continue to exist in major areas: poor urban transport services characterized by inadequate mass public transport, congestion, and poor air quality; limited access to rural areas; significant contribution to greenhouse gas emissions that cause climate change; and weak trade flows caused by inefficient transport systems.

Against this background, some Arab governments are increasingly investing in green transportation. One of the most ambitious projects has been the construction of the underground metro network in Cairo, which is being expanded. In 2009, Dubai inaugurated an urban rail transit system, with further expansion of the network expected. Other noteworthy measures include the introduction of alternative fuels, such as compressed natural gas (CNG), to be used by taxi and public bus fleets in Cairo, offering duties and tax exemptions to accelerate the replacement of old inefficient vehicles with more efficient ones, the construction of a bus rapid transit system in Amman, and electrification of existing diesel trains on some routes (AFED, 2009).

Arab countries have also been taking up fuel quality upgrades to remove lead from gasoline and reduce the content of sulfur in gasoline and diesel fuels. For instance, currently in Morocco the gasoline sold is lead free and the Sulfur level in fuels is at 50 parts per million (ppm) or less, while Tunisia has phased out leaded fuel in January 2010 and is adopting new sulfur level standards for gasoline, in conformity with European standards (Allam, 2010). As for other countries, Table 2 is a matrix developed by the 'Partnership for Clean Fuels and Vehicles' that shows the status of lead phase-out as of January 2011. According to the matrix, most Arab countries have switched their gasoline fuel to unleaded. Yemen remains far behind. Exposure to leaded gasoline poses serious developmental risks in children.

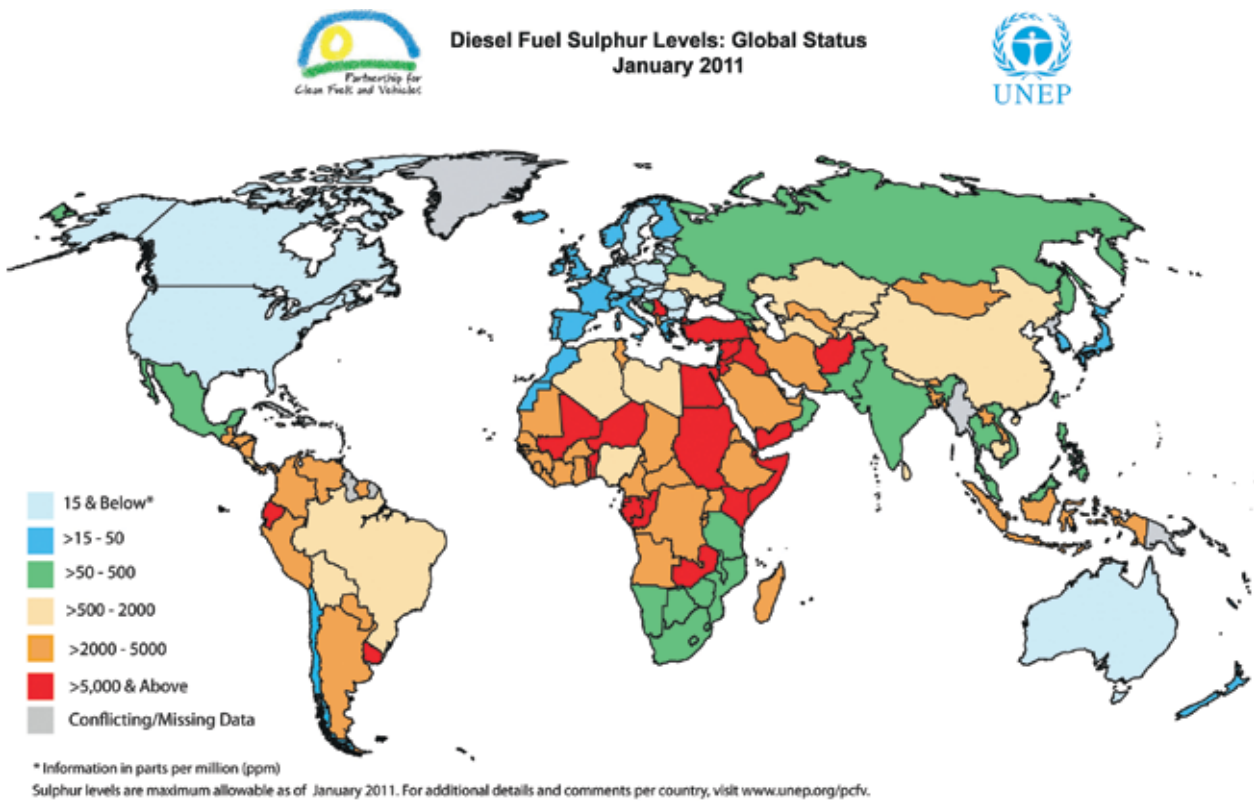
The United Nations Environment Program's (UNEP) 'Partnership for Clean Fuels and

TABLE 2 **LEAD IN GASOLINE MATRIX IN ARAB COUNTRIES (JANUARY 2011)**

Country	Current Status of Lead in Gasoline Fuel			Comment
	Leaded Only	Unleaded Only	Dual System	
Algeria			✓	
Bahrain		✓		
Egypt		✓		
Iraq			✓	
Jordan		✓		
Kuwait		✓		
Lebanon		✓		
Libya		✓		
Morocco		✓		
Oman		✓		
Palestine		✓		
Qatar		✓		
Saudi Arabia		✓		
Syria		✓		
Tunisia		✓		
United Arab Emirates		✓		
Yemen			✓	10% unleaded

Source: UNEP, 2011a

FIGURE 2 **GLOBAL STATUS OF DIESEL FUEL SULFUR LEVELS (JANUARY 2011)**



Source: UNEP, 2011b

Vehicles' initiative undertook a study in 2009 to demonstrate the status of diesel fuel sulfur levels worldwide. Figure 2, last updated in January 2011, compares the Arab region's performance with the rest of the world. As demonstrated in the Figure, in most Arab countries today, sulfur levels in diesel fuel remain high, which contributes significantly to high emission rates of particulate matter (PM) in cities and urban areas. Not only is PM linked to lung cancer and other cardiovascular illnesses, but it also contributes to climate change.

In many Arab countries, old and inefficient vehicles on the road pose a significant challenge because they contribute to a higher proportion of fuel consumption and air pollution emissions than newer models. Arab countries have their own import, inspection, and maintenance standards for vehicles and fleets. Table 3 summarizes the main standards and testing procedures currently adopted in the region.

Arab investments in the transport sector

Population growth, industrialization, and economic growth projections have compelled Arab governments to invest in transportation infrastructure. According to the online business intelligence platform, Zawya (2010a), "as much as $147 billion has been committed for infrastructure developments such as road, rail, and pubic transport in the Middle East that would drive the growth of land, air, and seaborne logistics industry in the region." A $25 billion railway line linking the six countries of the Gulf Cooperation Council (GCC) has been proposed, and will be complemented by internal railway lines within each country. Saudi Arabia is completing construction of its north-south railway project for freight use only, while the east-west railway line, supposed to link Jeddah, Dammam, and Jubail, will consist of passenger and freight tracks (Arab News, 2010). Egypt has attracted foreign direct investment to develop

TABLE 3 **VEHICLE & FLEET STANDARDS IN ARAB COUNTRIES**

Country	Import Requirements	Fleet (motor vehicles/1000 people)
Algeria	Imported second-hand vehicles must be less than 3 years old	112
Bahrain	No import restrictions found	509
Egypt	All imported vehicles must be equipped with a catalytic converter; imported second- hand vehicles must be 3 years old	43
Iraq	No information found	50
Jordan	Imported second-hand vehicles must be less than 5 years old	146
Kuwait	Imported second-hand vehicles must be less than 5 years old	507
Lebanon	Imported second-hand vehicles must be less than 8 years old	434
Morocco	No import restrictions found	71
Oman	Import of second-hand vehicles requires permission by Ministry of Commerce and Industry	225
Palestine	Imported second-hand vehicles must be less than 3 years old	-
Qatar	Imported second-hand vehicles must be less than 5 years old	724
Saudi Arabia	Imported second-hand vehicles must be manufactured after 1974	336
Syria	Imported second-hand vehicles must be less than 2 years old	62
Tunisia	Imported second-hand vehicles must be less than 3 years old	114
United Arab Emirates	No import restrictions, but strict inspection upon arrival to UAE	313
Yemen	Imported second-hand vehicles must be less than 5 years old	35

* Inspection and maintenance
Sources: UNEP, 2008; Wikipedia, 2011; World Bank, 2011a

