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Air Quality and Atmospheric Pollution In the Arab Region

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DRAFT

Air Quality and Atmospheric Pollution In The Arab Region [*]

Executive Summary

The issue of air quality conditions and atmospheric pollution in the Arab Region (or Middle East and North African countries) has been addressed through consideration of the energy production and energy consumption pattern. Global, regional and local sources of air pollution in the region have been considered. Emission scenarios of many countries of the region have been outlined. Even though it has been long realized that air pollution constitutes one of the major sources of loss on GNP of many countries in the region weak institutional capabilities for air pollution management and control still exist in the region.

Major types of pollution sources in the region such as dust storms and sandstorms, greenhouse gas emissions and other gases from various industries are outlined. Local sources including urban growth, transportation systems, industrialization, and lack of awareness and shortage of institutional capabilities all contributed to the relatively low air quality and weak control. The risk of radioactive contamination of air and shortage of contingency plan has not taken into consideration. Examples of potential impacts of air pollution on the national gross product as well as potential impacts of climate change on various economic and health sectors have also been investigated.

An outline of the required ground-based monitoring networks and its needs as well as the most recent capabilities of satellite monitoring systems have been presented and needs for capacity building concerning new air pollution monitoring and control techniques have been addressed. Examples of the output of monitoring networks of Egypt has been presented and discussed. The need for change of fuel strategy shift with particular emphasis on transportation systems, industry and urban systems is emphasized.

Priorities for action on the global, regional and local scales have been addressed for improving consumption pattern, minimizing impacts of climate change and depletion of ozone layer, upgrading air quality and promoting better governance and Public Participation for Sustainable Development . Particular emphasis was also placed on building up and upgrading institutional capabilities in member countries through establishing of monitoring and assessment networks.

1. Introduction

Across the Middle East and North African region, people have always contended with excessive heat, dust storms, shortage of rainfall and harsh geography. In this century, industrial development, climate change, political upheaval, and war have left a legacy of environmental impacts and health problems. Scarce fresh water is diverted, misused and polluted with hazardous wastes, sewage, agricultural waste and other chemicals. Arable land is being lost to desertification and unplanned urbanization. Coastal zones are mismanaged and polluted with oil, threatening pristine coral reefs, mangroves, wild fowl, and fishing areas. Unprecedented unplanned urbanization, industrialization and migration of traditionally rural peoples and resettlement of political refugees and foreign workers strain city services and give rise to air pollution.

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A. The atmosphere and Climate in the Arab region

The Arab Region is the main geopolitical region in the world characterized by the prevailing hyper-arid and arid climatic conditions, occupying more than 78% of its total area. Other climatic conditions including semi-arid and dry sub-humid occupying relatively limited areas. Aridity is depicted by a short rainy season that extends for few months either during the winter/spring or summer seasons. The annual rate of evapotranspiration far exceeds the annual rate of precipitation with a prolonged season without precipitation. Average annual rainfall through most of the Arab Region varies considerably from less than 50 mm to 500 mm with limited areas, especially elevated and mountainous areas, where annual rainfall might reach or exceed 1000 mm.

The average annual rainfall in the Region is hardly indicative of rainfall efficiency. Climatic data have been compiled throughout the Region for varied lengths of time. Rainfall in the Region is characterized by erratic seasonal distribution with many years significantly deviating from the accumulative mean. Droughty years are those with large deviation blow the annual mean. Detailed rainfall records in the Region show wide inter-annual and seasonal variability, changing intensities and varied length of the rainy seasons, (FAO, 1999) and (El Bagouri, 2000).

The prevailing climatic conditions in the Arab Region have highly significant impacts on the other components of the fragile dominating ecosystems. Major impacts include the limited development, inferior physiochemical properties and weak resilience of the soil resources in the Region. The lack of adequate soil moisture throughout most of the year is a key factor with major impacts on the development and productivity of the agro-pastoral systems widespread in the area. Due to the limited availability of surface and groundwater resources for irrigation purposes, rainfed areas and rangelands represent the major two land use categories in the Region. Out of the total area in the Arab Region, 54.8% are barren lands while rangelands occupy 26.8% as the major land use category. The remaining areas include non-cultivated arable lands 10.3%, cultivated lands 4.2% and forest areas 3.9% Distribution of categories within the cultivated lands includes rainfed areas representing: 68.18% of the cultivated lands while 20.1% and 11.7 % of the total area are irrigated and permanent crops respectively (El Bagouri, 2000).

B. Drought episodes

Historical records show that ever since the Biblical times, thousands of years ago, the inhabitants of the Arab Region endured recurring drought episodes of varied nature, severity and impacts. Recently, a severe and protracted drought menaced the African Sahel Countries at the Southern fringes of the Region (1968-72). Drought continued till the early eighties and spread eastward menacing the whole Sudano-Sahelian belt of countries, extending from the Atlantic to the Red sea and the Horn of Africa. By 1984, twenty African countries, including several Arab countries such as Mauritania, Libya, Sudan and Somalia were severely affected. Recurring droughts in Sudan and Somalia had significant adverse impact in the late eighties, nineties and during the last few years as well. The flow of the River Nile in Egypt records drought episodes at the River sources especially Ethiopia since Biblical times.