Standards & I/M*	Comment
Indication of roadworthiness inspection system, no indication if it includes emissions	State-owned trucks make up about 80% of the vehicle fleet; since 1980s there has been a policy for development of the LPG vehicle sector
UN report indicates there are emissions control regulations	Has ongoing air quality monitoring program, and UN report indicates there are air quality standards
Vehicle inspection system, including emissions testing; I/M program for transit buses; Euro2 standards were meant to be in effect from January 2002, but fuel specs were incompatible- sulfur too high (PCFV document)	According to USAID report, Egypt plans to integrate emissions inspection, safety inspection, and vehicle registration in "one-stop" government facilities
New traffic code established in 2004 requires vehicle inspections, with stations to be located at traffic police stations	
Indication of roadworthiness inspection system, no indication if it includes emissions	
Cars over three years old require an annual roadworthiness test that is administered by the Traffic Department; no indication if it involves emissions testing	
Roadworthiness inspection system established in 2004 for vehicles over two years old; inspection is annual for petrol vehicles, every six months for diesel vehicles	
Air quality program established in 2005 to check vehicle emissions – includes two stations and a mobile laboratory	
Vehicle inspection system in place, though no indication if it includes emissions testing	
No emissions standards, no indication of any vehicle testing	
Roadworthiness inspection system in place; inspections are regular, no information as to time interval	
Indication of roadworthiness inspection system, no indication if it includes emissions	
UN ESCWA report indicates a vehicle testing program is in place	
Indication of vehicle emission testing	
Vehicle inspection system in place, though no indication if it includes emissions testing	

BUS RAPID TRANSIT IN LEBANON

Isam Kaysi

In an attempt to study the potential of mass transit in Lebanon, various studies have endeavored to estimate the costs and benefits of different mass transit options. From those studies, the Lebanese government can decide on the best option that allows for the shift from passenger auto use to public transport use. In a relatively recent study conducted in 2003 by DMJM+HARRIS Inc. in association with IBI Group — the "Beirut Suburban Mass Transit Corridor Feasibility Study" — some criteria were followed to rate several mass transit alternatives including Bus Rapid Transit and Light Rail Transit. The criteria upon which every option was evaluated are the following:

- Anticipated ridership increase
- Cost
- Environmental impact
- Time-frame for implementation
- Risk of implementation and performance
- Private sector involvement
- Ease of physical implementation
- Enforcement
- Policy implications
- Impact on private operators, service operators, and travelers on the corridor
- Impact on the government
- Impact on businesses along the Right of Way (ROW)
- Impact on travel time, on emissions, and on parking
- Impact on additional roadway construction
- Impact on trade and job balance

Light Rail Transit (LRT) emerges in this analysis as less desirable than Bus Rapid Transit due to its much higher cost. Hence, the study recommended initiating mass transit in Lebanon by introducing Bus Rapid Transit along the right of way of the old coastal rail line in Lebanon, which has been abandoned for about 50 years. Although benefits might not occur immediately upon implementation, the study verifies that there will certainly be long term benefits. Based on the above mentioned criteria, Bus Rapid Transit had a superior score on the more critical criteria such as anticipated ridership increase, environmental impact, and impact on travelers on the corridor.

A related study focused on the economic indicators related to major impacts of the implementation of suburban mass transit system for Beirut for the period between 2005 and 2015. Based on a cost-benefit analysis, the bus Rapid Transit with Feeder/Distributor system proved to be the superior choice among other options, and its benefits proved to outweigh its costs. The benefits resulting from this option are:

- Decrease in the total amount of time required to commute and the monetary savings resulting from this reduction

Year	Vehicle-km per peak hour - With MT	Vehicle-km per peak hour - Without MT	Vehicle-km savings per peak hour	Vehicle-km savings per year
2005	949,500	1,111,400	161,900	323,800,000
2015	1,205,700	1,391,600	185,900	371,800,000

more of the country's logistics and transportation infrastructure covering tourism railway lines (AMEinfo.com, 2006). Iraq is also poised to invite private investors to help the country develop road infrastructure, railway networks, river ports, and airports (Global Arab Network, 2009). In Morocco, the rate of passenger rail use is increasing by 10-15% annually, and plans are underway to construct 1,500 km of high speed rail lines by 2030, some of which will be powered by solar energy (ENN, 2007). In general, it is estimated that "the transport and logistics market in the Middle East – encompassing ground transport, air and sea freight, freight forwarding, warehousing, and supply chain management – has seen double-digit growth in recent years and will have a total value of $27 billion by 2012" (Zawya, 2010a).

Since these investments are being committed now, Arab governments have a unique opportunity at this early planning phase to develop a transportation

- Reduction in the amount of land required for automobile parking and the subsequent cut in costs incurred from parking spaces
- Reduction in the need for roadway construction
- Increase of governmental revenues as a result of import reduction
- Creation of new jobs related to the new implemented system

Most importantly, knowing that the mass transit system is likely to reduce trips, vehicle use, and travel time, the system is expected to result in significant reduction of pollutant emissions. The adjacent table shows the expected vehicle-km savings due to the implementation of the Mass Transit system between Jiyeh and Jounieh, passing around Beirut.

The region's dependence on automobiles and the severe congestion ensuing from it should encourage the Lebanese government to work towards reducing passenger auto use and shift to mass transit system. Based on the above, implementing the Bus Rapid transit system seems to be a cost effective solution. Its execution is expected to be a major step towards mitigating the Lebanese economic and environmental challenges and, as a result, will help to bring a better quality of life to the citizens of Lebanon.

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sector that promotes sustainable development and reduces poverty. How transport investments are made over the next 10 years will determine whether or not more sustainable patterns of transport will emerge in Arab countries.

III. IMPLICATIONS OF CURRENT TRANSPORTATION POLICIES

The unsustainable trends in the transport sector on a global scale are made obvious by the rapidly growing demand for transport activity (for both passenger and freight) where "it is predicted to roughly double between 2005 and 2050" (UNEP, 2011c). In the absence of institutional capacity that can introduce regulations and offer incentives for more sustainable patterns of transport, the economic, societal, and environmental costs of these trends will lead to deterioration in the quality of life. The effects of unsustainable trends in transportation can be summarized as follows:

- Increased energy consumption, which is associated with energy security risks for oil-importing countries,

and opportunity costs for oil-producing countries.
- High contribution to greenhouse gas emissions that cause climate change.
- Traffic congestion and associated time delays and productivity losses.
- Deterioration of rural and agricultural communities (through land misuse and migration).
- Inequitable access to jobs, services and markets and hence increased poverty.
- Weak contribution to equitable social development and cohesion.
- Deterioration in public health (caused by air pollution and stress).
- Reduction in human safety (reflected by high death and injuries rates caused by traffic accidents).
- Depletion of resources and increased contribution to solid waste loading.

WHAT ARE THE EFFECTS OF REDUCING PRIVATE VEHICLE USE?

"During the [1996] Atlanta [Summer] Olympics, Georgia officials expanded their transit system with roughly 1000 buses, promoted travel alternatives, telecommuting, and travel incentives, and cut morning peak traffic levels by almost one-fourth while the region accommodated a million visitors over three weeks. This cut [ground-level] ozone 28 percent and cut hospital visits for asthma by 42 percent."

Source: EDF, 2007

a. Implications of transportation policies/infrastructure on the economy

Transportation infrastructure is critical to improving the competitiveness of a country and for integration with other countries and regions through trade, "with the potential to accelerate economic growth and investment" (Zawya, 2010b). Therefore, gaps and unsustainable trends in the transportation sector will always have negative consequences on any economy.

The World Resources Institute (WRI) has estimated gross domestic product (GDP) losses caused by unsustainable transport. According to WRI (2007), "the economic cost of congestion has reached over three percent of gross domestic product (GDP) in many cities. Furthermore, urban road accidents cost developing countries $65 billion each year,

and in the most heavily polluted cities, economic losses from air pollution reach 10 percent of GDP. Developing countries also stand to suffer most from the consequences of climate change, with the poorest countries losing an estimated five to nine percent of their total GDP."

The Arab transport sector is a large and inefficient consumer of energy, accounting for 32% of the total energy consumption in Arab countries (AFED, 2009). High rates of car ownership and use in some Arab countries and the lack of fuel economy standards contribute to high on-road fuel consumption. The increased pace and intensity of construction activities also contributes to high rates of diesel fuel consumption by off-road construction equipment vehicles. Investments in tourism, special economic zones, and seaports as global trade hubs add to fuel consumption in air, marine, and land transport. For oil-importing countries, inefficiency in fuel use by the transport sector coupled with the ever-increasing demand for transport pose oil security threats and puts a financial burden on their energy import bill. For oil-producing countries, larger proportions of their crude oil are diverted to local markets at highly subsidized rates, with high opportunity costs associated with forfeiting high oil revenues from the sale of crude or refined oil on the international market.

Low performing transportation infrastructure in the Arab region has adversely affected trade due to higher costs, delays, and uncertainty. As trade is one of the main drivers for economic activity, transportation infrastructure remains not fully attuned to economic growth in many countries in the region.

Population growth and urbanization in Arab cities have induced a rapid growth in urban transport demand, while improvements in the transport system and supply have not kept pace with the growth in demand, creating a shortage in supply levels. This shortage is causing higher levels of traffic congestion and air pollution, and inefficiency in the movement of goods and people, ultimately leading to a decline in Arab cities' economic productivity and competitiveness.

Moreover, current transport infrastructure investment trends encourage urban sprawling, with negative social, economic, and environmental consequences. The result is restricted mixed land use practices in urban areas, increased demand for more roads, increased levels of private car ownership, and inefficient rural and urban development.

STANDARDS IN CHINA

The Chinese national government has been concerned about the trend to larger and more powerful vehicles and has taken two steps to control this trend in the future. First, it has imposed fuel economy standards that are more stringent for heavier vehicles than lighter vehicles. Second, it has lowered the tax rate on vehicles with engines smaller than 1.6L from 3% to 1%, while increasing taxes on vehicles with engines over 3L from 15% to 25%.

Source: GFEI, 2011

b. Social Implications of current transportation policies/infrastructure

Transportation can contribute to equitable social development by providing populations in rural

PUBLIC TRANSPORTATION VIA LIGHT RAIL TRANSIT IN DUBAI, UAE

The Dubai Metro has started operations in September, 2009. When fully, expanded, it is predicted to reduce the number of cars (1 million) in Dubai, by 30%, hence creating less demand for private car ownership. It is expected to generate fuel cost savings, while providing enhanced mobility to places of work and minimizing time losses in congested roads.

Source: Nasr, 2010 and ESCWA, 2009a

and urban centers, especially the poor, affordable, dependable, and safe access to marketplaces, health care centers, schools, and other destinations where social and administrative services are delivered and economic activities take place. A World Bank (2010) transport sector brief suggests that in Arab countries "there are specific areas, namely road safety, women's empowerment, and the accessibility of persons with reduced mobility (PMR), where the sector's contribution could be enhanced if there was greater understanding of issues among governments and focused interventions whenever justified." Although several Arab countries are signatories to the Convention on the Rights of Persons with Disabilities, none seem to have started to implement the Convention in the transport sector. Although action towards transport infrastructure growth and expansion is taking place in Arab countries, the benefits have not been large enough or equally distributed, forfeiting social, environmental, and economic opportunities.

Poor road and traffic system design in some Arab countries has taken a large toll on road safety. The relatively high death and injury rates in Arab countries caused by road transport causes suffering, lost incomes, and high health care costs, all of which translate to economic losses.

c. Implications of transportation policies/infrastructure on environmental sustainability

According to a report by UNEP (2011c), "transportation consumes more than half of global liquid fossil fuels; emits nearly a quarter of the world's energy-related CO_2; generates more than 80% of the air pollution in developing countries; results in more than 1.27 million fatal traffic accidents per year; and produces chronic traffic congestion in many of the world's urban areas." The report further adds that these costs to society, which can add up to more than 10

per cent of a country's GDP, are likely to grow, primarily because of the expected growth of the global vehicle fleet (UNEP, 2011c).

In the Arab region, the transport sector is becoming increasingly linked to economic and environmental problems. It accounts for 32% of the total energy consumption in Arab countries (AFED, 2009) and 22% of the total greenhouse gas emissions (ESCWA, 2009a).

Given population growth and increased urbanization in Arab countries, the region is witnessing a rapid rise in transport demand and in private car ownership. For example, in Jordan vehicle fleet is rapidly increasing at an annual rate of 7 to 10 percent (Croitoru and Sarraf, 2010).

In a study on the environmental impacts of transportation performed by Rodrigue and Comtois (2009), greenhouse gas emissions and air pollution are identified as the most alarming implications of current transportation policies and infrastructure development. On-road vehicles and off-road vehicles that use internal combustion engines emit pollutants that affect air quality, causing damage to human health. They also cause damage to vegetation and reduce crop yields. The emissions include carbon monoxide (CO), volatile organic compounds (VOCs), nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter (PM). Ground-level ozone, which causes lung damage and triggers asthma attacks, is formed when NOx and VOCs react in the presence of sunshine. Smog, which is a highly reactive and oxidizing mixture of airborne particles and ground-level ozone, can now be observed in some Arab cities. Those toxic air pollutants are associated with lung cancer and cardiovascular, respiratory, and neurological diseases. The health care costs and productivity losses associated with these diseases lay a burden on a country's budget and economy. For example, a World Bank study found that the total cost of damage from air pollution in Jordan averages about $161 million, or 1.15 percent of GDP in 2006 (Croitoru and Sarraf, 2010).

A new study on air pollution in Beirut published in January 2011 has shown that the transport sector in the city is contributing to oxides of nitrogen concentration levels much higher than international norms (AUB, 2011). High levels of particulate matter were consistently recorded as well. The World Bank (2010) transport sector brief states that "in Cairo, ambient concentrations of pollutants exceed, most of the time, World Health Organization's (WHO) guidelines." Similar results were reported in other cities including Algeria, Amman, Damascus, and Dubai. "All this reduces social and economic opportunities and quality of life, especially for the poorest, while affecting cities' competitiveness and economic growth" (World Bank, 2010), the brief concludes.

Furthermore, transportation infrastructure such as roads, harbors, airports, and railways, as well as the construction activities associated with them, will often pose challenges to the health and integrity of land and marine ecosystems. Marine shipping activities "can create environmental problems through the discharge of ballast wash, the modification of water systems during port construction, canal cutting and dredging, sanitation discharges, and, in the event of an accident at sea, environmentally devastating oil spills" (ESCWA, 2009a).

The environmental impacts of transport can have negative spillover effects on other economic sectors. Worsening air pollution, traffic congestion, and increased marine pollution will reduce the attractiveness of a city or region as a destination for tourism, international conferences, or business meetings.

GREEN SCHOOLS TRAVEL MODULE IN IRELAND

The SmarterTravel policy recognizes the need to achieve significant modal shift, and the Minister has made €2 million available in 2008 and 2009 (with similar funding projected in the years to 2012) to enable a significant expansion of support for the Green Schools Travel Module. This scheme is funded by the Department of Transport … through the Dublin Transportation Office (DTO). The Module aims to reduce dependency on car transport for journeys to and from school (and create a life-long culture of using alternatives to the car) and is an important element of implementing the SmarterTravel policy and the National Cycle Policy. In 2008, the initiative reached around 70,000 school children in 264 schools, and the target for 2012 is to reach over 1,000 schools and 265,000 pupils. The pilot project in 2007 delivered excellent results with walking and cycling increasing by 31% and 52% respectively.

Source: Department of Transport, 2002

HOW MUCH ADDITIONAL CO_2 SAVINGS ARE POSSIBLE IF INCREMENTAL PUBLIC TRANSPORTATION PASSENGER RIDERSHIP IS INCREASED?

"A solo commuter switching his or her commute to existing public transportation in a single day can reduce their CO_2 emissions by 20 pounds or more than 4,800 pounds in a year."

Source: SAIC, 2007

IV. ENABLING POLICIES AND CONDITIONS FOR A GREEN TRANSPORT/MOBILITY SECTOR

Creating conditions for a green transport system requires government-mandated regulatory measures together with incentive measures that motivate a shift in behavior. Voluntary actions by the private sector have an important, reinforcing role in accelerating this shift. The ultimate objective of a green transportation sector is to provide an affordable, reliable, and safe mobility services to all segments of the population, while minimizing the sector's contribution to greenhouse gas emissions, air pollution, non-renewable energy use, and degradation of ecosystems.

The transportation sector in Arab countries today poses serious challenges in meeting the goals of sustainable development. It is imperative for Arab governments to engage in an effort to reform current transportation policies and adopt innovative policies that are more conducive to making the transition to a green transport system. These policies, in the form of regulations, incentives, subsidy reforms, public-private partnerships, financing, and awareness campaigns, if adequately designed and implemented, can be the catalysts to enabling the transition to a green and sustainable transport system. For example, studies have clearly indicated that investments in both mass public transit and improved vehicle efficiency generate exceptionally high payback, while a green, low carbon, transport sector can reduce greenhouse gas emissions by 70% without major additional investment (UNEP, 2011c). These steps would significantly reduce the consumption of fossil fuels as well as the number of vehicles on the road. To succeed in achieving these transformations, the set of enabling conditions and policies articulated by government planning agencies have to be well developed and contextually relevant to local conditions in order to motivate consumers, developers, investors, and other stakeholders make the transition to a green transport sector.

a. Regulations

Appropriate regulations are essential to a green and sustainable transport sector. In addition to being effective in reshaping behavior, regulations have to be socially and politically acceptable.

Based on analysis of current trends in the Arab transport sector, the following regulations are suggested so that undesirable trends may be eliminated and conditions favorable to green transport can be cultivated:

- Adopting national fuel economy standards for vehicle fleets.
- Regulating vehicle emissions by issuing national standards and qualifying emission control technologies.
- Imposing clean fuel quality standards for gasoline and diesel. Because diesel is the fuel of choice for medium and heavy-duty vehicles (trucks), buses, and off-road vehicles, such as construction equipment, the reduction of sulfur content in diesel should become a priority for transportation planners and policy makers.
- Imposing import regulations with respect to car model, year of production, and emission standards.
- Imposing requirements upon renewal of vehicle registration to include safety, maintenance, and emission standards testing.
- Mandating mixed urban planning to institutionalize public transit and minimize travel distances.
- Dedicating safe space for walking and bike-riding.
- Dedicating lanes for high occupancy vehicles.
- Developing transport systems in rural areas.
- Mandating environmental impact assessment

studies and remediation actions for transportation infrastructure projects such as airports, seaports, highways, and railroads.

b. Incentives

To reinforce regulated mandates, incentive measures are often used to send market signals and influence behavior. Incentives are also needed in areas that cannot be regulated by law. A combination of financial as well as non-financial instruments can be used to motivate public and private organizations to utilize strategies to improve the efficiency of transportation use that would in turn result in reduced congestion and distances traveled by car. Local authorities can also create incentives to increase use of mass public transit and reduce use of private cars. The list of incentive measures may include:

- Marketing cleaner fuels at lower prices compared to other types. This measure has proven to be very effective in many countries, including Lebanon where a price differential of around 6% increased the share of unleaded fuel in the market from 15% to 85% in less than 3 months in 2003 (Chaaban, 2003). Similar results were obtained in other countries in the region.
- Providing funding to public agencies and non-profit organizations to acquire alternative fuel vehicles that have higher fuel economy and lower emissions.
- Offering financial incentives to speed the replacement of the existing stock of old taxis with higher fuel economy, low-emission vehicles.
- Offering financial incentives to speed the conversion from gasoline or diesel fuel to low-carbon fuel such as compressed natural gas (CNG).
- Offering consumer rebates to support the purchase of high fuel economy, lower emission vehicles. Revenue neutral rebate programs can be designed by channeling fees collected from the purchase of inefficient vehicles to

KLM FLIES PLANES ON REUSED COOKING OIL

The Dutch airline KLM announced plans to use recycled cooking oil on 200 flights between Paris and Amsterdam during the fourth quarter of 2011.