The North African countries including Morocco, Algeria, Tunisia and the north coastal areas of Libya suffered frequent and major episodes of drought since the late seventies. In addition recent drought events in the eighties and nineties were recorded in Jordan, Syria, Saudi Arabia and Sudan with alarming shortages of rainfall and serious adverse impacts on natural resources and socio-economic conditions in major locations of these countries.

The exact causes of measurable drought episodes are not very well defined till the present time. Several hypotheses and probable causes are presented by various investigations and specialized institutions. Drought was attributed and linked to varied atmospheric processes, turbulences, climate change, El Niño and other global patterns. Further research efforts are needed to verify the probable causes of drought (Wilhite and Glantz, 1985; UNESCO/WMO, 1985, WMO, 1989 and 1990; Chbouki et al., 1995; Al-Labban, 1999 and Reid, 2000)

C. Drought Impacts

The negative impacts of drought include reduction of productivity, degradation of natural resources, human and societal conditions, immediate and deferred economic considerations. Among the direct impacts of immediate concern are the sizable reduction of productivity of rangelands and rainfed cultivated areas. Hydrological and agricultural droughts effectively reduce soil moisture and certain nutrient availability thus reducing productivity of rainfed fodder and food crops. The reduced productivity of rangelands will negatively impact livestock carrying capacity, fertility and livestock products.

It is suggested that the most important and direct impact of drought is on crop yields, planted acreage, and in certain cases the acreage of export crops are affected. Farmer's grain storage would be reduced leading to successive planting failures and reducing also the seed reserves for cultivation in the following seasons.

Drought could have an added impact in shifting agroclimatic zones. In the Sahel area, the rainfall isohyets during the 16-year dry period were drawn 110 km further south. A similar scale of change was indicated for semi-arid regions in Australia, (Parry, 1990).

Reduction of food production levels due to drought would exert considerable pressures to bring more land into production, forcing farmers to cultivate marginal lands which are originally, productive rangelands. The sensitivity of marginal cultivation to climatic variability is especially great. The probability of critical levels of warmth and or moisture required avoiding crop failure or a critical crop short fall tends to increase not linearly but quasi-exponentially towards the margin of cultivation. Marginal areas are thus commonly characterized by a very steep "risk surface." With the result that any changes in the average warmth, aridity, and in their variability, would have a marked effect on the level of risk in agriculture, (Perry, 1990).

Drought conditions invariably lead to degradation of natural plant cover, which is already deteriorated by overgrazing of palatable plant species. Sparse plant cover of rangelands and reduced crop residues left in the soil as stubble after rainfed crop harvests would enhance the vulnerability of soil to wind and water erosion which are among the major factors of environmental degradation in the Arab Region. This would lead to serious losses of soil materials and nutrients while exposing non-fertile soil layers. The eroded soil materials would also enhance airborne sediments and dust storms causing hazardous risks to human health, infrastructures, urban and industrial areas; while water-carried sediments could cause siltation of dams and irreversible loss of soil material and pollution of marine environment. Other environmental impacts include adverse changes in soil structure especially in the surface layers due to trampling of the dry surface by moving animal herds.

One of the major impacts of drought is the migration of people from rural areas to urban centers. During prolonged drought, members of the farmers and rangeland herders families may migrate to the urban centers in search for work. These are mostly the younger generations, which are the

backbone of the labor force in rural areas. In case of severe droughts, entire families may abandon their land in search for emergency food supplies at famine relief centers.

Droughts have significant adverse impacts on several economic parameters including increased food imports, imbalance of import/ exports, price volatility, market failure, movement of surplus food commodities as well as, the decline of individual, family and national incomes. The magnitude of these adverse impacts will vary according to longevity and severity of drought. It will also vary according to income level and the gender factor as it will be reported in the following sections of this report.

Added to the direct drought impacts referred to above, investigations through the last three decades have shown that the impacts of drought can differ greatly, even when occurring in the same location but at different times. Studies also show that different socio-economic groups within the same area are affected by drought in different ways; underscoring the fact that not all people are equally affected by adverse weather or by drought-related famine situations. Factors pertinent to the status of the natural resources, as well as, societal preparedness to cope with drought in addition to local conflicts and wars have significant bearings on the inequitable and varying impacts of drought. Land degradation resulting from inappropriate land use can render the soil more vulnerable even to the "normal" variability of rainfall and othe climatic factors from one year to the other. In other words, the mismatch between inappropriate land use practices and drought would enhance environmental degradation and desertification processes. However, drought and desertification can occur independently of one another. Therefore, distinction should be made between drought and desertification processes.

Alleviation of the adverse impacts of drought is interrelated to the state of societal preparedness. It was reported by (Kassas, 1988) that during the fifties, drought recurred but passed almost unnoticed in the Great Plains of USA. This was attributed to the fact that land use practices that prevailed prior to the drought of the 1930's caused the land system to be so fragile and thus was seriously damaged by drought, while the preparedness measures applied during 1934-1950 enabled the land system to withstand drought with little damage in the fifties. Investigations of drought impacts in Sudan and the countries of the Horn of Africa clearly show the negative impacts of armed conflicts and local wars in enhancing the adverse impacts of drought, (Firebrace and Hulland, 1984, Merryman, 1987 and Keller, 1992). The negative impacts of conflicts and wars include mass migration of inhabitants and livestock, shift from pastoral to sedentary livelihood with possible degradation of the natural resources, mis-use of available funds and relief commodities for military objectives, livestock losses and other serious economic impacts, all of which when combined with drought, will lead to serious famines.

D. Air pollution in the Arab Region

In particular, air pollution has become an increasingly important environmental issue in the region. High levels of suspended particulates have become a common parameter of many regions. Emissions of sulfur dioxide have been rising steadily as industrialization occurs. Nitrogen oxides have been increasing steadily in many localities. Projections indicate that potentially large increases in emissions may occur during the next twenty to fifty years if current development patterns persist. With expected climate change, this constitutes very serious situation that needs to be addressed right now before it is too late. The main objective of this survey is to explore the situation in the Arab countries and investigate policies and regulations in progress to cope up with this ever growing problem of the Middle East and North Africa.

Both natural and anthropogenic components of air pollution have been long recognized and investigated on the global scale. Long range trans-boundary dust storms and short range local emissions were also well recognized. It was only recently realized that air quality has emerged as one of the most important environmental parameters that affect sustainable development on the regional scale. Emissions of greenhouse gases responsible for climate change, the impacts of climate change and their wide spread adverse consequences for all sectors of development have made it necessary for all countries to consider national and international policies and regulations for air emission control.

On national scales, it was realized that local anthropogenic air pollution implies inefficiency of energy utilization and economic losses and that energy over-consumption exacerbates these losses. In addition, it was also well understood that air pollution is responsible for many aspects of human health, inefficiency and loss of environmental productivity. It was also realized that natural air pollution may be synergistic with some specific anthropogenic air components leading to prospects of higher damage to health, materials, productivity and economy. Nowadays, air quality is taken as a major aspect of the quality of life leading to sustainable development in many areas of the world. Air pollution control strategies have been taken seriously, on both global and local scales, and governments have taken important steps for air pollution control.

Efforts of international organizations to illustrate, identify, assess and study options for actions have been in progress for about two decades. Many results of success on the global scale have been reported on the global scale. However, problems at the regional and local levels have been severely lagging and calls for attention for development of regional action. It has been realized that, based on the precautionary principle, it is necessary to start efforts for mitigation and adaptation as soon as possible.

Historically, very limited recognition of the importance of developing institutional capability for air pollution control on the regional scale in the Arab world was reported. The Convention on Long range Transboundary Air Pollution was one of the main corner stones for protecting the environment after scientists demonstrated the link between sulfur emissions in continental Europe and the acidification of Scandinavian lakes. Later studies confirmed that air pollutants could travel several thousand kilometers before deposition and damage occurred. This implied that cooperation at the international level was necessary to solve problems such as acidification. The Convention, signed in 1979 and entered into force in 1983, was the first internationally legally binding instrument to deal with problems of air pollution on a broad regional basis.

Efforts to establish research orientation and institutional capabilities in air pollution monitoring and management, as a first step for coping up with potential impacts of these pollutants are at the primary stage. Priorities for protection, building and implementing decision support systems, upgrading the role of NGO, and law enforcement of air quality conditions are still very low in the enforcement list.

Air pollution management is usually developed from awareness, demands and realization of needs of the community and decision makers. Air pollution management requires capacity building, ground-based monitoring systems and networks for proper operation and strategic decision support. It also requires quality assurance and quality control, modeling tools and institutional capabilities for implementation. Satellite systems for earth observation of air pollution have recently been introduced as new capabilities in the effort for monitoring and quantification of trans-boundary air pollution transport, but these have not been so far considered for use and operation in the Arab world to the author’s knowledge.

The outlook to 2015 is mixed for such localized environmental problems as high concentrations of ozone and noxious chemicals in the air and the pollution of rivers and lakes by industrial and agricultural wastes.

- Developed countries will continue to manage these local environmental issues, and such issues are unlikely to constitute a major constraint on economic growth or on improving health standards.
- The developing countries, however, will face intensified environmental problems as a result of population growth, economic development, and rapid urbanization. An increasing number of cities will face the serious air and water quality problems.

Some existing agreements, even when implemented, will not be able by 2015 to reverse the targeted environmental damage they were designed to address. The Montreal Protocol is on track to restore the stratospheric ozone layer over the next 50 years. Important new agreements will be implemented, including, for example, a global treaty to control the worldwide spread of such persistent organic chemicals as DDT and dioxins. Other agreements, such as the Convention on Biodiversity, will fall short in meeting their objectives.

Looking into the future, contemporary environmental problems will persist and in many instances grow over the next 15 years. With increasingly intensive land use, significant degradation of arable land will continue as will transportation systems. Given the promising global economic outlook, greenhouse gas emissions will increase substantially. The depletion of tropical forests and other species-rich habitats, such as wetlands and coral reefs, will exacerbate the historically large losses of biological species now occurring. Environmental issues will become mainstream issues in several countries, particularly in the developed world. The consensus on the need to deal with environmental issues will strengthen; however, progress in dealing with them will be uneven.