The fuel, biokerosene, is derived from used frying oil, which will be tested to ensure it meets the same technical specifications as traditional kerosene.

Airlines are under European Union (EU) pressure to cut their carbon emissions by 3% by 2012.

KLM's interest in biofuels dates back to 2009, when the airliner ran a biofuel test flight with 40 people on-board, including the former Dutch Economics Affairs Minister.

During the 90-minute flight, three of the four engines were powered by traditional aviation fuel. The fourth engine was powered with an aviation fuel that was mixed with 50% biofuel. Under the new plan, flights will use a 50-50% fuel mix of traditional kerosene and biofuel in all engines.

KLM said its supplies of recycled cooking oil - which are collected from hotels, restaurants, and factories before

being sent to the US for refining – are sufficient for only 200 journeys.

But KLM's managing director, Camiel Eurlings, said the airline was aiming to go much further than that: "The route to 100% sustainable energy is enormously challenging. We need to move forward together to attain continuous access to sustainable fuel." The bio-kerosene flights are expected to include some or all six daily flights between the two cities.

http://www.bbc.co.uk/news/business-13877623

the purchasers of efficient vehicles.

- Offering financial incentives for the purchase of hybrid electric, plug-in, and all-electric vehicles.
- Developing a clean school bus program to reduce emissions from school bus fleets by supporting the installation of diesel emission control equipment.
- Imposing higher taxes on vehicles with large engines.
- Using parking pricing, particularly in congested areas, to discourage single-occupancy car use and preferential pricing to motivate carpooling.
- Offering financial incentives to commuters who use public transit or shared riding transport to travel to their places of work.
- Adopting innovative car insurance schemes such as pay-as-you-drive, whereby insurance rates are linked directly to the number of kilometers traveled.
- Removing broad fuel subsidies, while developing targeted subsidies to assist low-income groups.

Transportation planners may also combine the implementation of transportation demand management (TDM) with the appropriate set of incentives to influence travel behavior. TDM is a term used to describe practices, procedures, and measures that reduce vehicle trips by increasing vehicle occupancy, reducing vehicle distances travelled, or both. This can be accomplished by having more people share rides in fewer vehicles, which also reduces traffic congestion. TDM also includes programs that motivate a reduction in single-occupant vehicles such as mass transit, carpooling, biking, and walking. Other TDM strategies work by changing the time of a trip or the need for a trip. This can be accomplished by employer-flexible time programs and telecommuting. By managing the demand for transportation services, TDM reduces the amount of investments sunk into road building and highway expansion that often remain short-term fixes and produce unintended consequences.

One of the most important strategies that can be adopted is shifting to alternative modes of transportation and reducing the use of private vehicles. Promoting mass public transport entails providing reliable, efficient, and environmental friendly busses, trains, and rapid transit at affordable rates, particularly for the low-income groups. The private sector can play a supportive, voluntary role in promoting the use of mass public transport by offering employees group discounts or season ticket allowances.

An effective incentive that has been proven successful in many countries in order to encourage commuters to shift from private to public transport is free shuttle bus services, which can be sponsored by government or private institutions. Such a service is available today in the United Arab Emirates (UAE), where busses transport commuters from pre-determined locations to places such as malls and other service centers.

In addition, improving non-motorized transport has to be associated with improved city planning to make walking and biking more attractive, and space for individual car parking restricted and at a cost. This can be accomplished by ensuring that large sidewalks are designed for safe pedestrian use, by dedicating lanes for bike use, and by promoting bike-sharing programs. To further promote non-motorized means of transport and reduce reliance on private cars, mixed land use planning offers a powerful design tool for shortening travel distances.

With car-ownership rates increasing significantly, as clearly shown in Table 2, preventive measures

ARE THERE FAVORABLE LAND USE IMPACTS THAT PUBLIC TRANSPORTATION CONTRIBUTES TO THAT RESULT IN POSITIVE ENVIRONMENTAL AND SOCIAL BENEFITS?

Public transportation provides many benefits that go beyond energy and CO_2 savings – as transit assets are being used to accomplish these important functions. Investments in public transportation have the benefit of supporting higher density land uses that allow for fewer vehicle miles of travel. While it is difficult to precisely measure this impact, a number of studies have attempted to estimate the relationship between transit passenger miles and vehicle miles traveled (VMT) reduction as a proxy for this effect. The results range from a reduction in VMT of between 1.4 miles and 9 miles for every transit passenger mile traveled. The outcome would be more efficient use of roadways, reduced road maintenance, shorter highway commute times and reduced need for street and off-street parking.

Source: SAIC, 2007

for private car usage should be enforced. Incentives such as introducing road and parking fees are vital to reducing private automobiles usage. Moreover, motivating people to use carpooling or other ride-sharing programs is one method to decrease the number of vehicles on the road. Achieving this might require providing innovative forms of incentives. Cash or parking vouchers for sharing on a daily basis, regular draw prizes, dedicated parking spaces for car sharers only, and extra annual leave and time off from work can be applied to encourage employees to adopt carpooling. Most importantly, carpool lanes can be designed to encourage carpooling, thus decreasing single-occupancy use of private vehicles.

To encourage the purchase of fuel efficient, hybrid, or all-electric vehicles, government agencies may choose to offer local fee exemptions, temporary tax credits and/or reduction, lower vehicle registration charges, or reduced custom tariffs in order to minimize the entry barriers of these clean vehicles to the market.

Alternative, low-carbon fuels, such as biofuel and compressed natural gas (CNG), potentially offer options to reducing transportation-related greenhouse gas (GHG) emissions. However, the long-term viability of biofuels will depend on their technological and economic feasibility, as well as on the choice of feedstock used for their production. The development of biofuels should focus on second-generation technologies that utilize sustainable biomass, agricultural waste, and wood chips as feedstock. Substituting carbon-intensive fuels with low-carbon fuels can be accelerated by offering incentives for the purchase of alternative fuel vehicles. Such incentives should also extend to those providing the infrastructure for alternative fueling facilities.

Transportation policies in most Arab countries further exacerbate market distortions, including fuel pricing, vehicles taxation, and public transport tariffs. Fuel price distortions lead to inefficient transport, over-consumption, and waste. Removing market distortions and increasing fuel prices is considered an essential tool for increasing transport sector energy efficiency and reducing GHG emissions. China, Russia, and Vietnam have shifted from low fuel-price policy to a high fuel-price policy, and the associated fears of an economic collapse from such a shift have been proven to be unfounded. Despite these successes, there are still some countries in the Arab region, such as Egypt and Yemen, which regard subsidized fuel prices to be essential for poverty reduction and economic growth.

Across the board fuel subsidies should therefore be incrementally removed, while targeted subsidies can be employed to reduce the vulnerability of low-income groups to high transport or commodity prices. Public government savings gained from the removal of subsidies can be directed towards expanding or improving mass public transit system, and towards reducing the potential impact of higher prices on the poor. Eliminating fuel subsidies reduces the burden on public budgets, spurs improvement in fuel efficiency, and fosters the use of alternative and cleaner fuels. Such policy changes enhance the energy security for oil-importing countries by reducing their energy bill.

While vehicles powered by gasoline are equipped with catalytic converters that capture toxic vehicle emissions, trucks and buses, and other vehicles powered by diesel, lack emission control systems that prevent the release of diesel exhaust emissions. To control these emissions, trucks and buses can be retrofitted with after-treatment systems. The following set of incentives can be introduced to encourage truck and bus fleet owners to install diesel emission control technologies:

- Reduced vehicle registration fees, taxes, or user fees.

HOW MUCH NET CO_2 IS PUBLIC TRANSPORTATION SAVING IN THE U.S. FROM THE CURRENT LEVEL OF SERVICES BEING OFFERED?

In 2005, public transportation reduced CO_2 emissions by 6.9 million metric tons. If current public transportation riders were to use personal vehicles instead of transit they would generate 16.2 million metric tons of CO_2. Actual operation of public transit vehicles, however, resulted in only 12.3 million metric tons of these emissions. In addition, 340 million gallons of gasoline were saved through transit's contribution to decreased congestion, which reduced CO_2 emissions by another 3.0 million metric tons. An additional 400,000 metric tons of greenhouse gases (GHG) were also avoided, including sulfur hexafluoride, hydrofluorocarbons (HFC), perfluorocarbons, and chlorofluorocarbons (CFC).