The main objective of this survey is to:

1. Review development of regulations, policies and institutional capabilities of air quality control and its impacts on sustainable developments in the Arab world
2. Identify gaps and assess priorities of actions for further developments of efforts for air pollution control

2. Energy production and consumption in the Arab Region

Oil and gas resources in the region not only play an important role as primary exports, but also as supporting inputs for energy-intensive, value-added industries that are proliferating throughout the region. This poses the challenge of addressing the air quality impacts associated with intensive oil and gas exploitation, processing, reformulation and shipping as well as those from expanding energy-intensive industries; power generation, petrochemicals, fertilizers, steel, aluminum and cement sectors. Low-cost and low quality petroleum also permits the fuelling of joint power-water desalinization plants.

Mining and processing of industrial minerals and metals has increased alongside of mineral fuel extraction throughout the region, and is considered an important source of foreign currency in Egypt, Syria, Yemen, Tunisia and Sudan. Extracting iron in Mauritania, Algeria and Libya represents 6 percent of the extracting industries outputs, while extracting phosphate in Morocco, Jordan, Tunisia, Egypt and Syria, and potash in Jordan represents 12 percent of the total extracting industries outputs. Mining in general (metallic and non metallic ores) account for18 percent of

extracting industries in the Arab region. The region holds considerable reserves of iron, copper, phosphate and potash.

A. Production and consumption patterns

Greenhouse gas emissions come mostly from energy use. These are driven largely by economic growth, fuel used for electricity generation, and weather patterns affecting heating and cooling needs. Energy-related carbon dioxide emissions, resulting from petroleum and natural gas, represent 82 percent of total U.S. human-made greenhouse gas emissions. Table (1) presents a comparison of the regional distribution of CO2 emissions indicating that the main contributors are developed countries.

Table 1- Regional distribution of carbon dioxide emissions

	Population (million)	**Emissions (million tons CO_2)**	**Emissions per capita (tons CO_2)**
World total	5 624	22 620	4.2
OECD	1 092	12 117	11.09
Former Soviet Union	292	2 346	8.03
Non-OECD Europe	60	320	5.33
Middle East	155	882	5.69
China	1 215	3 142	2.59
Other parts of Asia	1 699	1 867	1.10
Latin America	390	840	2.16
Africa	721	691	0.96

The data refer to 1996. Figures cover only emissions stemming from burning fuel.
Data are missing for Albania, North Korea and Vietnam. (International Energy Agency 1998)

On the scale of the Arab region it was realized that, there is an urgent need to alter consumption and production patterns in the region. Regional assessments and responses, however, need to take into consideration the large variance that exists between states in the region. Furthermore, while few countries are using fiscal measures, economic incentives and conventional environmental management tools to change unsustainable production and consumption, much remains to be done. Special effort is needed to promote cleaner production in industry and other production sectors and harmonized environmental standards among Arab States.

The energy consumption patterns in the region are unsustainable. As a result – and despite its vital role to regional development – the energy sector in most countries of the region has had significant adverse environmental impacts, particularly on air and water resources. While demand remains high, on the supply side, there has been significant diversification of the energy resource mix over the past decade, with a remarkable increase in the use of natural gas in the electrical power and transport sectors. Many states have partially switched to natural gas fired combined cycle power plants, which operate at low-cost and high efficiency with reduced environmental impact. The application of large-scale solar and wind technologies has started in some countries, which will likely further diversify the energy mix and reduce environmental impacts.

B. Materials production and consumption

As population increases and the regional economy expand, so does the supply and demand for consumer goods and industrial products. This affects the capacity of governments and municipalities to manage increased quantities of solid waste and effluent, and forces them to face new challenges related to hazardous waste management and medical waste. Furthermore while

informal recycling systems for paper, cardboard and scrap metal exist in some countries of the region, limited awareness and incentives have delayed the formalization of recycling as national policy.

Table 2 - Total Energy Consumption in Arab Countries (Thousand boe /d)

Country	**1998**	**1997**	**1996**	**1995**	**1990**	**1985**	**1980**
Algeria	621	607	580	572	486	435	278
Bahrain	173	162	153	151	129	72	56
Egypt	832	781	744	714	599	487	332
Iraq	515	506	480	448	425	408	274
Kuwait	285	278	249	240	170	238	249
Libya	288	280	260	262	197	169	117
Qatar	151	151	144	141	114	100	61
S. Arabia	1725	1702	1691	1469	1131	1114	773
Syria	275	259	237	257	187	155	111
Tunisia	120	113	110	105	89	76	60
UAE	530	520	511	498	396	268	122
OAPEC	5515	5359	5160	4857	3922	3522	2435
Djibouti	6	5	5	5	4	3	3
Jordan	101	95	92	88	66	55	36
Lebanon	101	100	97	95	51	54	52
Mauritania	8	8	7	6	5	4	4
Morocco	172	171	170	168	130	109	98
Oman	88	84	80	76	59	46	24
Somalia	4	4	4	3	8	8	6
Sudan	46	43	41	39	40	33	26
Yemen	71	70	69	67	38	39	24
Other Arab Countries	596	582	564	548	402	352	272
Total Arab Countries	6111	5941	5724	5405	4325	3874	2707