Source: SAIC, 2007

COMPRESSED NATURAL GAS (CNG) FOR VEHICLES IN EGYPT

Ibrahim Abdel Gelil

Current natural gas reserves in Egypt are estimated at around 78 trillion cubic feet. Updated estimates and potential new discoveries continue to push the size of these reserves upward. Since the early 1980s, the Government of Egypt recognized that utilizing Egypt's abundant natural gas resources could, in addition to fostering economic growth, make a significant contribution toward improving air quality and protecting public health. Egypt's energy policy was thus developed to maximize switching to natural gas in various economic sectors, given the economic and environmental advantages of natural gas relative to other fossil fuels. Strategies to achieve this policy included developing natural gas infrastructure, whereby a national gas pipeline grid expanded from 1,000 km to more than 17,000 km.

Expanding the local gas market and developing domestic gas demand have proved to be effective strategies. As a result, the share of natural gas in Egypt's primary energy consumption has grown from about 24% in 1990 to nearly 45% at present. The number of domestic gas consumers has reached 3.3 million and is predicted to grow to 5.5 million by 2015. Accounting for about 60% of total gas consumption, the electricity sector is the largest gas consumer. In the years to come, the government plans to switch the electricity generation sector exclusively to natural gas.

In addition to switching to natural gas in power generation, industry, and residential buildings, the Egyptian government has encouraged the private sector to commercialize natural gas vehicles (NGVs). In December 1994, the first company to convert gasoline vehicles to natural gas was formed. Currently, there are 6 operating compressed natural gas (CNG) companies, 119 CNG fuelling stations, and about 110,000 CNG vehicles in use, 75% of which are taxis, mainly in Cairo. A primary key to the NGV industry's success in Egypt is a package of financial incentives offered by the government including a 5-year tax holiday for CNG companies, low-cost conversion charges for car owners, and a CNG purchase price lower than gasoline. At about $0.08 per cubic meter of CNG (equivalent in energy content to a liter of gasoline), it is less than a quarter of the local gasoline price of $0.30 (or 1.75 Egyptian Pound) per liter. In addition, a typical vehicle conversion kit costs about $900. Owners of high fuel consumption vehicles, such as taxis, can recover their cost of vehicle conversion in as little as six months from fuel savings alone. This clearly explains why taxis have been the most converted fleet.

Another development for Egypt's CNG growth was the joint Egypt/US-sponsored $63 million Cairo Air Improvement Project (CAIP). This initiative focused on improving Cairo's air quality by reducing vehicles' tail emissions, among others. Part of this program included incorporating 50 dedicated CNG public transit buses into the Cairo public transport fleet. The bus bodies were locally manufactured, but the CNG engines and the rolling chassis were manufactured in the United States. However, replicating the taxis' conversion initiative by funding the conversion of the 5,000 public

- Clean diesel awards/publicity for fleet operators who use retrofit control technologies.
- Funding by government agencies for public and school bus fleets to offset part of the incremental capital costs of these systems.

Vehicles reaching their end-of-life pose a solid waste problem. To encourage end-of-life vehicle materials reuse or recycle, some auto-dealers have put in place a trade-in program, whereby potential car buyers may turn in their old cars for cash applied towards the purchase of a new vehicle. Governments should offer incentives to encourage more auto-dealers to establish trade-in programs, and if necessary mandate a take-back program, whereby auto-manufacturers and auto-dealers are required to take back their own car brands for reuse and recycle. This would reduce the size of auto-shredder residue going to landfills and generate employment opportunities in solid waste recycling.

c. Finance/Investment

The United Nations Environment Program (UNEP) recommended increasing financing in size and scope to adequately address climate change vulnerability of existing and new transport infrastructure and services. Scaling up financing for sustainable transport must be complemented with sound pricing practices. Moreover, UNEP has suggested that GHG mitigation-related funds

buses operating in Cairo has been a key challenge for the government. With diesel fuel heavily subsidized, the price differential between CNG and diesel has not been compelling enough. So far, the government has managed to increase the number of CNG buses to nearly 200. In parallel, another program is being implemented to convert government-owned vehicles to CNG. To date, more than 2,000 vehicles have been converted.

Furthermore, the government is currently implementing an initiative to replace a fleet of nearly 40,000 old polluting taxis with modern CNG-fuelled vehicles. The initiative started in Metropolitan Cairo, hosting 25% of Egypt's population and about 60% of registered vehicles, and will be expanded to other governorates. Economic incentives have been critical to the success of this initiative. In addition to concessional loans, new locally assembled CNG vehicles are exempt from about 55% of customs and consumption taxes. In return, participating taxi owners have to scrap their old vehicles. The project will have significant impacts on the air quality of Cairo, a megacity suffering from a high level of air pollution.

Switching to natural gas has improved air quality in Cairo. A recent state of the environment report on Egypt recorded a gradual improvement of air quality, indicating a steady reduction in the concentrations of sulfur dioxide, lead, and carbon monoxide over the period of 2004 to 2008. On the other hand, particulate matter (PM) and nitrogen oxides (NOx) continue to cause chronic air pollution problems in Cairo and other cities. The average concentration of NOx during the past five years exceeded Egyptian air quality standards.

Egypt's natural gas switching policy, while achieving economic, social, and environmental objectives, is also considered a cornerstone in mitigating greenhouse gas emissions. Switching to low carbon fuels such as natural gas is eligible for credit under the Clean Development Mechanism (CDM) of the Kyoto Protocol. It is estimated that about one-third of the projected carbon credits to be earned by Egypt within the CDM could come from natural gas projects.

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can be instrumental in providing support for technology/knowledge transfer, capacity building, and policy development, and in leveraging funding and investments by the private sector.

d. Research and development

Arab countries may benefit significantly from investing in research and development for converting agricultural waste into biofuels, to power transport vehicles. To encourage investments in biofuels, governments must demonstrate a long-term commitment to renewable energy sources and provide a set of incentives for key stakeholders to minimize entry barriers to market. Technical and economic feasibility studies must be conducted to demonstrate profitability margins and environmental quality of the conversion process.

Arab governments should also accelerate the development of an electrification infrastructure for railway trains and vehicles. This can particularly reap great dividends if accompanied by long-term plans to switch to natural gas or solar and wind resources for electricity generation. Many Arab countries already rely on natural gas for power generation, while investments in solar energy and wind farms are on the rise. Technologies used in hybrid, plug-in, and all-electric vehicles provide a transition bridge into fuel cell technology.

e. Institutions and governance

The development of an institutional framework for the transport sector is needed in order to reduce transport-related emissions and meet the rising demand for transport safely and affordably. This requires cooperation and coordination between government agencies, private sector enterprises, and non-governmental organizations. Governments can play a key role in developing the institutional framework for the transport sector by focusing on the development of regulations, coordinating national transport activities, introducing incentive measures, disseminating best practices, establishing partnerships with the private sector, and developing financial plans that sets transport on a sustainable path.

Because public agencies and institutions at the national and municipal levels own large vehicle fleets, the government can set an example by introducing green transport strategies into these public fleets to improve their fuel efficiency and reduce their emissions. Governments can take advantage of economies of scale by aggregating purchasing of fuel-efficient vehicles for public fleets.

There is also a need to institutionalize intra-government coordination at the highest possible levels to promote sustainable practices such as mixed land use. Therefore, urban and transportation planning need to be integrated so that city master plans may incorporate sustainable patterns of transport such as public transit. Considering that the majority of trips made in the city involve short distances, mixed use planning can have significant effects on reducing the demand for transportation while lessening the burden on government budgets.

A transport overview report by the World Bank (2010) recommends the need to increase the performance and capacity of the public sector, indicating that many senior decision makers in Arab countries "often do not have the systems, institutions, or even the staff to formulate and implement adequate strategies and investment plans, and to ensure that operations are organized and managed efficiently." The report noted the need to build capacity in proper planning and asset management systems, regulatory capability, improved cross-border facilities, technical competencies in vehicular and fuel technologies, and better governance and accountability.

f. Education

Transportation is an established component in civil and environmental engineering department curricula in a number of universities in the Arab region. Courses addressing the environmental implications of transportation activities and the technological options to make the sector more environmentally sustainable are taught by experienced lecturers within more specialized courses. Green transport concepts, like energy efficiency, are mostly taught as part of broader content areas in the undergraduate programs, and in selected graduate courses. There is a need to establish academic research and education programs that focus on the role of public policy in formulating the right mix of mandates and incentives for more sustainable patterns of transport. If established, such programs could conduct research to evaluate the efficacy of proposed regulations, quantify their market and non-market values, and offer proposals for new measures and for improving existing ones.

g. Training and public awareness

Extensive training is necessary at national and regional levels as part of a long term capacity building program, such as seminars or train-the-trainers workshops, to educate public officials about designing and implementing effective and efficient policies for a green transport sector. In addition, awareness campaigns should be designed and guidebooks produced to provide vehicle owners with tips about proper fuel-saving driving habits. These guides should also include advice about how to reduce the number of trips made and the distance travelled. Corporate fleets have a responsibility to conduct training for their drivers and offer financial incentives for the best performers. Government and public sector institutions should conduct public awareness campaigns for policy and decision makers in order to promote the mainstreaming of sustainable and green transportation in their planning and decision making processes.