Source: OAPEC Annual Statistical Report 1999

Based on historical data, about 90 per cent of total emissions of Carbon Monoxide (CO) in Arab countries are due to transportation activities. It is estimated that Arab countries emit collectively about 16 million tons/year of CO (WB 1994). The Arab vehicles emit 1.1 million tons/year* of Nitrogen oxides (NOx). NOx and Sulfur oxides (SOx) cause the acid rain/deposition, also, NOx are the precursor of the photochemical smog. Also, Arab countries emit approximately 3 million tons/year* of Hydrocarbons (HC) from vehicle emissions (WB, 1994). Between 70 and 80 per cent of total HC emissions are originated from the transportation sector, and play an important role in the formation of photochemical oxidants. Lead**,** used as an additive in petrol, still accounts for more than half of total lead atmospheric emission in the Arab countries and almost 100 per cent in urban areas. Diesel engines also emit Sulfur dioxides (SO2) and fine particulate. Other development activities and their proximity and locations, such as uncontrolled construction, incineration and industrial works (e.g., cement industry) can also increase particulates matters in the air especially in urban areas. Gulf countries emit about 50% of total Arab countries (254 million metric tons of carbon) emissions of CO2 (a greenhouse gas). The issue of energy consumption and forms is still a sensitive one in the region.

Emission of GHG in most of the Arab countries is still very limited on the global scale. In an estimate by EEAA in Egypt it was realized that Egypt's emissions of GHG do not exceed 0.1% of total world estimates (e.g. El Raey et al, 1996).

C. Emission Scenarios in Developing Countries

Vehicular emission is the main source of air pollution in the Arab Region. Other stationary sources, such as outdated power generation stations, refineries, outdated smelters, fertilizers plants, cement manufacturiong, and water desalination plants also significantly contribute to and air quality deterioration. The situation is exacerbated by the fast urbanization expansion, the use of old technoilogies and the inadequate measures to curtail air emmission. Industrial compounds and manufacturing facilities emit gases including, CO, methane, volatile organic carbons and nitrogen oxides. In the GCC countries total atmospheric emission loads is about 3,847,755 tones per year, made of 28 per cent CO, 27 per cent SOx and 23 per cent particulates (UNEP 1999).

Seasonal sand and dust storms can also aggravate the air quality situation (ROPME 1999). Dust storms are capable of carrying pollutants to great distances. It is estimated that the mean amount of dust fallout along the coastal area of Kuwait may reach up to 1002.7t/km^2 with an overall mean of TSP equal to 207.8 µg/m^3 (Khalaf et al. 1980, EPA 1996). Total solid particulates (TSP) in Damascus air is estimated at 749 µg/m^3 in highly congested traffic areas and 333 µg/m^3 in residential zones. This obviously exceeds the maximum allowable concentration determined by WHO norms (WB and UNEP 1998). The health related cost of poor air quality in Syria is estimated at about 188 million US dollars per annum (WB and UNDP 1998). In Egypt, levels of PM_{10} have reached 580 µg/m^3 in Cairo and 450 µg/m^3 in Alexandria, respectively

Hydrocarbons (HC) in air, e.g., Benzene, are the resultant of incomplete fuel combustion or from evaporated unburned petroleum products from vehicles fuel tanks and/or carburetor. Arab countries emit approximately 3 million tons/year of HC from vehicle emissions (WB 1994). Between 70 and 80 per cent of total HC emissions originate from the transportation sector, and play an important role in the formation of photochemical oxidants. Lead**,** as an additive in petrol, has been removed from gasoline in many of the Arab countries, however, still contributes a varying percentage in many urban areas. Diesel engines also emit Sulfur dioxides (SO2) and fine particulate**:** the latter can penetrate easily into the respiratory system. Egypt emits 69 micrograms/m3 of SO2 (compared to the WHO standard of 50 micrograms/m3, WB 1999). Other development activities and their proximity and locations, such as uncontrolled construction, incineration and industrial works (e.g., cement industry) can also increase particulates matters in the air especially in urban areas.

Carbon dioxide (CO2), a major greenhouse gas, is an important contributor to global climate changes, has become a principal concern. Gulf countries emit about 50% of total Arab countries (254 million metric tons of carbon) emissions of CO2 (Energy Information Administration, 1997). The issue of energy consumption and forms is still a sensitive one since the region is the most oil-producing region on the globe.

Air pollution is caused by vehicular emissions, particulates and lead. Cairo, in particular, is a very crowded city with a large number of gasoline burning buses, vans and cars. The lead smelting industry has been concentrated in some of the more densely populated areas of the city, resulting in some of the world's highest airborne lead levels. This impacts on the physical development of Cairo's children and increases the incidence of respiratory illnesses. The USAID program has tackled these problems by introducing clean-burning compressed natural gas vehicles and bakeries (practically every street corner in Egypt has a bakery because bread is the major staple, especially for the poor). A side benefit of these programs has been to reduce Egypt's dependence on imported

gasoline – Egypt has extensive natural gas reserves but has to import much of its petroleum needs. USAID has also been working on moving lead smelters out of downtown Cairo and updating the industrial processes and equipment used in the smelting facilities. This year, Cairo governorate and Egypt's Ministry of Petroleum were the joint recipients of the U.S. Department of Energy's annual International Clean Cities Award. The award recognized Cairo's efforts to improve air quality, largely reflecting work that was supported by USAID programs. A program for development and relocation of all smelters outside Alexandria city has also been approved by the Governorate (IGSR, 2003)

Table 3 - Arab countries and MNA Region Estimated Pollution Loads (1000 ton) in Main Sectors

	SO_2	**NO_x**	**TSP**	**CO**	**HC**
- Power	1600 (39%)	1000 (34%)	200 (17%)	150 (>1 %)	50 (>1 %)
- Industry*	750 (18%)	400 (13%)	120 (10%)	50 (>1 %)	30 (>1 %)
- Refineries	1100 (27%)	80 (>5 %)	50 (>5 %)	10 (>1 %)	300 (10%)
- Cement/Steel	150 (>5 %)	300 (10%)	600 (50%)		
-Total Industry	2000 (49%)	780 (26%)	770 (65%)	60 (>1 %)	330 (10%)
-Road Transport	200 (5%)	1100 (37%)	120 (10%)	16000 (<90 %)	3000 (<80 %)
- Residential	300 (7%)	100 (>5 %)	100 (8%)	20 (>1 %)	10 (>1 %)

(*) Other than refineries, cement / steel and metal smelters.

Source: World Bank, 1994

3. Major sources of air pollution in the Arab region

A. Types

(1)- Dust storms and particulates

The Middle East and North African countries are well known to suffer from strong dust storms that may cover the whole region in many occasions and many times during the year. Dust storms may even cross the Mediterranean and /or the Atlantic and cause severe damage to health and material there. A satellite image of the Saharan dust over Egypt is presented in Fig (1). Dust storms on the ground are shown in Figure (2) from Iraq indicating the severity of some storms.

The short-lived pollution particles, known as aerosols, didn't have to travel to Africa to do their dirty work. Instead, they were able to alter the physics of cloud formation miles away and reduce rainfall in Africa as much as 50 percent; a process, known as teleconnection, continues in the atmosphere today. Over the years, the disastrous lack of rainfall over the Sahel has been blamed on everything from overgrazing to El Nino.

Air pollution in Cairo has become an increasingly serious issue, as clouds of black smoke appear over the city each year. The cause of these clouds is still uncertain, but some sources believe that they are a result of certain industries, such as pottery and metals industries. The European Investment Bank approved a 90,000 EURO grant in order to investigate methods to reduce the burning of rice straw, which is thought to be one of the potential sources of these clouds. It is also suggested that the rapid expansion of some industries will contribute to increased levels of air pollution. According to a study recently conducted by the Egyptian Environment Affairs Agency (EEAA), air pollution is responsible for an average of 3400 deaths each year in Cairo. Air pollution is also considered to be responsible for about 15000 cases of bronchitis, 329,000 cases of respiratory infection, and a large number of cases of asthma each year.

Figure 1 - A dust storm over Egypt

Figure 2- A dust storm in Iraq indicating severity and potential damage

An article in the Jordan Times also points to the fact that air pollution has been increasing in Jordan, describing it as hard to breathe. The problem has been attributed to the facts that custom tariffs have

been reduced on cars and that older cars have been allowed into the country, resulting in a large number of cars on the streets and a high content of sulfur and diesel in the air.

(2)- Greenhouse gases

Recent in depth research has realized that many chemical compounds found in the Earth's atmosphere act as "greenhouse gases." These gases allow sunlight to enter the atmosphere freely. When sunlight strikes the Earth's surface, some of it is reflected back towards space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap the heat in the atmosphere. Over time, the amount of energy sent from the sun to the Earth's surface should be about the same as the amount of energy radiated back into space, leaving the temperature of the Earth's surface roughly constant. Many gases exhibit "greenhouse" properties. Some of them occur in nature (water vapor, carbon dioxide, methane, and nitrous oxide), while others are exclusively human-made (like gases used for aerosols). Levels of several important greenhouse gases have increased by about 25 percent since large-scale industrialization began around 150 years ago. During the past 20 years, about three-quarters of human-made carbon dioxide emissions were from burning fossil fuels.

Concentrations of carbon dioxide in the atmosphere are naturally regulated by numerous processes collectively known as the "carbon cycle". The movement (flux) of carbon between the atmosphere and the land and oceans is dominated by natural processes, such as plant photosynthesis. While these natural processes can absorb some of the net 6.1 billion metric tons of anthropogenic carbon dioxide emissions produced each year (measured in carbon equivalent terms), an estimated 3.2 billion metric tons is added to the atmosphere annually. The Earth's positive imbalance between emission and absorption results in the continuing growth in greenhouse gases in the atmosphere.