V. IMPLICATIONS OF TRANSFORMATION TO A GREEN TRANSPORT SECTOR

Introducing more sustainable patterns of transport in Arab countries will generate significant positive ramifications economically, socially, and environmentally. But sustainable socio-economic development goals cannot be achieved without addressing current deficiencies in the region's transportation sector.

a. Implications of green transport on the economy

Making a shift to a sustainable transport sector will bring gains in productivity, employment, and efficiency to any economy. In fact, the direct value added by the transport sector to the global gross domestic product (GDP) is about 3-5 percent, and transport directly provides 5-8 percent of total paid employment of an average country (ESCWA, 2009a). Investing in national public transit infrastructure and in alternative transport modes such as railway networks has been demonstrated to generate employment opportunities in many countries. Green transportation will save national economies the tremendous costs associated with traffic congestion, traffic-related deaths and injuries, air-pollution health care costs, and climate change-related costs. These costs may account for a significant percentage of GDP, ranging from 3-10% annually. As a sector, sustainable transport is a key component in a country's energy security policy, and contributes significantly to reducing spending on energy imports. Therefore, the effects of sustainable transport policies on productivity, competitiveness, and economic growth cannot be underestimated.

Local, regional, and international trade activities are accelerated or hindered by the quality of transportation infrastructure in a region. More efficient trade activities and financial benefits are eventually reaped from a well-funded, efficient, and strategically planned transport sector. Similarly, the facilitated flow of people and goods across state boundaries translates into higher employment and increased economic opportunities. Increased awareness of the benefits of regional cooperation and international trade has been one of the objectives of ESCWA since 2007. It has therefore been working towards empowering countries to implement policies for improving transport infrastructure and logistics within the framework of the Integrated Transport System in the Arab Mashreq (ITSAM) (ESCWA, 2009b).

b. Social implications of a green transport sector

As indicated earlier, a sustainable transport infrastructure promotes cost effective transport services including public transport. This enhances accessibility to markets, services, employment opportunities, and reduces poverty in communities regardless of gender and age. Improving affordable modes for commuting such as walking, cycling, and public transportation increases overall basic accessibility and economic opportunities.

When sustainable measures are introduced and implemented in the transport sector, remote and rural areas can be connected to the transport grid, which will tend to reduce rural to urban migration, enhance community development and productivity, and improve income distribution.

According to the World Bank (2011b), "efficient transport systems and roads also facilitate access by health workers to often sparsely-populated rural areas as well as the necessary monitoring and supervision of health services and initiatives." This will allow for efficient and affordable delivery of health care services to all regions within a country. Additionally, the impact of sustainable transport on children and women, especially in rural areas, who often suffer disproportionately from poor transport, is often profound. This is a reflection of the fact that better transport services help to ease the risks of travel and thus allow more opportunities for school attendance, home hygiene, and prenatal care.

c. Implications of a green transport sector on environmental sustainability

More sustainable patterns of transportation will significantly reduce GHG emissions and air pollutant levels. While these benefits contribute to environmental sustainability, the benefits extend to reducing the significant economic and social costs of environmental degradation alluded to earlier.

In addition, green transportation infrastructure promotes exercise and recreation and improves health. These are factors which are often overlooked but have essential positive impacts specifically on productivity and human wellbeing.

VI. CONCLUSION AND RECOMMENDATIONS

Deficiencies in the Arab transport sector continue to pose challenges for transitioning to more sustainable patterns of transportation. Urban transport services are characterized by inadequate mass public transport and road congestion. Poor fuel quality and an ageing vehicle fleet contribute significantly to the poor air quality observed in a number of Arab cities. The sector accounts for 22% of all greenhouse gas emissions in Arab countries and consumes 32% of the total energy used, posing energy security risks. In countries with large rural populations, such as Egypt, Yemen, and Morocco, access to rural areas is constrained by inadequate road infrastructure. Regional transport networks suffer from inefficiency. Fatalities and injuries from road transport in a number of Arab countries remain high compared with other regions of the world. Urban and transportation planning are not well integrated, leading to sprawl, land degradation, and increased vehicle use. These trends are exacerbated by the rising demand for transportation and the excessive reliance on private cars, which are driven by increased urbanization, high-income life style, and economic growth.

These transportation trends deprive Arab countries of the economic opportunities, desperately needed, to create new employment, improve competitiveness, and promote rural development. Trade flows are retarded, and so is economic integration, but they are vital for the economic growth prospects of Arab countries. Arab cities are increasingly chocked by high vehicle densities, traffic congestion, poor air quality, noise, and poor visibility. These trends add up to significant losses to productivity and to high health care costs, which place a high burden on government budgets and subtract from its GDP. The lack of adequate mass public transport in many Arab cities deprives many groups from access to economic centers and social services, which contributes to inequitable social development. These costs combined are estimated to lead to a 3-10% loss of a country's GDP.

To bring about a shift to green transportation, Arab governments are urged to take the following steps:

- Invest in public transport and non-motorized forms of transport, while providing incentives to promote their use.
- Invest in rail transport to move freight and to transport people within busy corridors.
- Adopt national fuel economy standards for vehicle fleets.
- Remove broad fuel subsidies gradually, while employing targeted subsidies to reduce the vulnerability of low-income groups to high transport and commodity prices.
- Accelerate car replacement programs using incentives to take ageing, polluting cars off the road, and establish a vehicles emission testing program.
- Upgrade the quality of fuels, particularly by reformulating gasoline and reducing sulfur content in diesel.
- Introduce and promote through incentives low carbon fuels, such as compressed natural gas.
- Apply mixed-use land management concepts in urban planning to reduce travel distances and protect land from degradation.
- Adopt transportation demand management practices that reduce vehicle trips by increasing vehicle occupancy, reducing vehicle distances travelled, or both.
- Accelerate the development of an electrification infrastructure for railway trains and vehicles.
- Improve the performance and capacity of public transportation departments and nurture appropriate technical expertise.
- Design appropriate interventions to reduce road fatalities and injuries caused by accidents.
- Raise awareness about fuel-saving purchasing, driving, and maintenance habits among vehicle fleet owners.

REFERENCES

AFED (2009). *Arab Environment: Climate Change.* Arab Forum for Environment and Development (AFED), Beirut.

Allam, H. (2010). Welcoming speech: "Middle East Cleaner Fuels & Vehicles for Clean Air Policy Forum." United Nations Environment Program (UNEP), Cairo. http://www.unep.org/transport/pcfv/PDF/Cairo_PCFVSpeech_Hossam.pdf [accessed June 16, 2011]

AMEinfo.com (2006). "Egypt an Excellent and Attractive Investment Option, Says Gulf Finance House CEO." AMEinfo.com. http://www.ameinfo.com/105092.html [accessed April 15, 2011]

Arab News (2010). "GCC rail project to cost $ 25bn." Arab News. January 31, 2010.

AUB (2011). *Workshop on Air Quality in Beirut.* Air Quality Research Unit, American University of Beirut (AUB)/Saint Joseph University (USJ), National Council of Scientific Research (NCSR), Beirut.

Chaaban, F. (2003). Air pollution: causes and remedies. Workshop on Religion and Environment, Saint Joseph University (USJ), Beirut.

Croitoru, L. and Sarraf, M. (2010). *The Cost of Environmental Degradation: Case Studies from the Middle East and North Africa*. The World Bank, Washington, DC.

Department of Transport (2002). "Sustainable Transport." http://www.transport.ie/transport/Sustainable/index.asp?lang=ENG&loc=1913 [accessed April 28, 2011]

EDF (2002). "Testimony of Michael Replogle Before the Senate Environment and Public Works Committee, United States Senate." Environmental Defense Fund (EDF). http://www.edf.org/documents/2280_ReplogleSenateTestimony07-2002.pdf [accessed June 18, 2011]

ENN (2007). "Solar Power for New Moroccan Rail Line." Environmental News Network (ENN). http://www.enn.com/sci-tech/article/24134 [accessed June 20, 2011]

ESCWA (2009a). *Transport for Sustainable Development in the Arab Region: Measures, Progress Achieved, Challenges and Policy Framework.* United Nations Economic and Social Commission for Western Asia (ESCWA), United Nations (UN), New York.

ESCWA (2009b). *ESCWA Annual Report 2008*. United Nations Economic and Social Commission for Western Asia (ESCWA), United Nations (UN), New York.

GFEI (2009). 50by50: *Prospects and Progress.* Global Fuel Economy Initiative (GFEI), London.

Global Arab Network (2009). "Investment Opportunities Driving Iraq's Transport Sector." http://www.english.globalarabnetwork.com/200906181290/Economics/investment-opportunities-driving-iraqs-transport-sector.html [accessed April 15, 2011]

Nasr, G.J. (2010). "Green Economy Implications of the Sustainable Livelihood Approach for Sustainable Development in the Arab Region." http://css.escwa.org.lb/sdpd/1350/17.pdf [accessed April 15, 2011]

Rodrigue, J-P., Comtois, C., and Slack, B. (2009). *The Geography of Transport System.* 2nd Edition. Routledge, New York.

SAIC (2007). *Public Transportation's Contribution to U.S. Greenhouse Gas Reduction.* Science Applications International Corporation (SAIC), McLean, VA.

UNEP (2008). "Middle East, North Africa, and West Asia Vehicle Standards & Fleets." Partnership for Clean Fuels and Vehicles, United Nations Environment Program (UNEP). http://www.unep.org/transport/pcfv/PDF/MatrixMENAWA-VEHSJun08.pdf [accessed June 24, 2011]

UNEP (2011a). "Middle East, North Africa and West Asia Lead Matrix." Partnership for Clean Fuels and Vehicles, United Nations Environment Program (UNEP). http://unep.org/transport/PCFV/PDF/MENAWALeadMatrix-Apr2011.pdf [accessed May 2, 2011]

UNEP (2011b). "Diesel Fuel Sulfur Levels: Global Status – January 2011." Partnership for Clean Fuels and Vehicles, United Nations Environment Program (UNEP). http://unep.org/transport/PCFV/PDF/MapWorldSulphur_January2011.pdf [accessed May 2, 2011]

UNEP (2011c). "Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication." United Nations Environment Program (UNEP). http://www.unep.org/greeneconomy/ [accessed June 17, 2011]

WHO (2009). *Global status report on road safety: time for action.* World Health organization (WHO), Geneva.

WHO (2010). "Road Safety: Estimated road traffic death rate (per 100000 population), 2006-2007." World Health Organization (WHO). http://gamapserver.who.int/gho/interactive_charts/road_safety/road_traffic_deaths2/atlas.html [accessed June 4, 2011]

Wikipedia (2011). "List of Countries by Vehicles per Capita." Wikipedia. http://en.wikipedia.org/wiki/List_of_countries_by_vehicles_per_capita [accessed June 24, 2011]

World Bank (2010). "Overview: Transport Sector Brief – Middle East & North Africa." The World Bank. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/MENAEXT/0,,contentMDK:20532420~pagePK:146736~piPK:226340~theSitePK:256299,00.html [accessed April 15, 2011]

World Bank (2011a). "Motor Vehicles (per 1,000 people)." World Bank Indicators. http://data.worldbank.org/indicator/IS.VEH.NVEH.P3 [accessed June 24, 2011]

World Bank (2011b). "Transport for Health Access." The World Bank. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTTRANSPORT/EXTTSR/0,,contentMDK:20835940~menuPK:2274762~pagePK:210058~piPK:210062~theSitePK:463716,00.html [accessed April 15, 2011]

WRI (2007). "Sustainable Transport in the Developing World." World Resources Institute (WRI). http://earthtrends.wri.org/updates/node/135 [accessed June 17, 2011]

Zawya (2010a). "Logistics to Regain Steam Riding on Strong Demand." Zawya. http://www.zawya.com/story.cfm/sidZAWYA20100103050255 [accessed April 15, 2011]

Zawya (2010b). "Transport Infrastructure Faces New Challenges." Zawya. http://www.zawya.com/story.cfm/sidZAWYA20100526044636 [accessed April 15, 2011]

SUSTAINABLE DESERT DEVELOPMENT CORRIDOR
A SUPERHIGHWAY TO SOLVE EGYPT'S PRESSING PROBLEMS

Farouk El-Baz

Introductory Remarks

This paper improves the case for a proposed superhighway west of the Nile from the Mediterranean Sea coastline to Lake Nasser. The proposal would provide numerous opportunities for the development of new sustainable communities, based on sustainable agriculture, industry, trade and tourism around a 2,000 km strip of the Western Desert. The proposal is resubmitted for consideration by the private sector – local, Arab and international investors.

Adequate transportation routes and mechanisms are essential to ever-increasing development. From the time of establishing the Egyptian State over 5,000 years ago, the Nile served as a mechanism to transport people, news, products, armies and tax collectors – all aspects of a unified, sustainable state. Similarly, the Greek, Roman, and Arab civilizations assured the ease and security of travel within the boundaries of their vast territories. More recently, European development was greatly assisted by the ease of transportation at the rise of Western Civilizations. It is also clear that superb transportation systems allowed the United States to better utilize its vast natural resources to reach its present position of prominence.

It is not possible to foresee the establishment of a modern network of transportation systems within the confines of the Nile Valley and its Delta, because that would reduce agricultural land. The fertile soil within the inhabited strip of Egypt was deposited by the Nile River over millions of year, and it is irreplaceable. In the meantime, the growth of population negates the potential of continuing to live on and utilize only 5% of the land area of Egypt. Thus, it is imperative to open new vistas for expansion outside of the inhabited strip, an expansion that would take into account social, environmental and economic development aspects. This proposal provides an innovative solution to the numerous problems that face Egypt today.

In addition to facilitating transport throughout Egypt, the proposed superhighway would ensure the creation of sustainable communities and activities without compromising the environment. It should limit urban encroachment over agricultural land and opens myriad opportunities for new communities and generate employment close to over-populated towns. It also affords unlimited potential for new schools and training centers, industrial zones, trade centers, tourism; i.e., virgin territory for development initiatives in every field that promotes sustainable development and green investment. This in itself gives hope to generations of Egyptians for a better future. It represents the best possible use of one of Egypt's natural resources – the strip of the Western Desert that parallels the Nile and is close to its high-density population centers.

This particular strip of land was chosen because of its unique natural characteristics. It is basically flat with a gentle northward slope from west of Aswan to the coast of the Mediterranean Sea; the lack of topographic prominences makes it easy to pave. This strip is also devoid of east-west crossing valleys that are prone to flashfloods as in the case of the Eastern Desert. It passes close to vast tracts of fertile soils that are amenable to reclamation; most of such regions have potential for groundwater resources. The strip is also comparatively free of sandy areas; it is not crossed by lines of shifting dunes as in the case of regions farther to the west. Furthermore, the region is endowed with plentiful sunlight and persistent northerly wind. These conditions allow the use of renewable solar and wind energy in the future.
Based on the above, the proposed project includes the establishment of the following:

- A superhighway to be built using the highest international standards, 1,200 km in length, from west of Alexandria to the southern border of Egypt.
- Twelve east-west branches, with a total length of approximately 800 km, to connect the highway to high-density population centers along the way.
- An efficient and affordable railroad for fast passenger and freight transport parallel to the superhighway.
- A water pipeline from the Tushka Canal to supply freshwater.
- An electricity line to supply energy from renewable sources.

North-South Highway

The main highway runs parallel to the Nile River from Egypt's Mediterranean Sea coastline to its border with Sudan. Its distance from the Western scarp of the Nile

Valley varies from 10 to 80 kilometers, based on the nature of the crossed land. It begins at a point between Alexandria and El-Alamein, perhaps near El-Hamman, to be selected for the establishment of a new international port. Egypt requires a technologically advanced port to serve future needs of import and export as well as increased trade with Europe and the expansion of maritime transport worldwide. In the meantime, the northern branch of the superhighway extends to Alexandria and its present port and airport and eastward through the Nile Delta coastal highway to Rosetta and Damietta.

The superhighway ends near the border with Sudan to allow a future extension to better link the two neighboring countries. Better ground links between Egypt and Sudan would have a positive impact on the economies of both countries. Near the terminal point, branches extend to Lake Nasser, Abu Simbel, and the Tushka depression – all regions that have promise in development of fisheries, tourism, and agriculture, respectively.

The aforementioned characteristics of the superhighway require the establishment of a private sector organization to manage the road and its maintenance. The organization would be responsible for manning the toll stations, providing emergency services, and maintaining the utility of the superhighway. Naturally, such an organization requires a specific mandate and clear laws and regulations by the Egyptian Parliament to assure the safety and utility of the highway while placing limits on excessive government regulations or company profits.

East-West Connectors

Branches of the main highway oriented in a roughly east-west direction would connect it to the main centers of population, based on comprehensive environmental impact assessment studies. They assure easy transport between the main cities of Egypt and between the main production areas and the outside world. Such branches may include the following:

Alexandria Branch: This branch connects the main north-south highway to the road leading to Alexandria, its port and airport. The eastern terminus of this branch would connect with roads leading to the northern cities and towns of the Nile Delta coastal zone including Rosetta and Damietta.

Delta Branch: This connects the superhighway with the heart of the Nile Delta, for example, at the city of Tanta. The branch would best be an elevated new road within the Delta to limit encroachment on the fertile land. It also might require a new bridge over the Rosetta Branch of the Nile River. From its terminal point at Tanta, it branches to upgraded roads leading to cities and towns of the Nile Delta. This would assure better links between the Delta and the rest of Egypt and the outside world.

Cairo Branch: This branch connects the superhighway with the Cairo-Alexandria road. It is envisioned to link it with upgraded roads leading to Maadi and eastward to Suez. This would allow the use of cargo land transport between Alexandria and Suez (the Mediterranean Sea and the Red Sea) as an alternative to the Suez Canal when the need arises.

Faiyum Branch: This connector would allow the development of the desert north of the Faiyum depression by establishing sites for tourism, new communities and agricultural areas. It also would allow an extension to the west of the depression for establishment of industries such as cement production.

Bahariya Branch: This branch improves the existing road to the Bahariya Oasis as a northern link to the New Valley Province to the south. It would also allow further development of the natural resources of the Bahariya depression including the iron ore deposits.