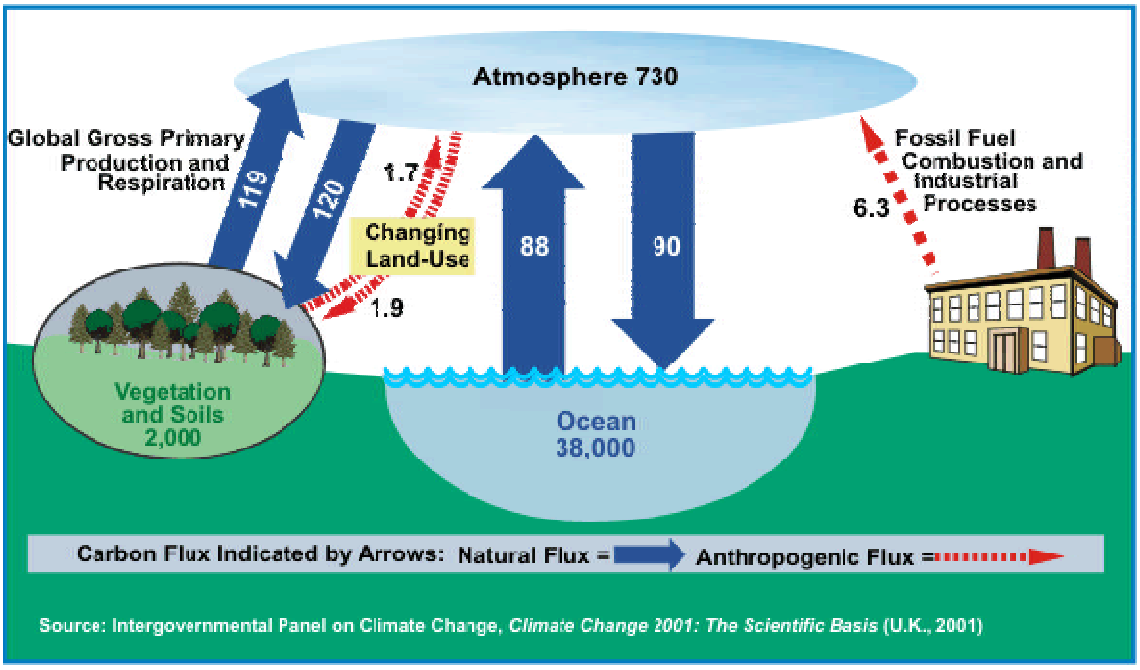

Figure 3- Atmospheric balance of carbon flux

Given the natural variability of the Earth's climate, it is difficult to determine the extent of change that humans cause. In computer-based models, rising concentrations of greenhouse gases generally produce an increase in the average temperature of the Earth. Rising temperatures may, in turn,

produce changes in weather, sea levels, and land use patterns, commonly referred to as "climate change."

Assessments generally suggest that the Earth's climate has warmed over the past century and that human activity affecting the atmosphere is likely an important driving factor. A National Research Council study dated May 2001 stated, *"Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and sub-surface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability."*

It has been unanimously agreed that greenhouse gases emitted from various sources, especially CO_2, troposphere O_3 and Methane are responsible for the observed increase of average global temperatures. This temperature increases has been measured and found to reach few tenths of a degree per decade. This increase of temperature is expected to have important impacts on all sectors of development with particular impacts on water resources, agricultural resources and the coastal zone all over the world. The understanding and the adaptation to impact of climate change on each and every country on the local scale is agreed to be a necessary prerequisite to proper initiation of plans for sustainable development. Lack of awareness, over consumption of energy and inefficient energy systems are considered the main promoters of emissions of greenhouse gases.

(3)- Other Gas emissions

Oil refineries are very common in many industrial sites of the Arab world. These are strong sources of various volatile and non-volatile organic carbon, Sulphur compounds, hydrocarbons and nitrogen oxides. Once Sulphur and nitrogen compounds have been emitted to the atmosphere, concentrations of gases and acidic deposition cause impacts to the local environment. Atmospheric transport and chemical transformation of the pollutants can also lead to deposition causing impacts far from the point of emission. Nitrogen and Sulphur pollutants cause acidification of lakes and soils and impacts on human health, crop productivity, forest growth, biodiversity and man-made materials. There was initial skepticism in Europe concerning the effects of long-range transboundary air pollution. This was overcome by research into causes and effects of air pollutant damage on ecosystems. One important approach, which produced evidence of cause-effect relationships, determined historical changes in lake acidity and linked these to increased Sulphur deposition.

Sulphur dioxide and nitrogen oxides, and pollutants produced from their reactions in the atmosphere such as small particulate matter and ozone can cause human health impacts. They irritate the respiratory tract and may give rise to disease, especially in children and asthmatics.

B. Sources

Fossil fuel is the largest source of atmospheric pollution in the region. It accounts for 100 per cent of West Asia commercial energy production. Major source of CO_2 emissions in the region comes from the burning of fossil fuels. GCC countries and Iraq are the major exporter of primary energy in the region. The total primary energy production rose from 38.24 quadrillion Btu in 1980 to 44.64 in 1998 (U.S. Energy Information Administration 1999). Consumption is rather smaller than the production of primary energy in the region. The consumption has been increasing steadily during the last two decades (1980-1998) in all countries of the region with variable levels (U.S. Energy Information Administration 1999). The highest rate of increase during this period was in UAE (6.7 folds).

By enlarge the increase in energy production and consumption as well as in the number of vehicles in major cities is the main source of air pollution in the region. The average per capita annual Carbon dioxide emissions in West Asia amounted to 11.7 tones in 1995 (WRI, UNEP, UNDP and WB 1998). The per capita share in the GCC countries was 16.75 tones. The average annual per capita emission reflects the great variations in living standards and the level of industrialisation development. In general nonetheless, there is an increasing trend of the per capita annual share of carbon dioxide emission in the region during the 25 years, 1970-1995. The per capita share of emitted CO_2 in West Asia for example has increased from 5.2 metric tones in 1970 to 11.7 metric tones in 1995 (WRI, UNEP, UNDP and WB 1998). Carbon dioxide emissions from fossil fuel and cement manufacturing have also increased in the region by about 46 per cent between 1990 and 1996.