Minya Branch: The city of Minya has been one of the major population centers from ancient times. However, little development has reached its shores because of the centralization of projects in and near Cairo. Minya has a university and can generate numerous avenues for local and regional development if it is better connected to the national market.

Assiut Branch: This case is identical to that of Minya in all aspects. In addition, Assiut has an airport that could be upgraded for civilian transport. It is also the end point of the road from Kharga, the capital of the New Valley Governorate, at the Nile Valley. This road is paved over the ancient Darb El-Arbain, the track of camel caravans connecting the Nile Valley and the oases of Darfur in northwestern Sudan, which can be upgraded and revitalized.

Qena Branch: This connector would open for agricultural development a vast area south of the Nile from the Qena Bend in the east to Nag Hammadi to the west. This plain represents fan deposits of streams that were more active

during wetter climates in the past; therefore, groundwater resources would potentially underlie it. A westward road could also connect it with the existing road to the Kharga Oases to link the superhighway with the southern part of the New Valley Province.

Luxor Branch: This branch would allow unlimited growth of tourism and recreation on the plateau that overlooks the largest concentration of ancient Egyptian archaeological sites. It allows the erection of hotels and resorts on top of a magnificent plateau overlooking the Nile Valley.

Kom Ombu-Aswan Branch: Like the Qena Branch, the Kom Ombu segment opens up a vast tract of fertile land west of the Nile for reclamation. The region once hosted the channel of the Nile; segments of its ancient courses were revealed by radar images from space. Because of geological reason, the Nile shifted its course eastward to its present location. Therefore, the abandoned land to the west would include fertile soil of the ancient Nile sediments. This makes it an excellent location for the expansion of agriculture west of the Nile. The Aswan segment connects the superhighway to the city of Aswan. It would allow the transport of products to and from the northern governates and the outside world. It would also allow the expansion of winter recreation resorts and ecotourism near the many archaeological sites and the High Dam.

Tushka Branch: The superhighway goes through the northeastern edge of the Tushka depression, where a canal from Lake Nasser has created several lakes. This region is slated for agricultural expansion. It is presently devoid of an adequate transportation infrastructure. The superhighway would provide all necessary mechanisms to transport people, material and products to and from the Tushka region.

Lake Nasser Branch: This connector is to be selected at a site that is amenable to the development of a major fishing port along the shores of Lake Nasser to the north (downstream) of Abu Simbel. Plentiful fish from the lake could be transported via the railroad to distribution centers throughout Egypt. The concept of sustainable fishing should be promoted with fish providing nutrition for the local population and for export. The branch might also increase the potential use of Lake Nasser for eco-tourism.

Modern Railway

Egypt's railroads are very old and their tracks are laid on relatively soft soils that do not allow fast

movement by heavy loads. Thus, the need exists for an advanced railroad system to serve present and future requirements of development. A rail-track parallel to the superhighway would serve that purpose. If deemed necessary, connecting tracks could be established along some of the east-west road branches in the future. An energy efficient and even an electric railroad system should be considered in order to reduce harmful emissions and their impacts on health, the environment, and ecosystem.

The aluminum manufacturing plant at Nag Hammadi west of Qena represents a good example of the need for a new railroad for industrial uses. At present, the raw material arrives from abroad at Alexandria. It is transported by heavy trucks from Alexandria to the factory in Nag Hammadi on the ailing and very crowded road network of the Nile Delta and Nile Valley. After processing, the aluminum is transported northward along the same road network. A railroad from the Mediterranean port to the Nag Hammadi connector would ease the operation, in addition to saving lives and property along the existing road network.

The superhighway ends at the southern border of Egypt along the Selima-Edfu camel caravan route. At this point, a short segment of road would connect it to the shores of Lake Nasser across from the town of Wadi Halfa, near the

northern border of Sudan. There is a railroad that connects Wadi Halfa to the rest of eastern Sudan. Thus, it would facilitate transport between Egypt and the main cities and town of Sudan.

Water Pipeline

No development could be assured without the presence of freshwater. Even though several areas along the path of the superhighway promise the existence of groundwater, a pipeline of fresh water from the Tushka Canal is required to run the length of the superhighway. It is envisioned that a pipe of about one meter in diameter would provide the necessary resources for human consumption during the early phases of the project. Agricultural and industrial development along the east-west connectors would be supplied either by groundwater resources or subsidiary canals from the Nile. However, measures for the efficient and rational use of water should be introduced, including the recycling of water for reuse.

After pumping the water from the Tushka canal up to the plateau for approximately 300 meters, it would flow northward along the topographic gradient without any need for energy. It is even possible to imagine that the water flow down-gradient might be usable to produce mechanical energy that can be converted to electricity.

Electricity Line

Initial phases of the proposed project require energy for lighting, refrigeration, and other needs. Therefore, a line to supply electricity is one of the requirements of the project. The required power can be supplied mainly from renewable sources of energy (wind and solar).

Urban communities, industrial plants, and agricultural farms to be initiated along the east-west branches should be encouraged to utilize solar and/or wind energy resources as much as possible. It might also be mandated by law to generate at least 25% of total energy needed from renewable resources. This encouragement can be in the form of tax breaks or grants from the Egyptian Government or international environmental agencies.

Project Benefits

It is important to evaluate the pros and cons of any proposed project. In the case of the present proposal, its design should ensure that it does not result in negative environmental and social implications. The main question that comes to mind though is how long it takes to secure a return on the investment of such an elaborate infrastructure. This question can only be answered by feasibility studies, which should take into account environmental and social costs and benefits.

In the meantime, it is possible to list the benefits of the proposed project as follows:

- Ending urban encroachment on agricultural land in the Nile Valley.
- Opening new land for desert reclamation and the production of food.
- Establishing new areas for sustainable urban and industrial growth near large cities.
- Creating hundreds of thousands of new jobs for Egyptian labor.
- Arresting environmental deterioration throughout the Nile Valley.
- Reducing CO_2 emissions, preserving the environment, the ecosystem and the services it provides.
- Relieving the existing road network from heavy and dangerous transport.
- Initiating new ventures in tourism and eco-tourism in the Western Desert.
- Connecting the Tushka region and its projects with the rest of the country.
- Creating a physical environment for sustainable development projects by the private sector.
- Involving the population at large in the development of the country.
- Giving people, particularly the young, some hope for a better future.
- Focusing people's energy on productive and everlasting things to do.

Method of Execution

Although the project was proposed twenty years ago for execution by the Egyptian Government, its scope and the variety of its benefits suggest that it can best be accomplished by the private sector. At the time of the original proposal, experts placed its cost at six billion dollars. Perhaps now the necessary infrastructure would cost four times as much. However, the cost would not be too high for decisive solutions to many of Egypt's present problems, and tangible options for a better future. Furthermore, it would not represent a burden to

the Egyptian Government, because it would be totally financed by the private sector – local, regional and international investors. Naturally, this would require a vigorous and well though-out marketing campaign.

During the past twenty years, I have repeatedly written and widely lectured on the proposal at universities and research centers throughout Egypt. Audiences receive it with great enthusiasm and consider it ideal for a "national project," that is something the whole nation can get involved in its planning, execution and utilization.

Therefore, it is envisioned to involve experts from universities and research centers in the study and evaluation of various aspects of the proposed project. It would also be necessary to plan the training of workers in numerous fields for employment in various aspects of the project. In addition, governorates may initiate lists of the kinds of development projects that could be established in their territories once the project begins.

It would also be advisable to involve the young in the process; the project is proposed to assure a better life for future generations. University students could compete for prizes in recommending projects on either side of the connectors along the superhighway. High school students could be given opportunities to compete for other prizes for naming the east-west branches and the new towns and villages to be established along these branches. If a large number of people become involved in the project, it would have a better chance for being considered a "national project," one that the society as a whole owns and protects.

Concluding Remarks

My granddaughter Yasmeen is 10 years old and attends school in Washington D.C., where her parents live. She returned from school one recent day to tell her mother that the teacher mentioned Egypt in the first lesson in history. She added that the teacher said that history repeats itself and asked if it were true. When her mother answered positively, she excitedly asked: "Does this mean that Egypt can be great again?"

We need to answer the question of this youngster who lives far away, but keeps Egypt in her heart and mind. The answer requires deep thinking and hard work by a generation or two. Egypt has lived through many great

episodes while its people were focused on their work, supportive of each other, and aimed at the common good. Once in a while, Egyptians fall into a quietude, hermitically sealing their minds, and receding from the world around them. But, stagnation events are usually short, and Egyptians spring back into action leading the way to civilized life. Is it fair then to ask: "When will Egyptians return to holding the banner of civilization?"

From the earliest time of recorded history, civilization blossomed among groups of people who were collectively able to achieve the following:

- Production of excess of food, for the growth of their bodies and minds.
- Division of labor among the society, in a fair and well-organized manner.
- Easy and healthy living in urban areas, where some of them could create and innovate.

Therefore, Egypt needs to satisfy these three conditions before paving the road for the re-spread of civilization along the banks of the Nile River. It is my belief that the proposed "Superhighway for Sustainable Development" would go a long way toward achieving these goals. This needs strong faith in the resilience of the descendents of the energetic builders of the Pyramids. It would require a mere generation or two for this development initiative to bear fruit. This is not a long time in the 8,000-year history of Egypt, which deserves a distinguished position among great nations now and in the future.

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