(1)- Urban growth

The urban environment in the Arab region has become an environmental issue that is becoming increasingly critical. Between 1990 and 1998 the total population of the Arab countries increased from 219.3 million to 271.6 million. This population has witnessed a rapid urbanization occurring across much of the region during the last three decades. In 1950, 27.5 per cent of the total population was considered urban. Within three decades (1950-1980) urban population increased to reach 54.4 per cent of the total population. In the year 2000, the urban population is expected to be 68.95 per cent, which is high above the world average (46 percent). This figure is projected to reach 75 per cent by the year 2015.

Independence and increased industrialization in the 1950s and 1960s have precipitated such accelerated urbanization. Since the end of the Eighties, the growth of urbanization, on the whole, started to decline in the Arab region. It was at an average of 6.2 percent over 1950-1955, and then grew to 7.43 per cent (1960/1965) and 6.1per cent (1975/1980) more than double the average annual growth rate of 3.0 per cent estimated for the total population, and even higher growth rates were recorded during the accelerated economic growth decades (1970-1990). From 1990-1995, average annual growth rate declined to 4.3 percent. Future prospects by the year 2015 reflect that the average growth rate of urbanization will continue to decline reaching an average of 2.7 percent.

The degree of urbanization varies considerably among Arab countries; Kuwait, Qatar, Bahrain, Libya, and Djibouti are the most urbanized (97.6, 95, 92.2, 87.6, and 83.3 percent, respectively) exceeding the level of the highest urbanized areas in the world (Northern Europe 85.5, and North America 77). The countries that are least urbanized "relatively rural"; Comoros, Somalia and Yemen have the highest average urbanization growth rate 4-5 percent in the region. Future prospects for those countries to the year 2010 indicates that urbanization rates will relatively decline, but will remain as the highest (an average of 4.4 percent) in the Arab Region.

In the Arab Maghreb and east Africa, there is a group of "highly urbanized" countries with an urban population exceeding two thirds of the total population, namely Libya and Djibouti (87.6 and 83.3 percent, respectively in 2000). Libya has undergone exceptionally high urbanization rates, the highest ever in the sub-region, 14.2 percent over 1965-1970 and 10.06 percent over 1970-1975. This high rate of urban growth was associated with early independence years and the booming of oil prices. Djibouti, on the other hand, has been a trade gateway to Eastern Africa, and became highly urbanized from the fifties through the seventies. The second group is "relatively highly urbanized" countries, which includes Algeria (56 percent) and Tunisia (63 percent). The third group is the "moderately urbanized" countries, which includes Egypt (45 percent), Morocco (53 percent) and Mauritania (53 percent), and the fourth is "relatively rural," which includes Comoros (31), Somalia (26 percent) and Sudan (32 percent).

Urbanization in the GCC countries was very rapid and sudden which took place within the last four decades. As their GDP and revenues from oil increased, large-scale projects were initiated. These included building modern urban infrastructures, municipal and Government buildings, industries, health and educational services. This has induced rapid shift of population from nomadic communities to urban centers as well as large-scale flow of foreign workers. In 1950, only 17.8 per cent of the total population was considered urban in. Urban population increased rapidly to 66.6 per cent of the total population by 1980, 79.5 per cent by 1990 and rea83.5 per cent in 1995. It is expected to exceed 86 per cent by the year 2000. Within GCC countries, urban population growth rates were variable. While almost all population in Kuwait (97.6 per cent) was urban in 2000, the figures for other countries were 92.2 percent for Bahrain, 85.7 per cent in Saudi Arabia and 85.9 per cent in UAE. However, the population in Oman was lower than in other GCC countries. Only 2.4 per cent of the total population of Oman in 1950 were urban and they increased at high rates of 14.5 and 10.3 per cent during the periods 1960/1965 and 1985/1990 respectively and were in 1990 at 62.1 per cent the least among GCC countries. The momentum of urban population growth was kept high during the recent decades and it will continue into the next century. Population growth rates beyond year 2000 indicate diminishing of the growth trends in line with a low rate of population growth of the region.

Urbanization in the Arab Mashreq countries took place through the slow shift of population from agricultural dominated activities to industry and services in the old and well-established urban centers like Damascus and Baghdad. Growth rates across the region varied. In 1950/1955 Lebanon growth rates were 8.14 percent, which then decreased dramatically to 1.18 percent in 1975/1980 and to only 0.3 percent in 1985/1990. This reflects the protracted Lebanese war and the political instability in the area during the period of 1970-1990. In other countries, the growth trends were in line with their slow but steady economic growth. Urban population has increased in Iraq from 35.1 percent in 1950 to 74.5 percent by 1995. In Syria it was 30.6 percent in 1950 and increased to 52.2 percent by the year 1995.

Over the last hundred years, changes in the urbanization growth rate and pattern have greatly transformed the cities of the Arab world in most aspects (economic, social and physical). For example cities that were in the past commercial, industrial, or spiritual centers lost some or all of their characteristic identities. Industrialization has become the focus of economic activities in most Arab cities. Processing industries, petrochemical industries and heavy industries are now widespread. Urban growth is partially due to rural-urban migration, but natural urban growth and reclassification account for more than 70 percent of urban development (World Bank 1995). The more industrialized the countries the more the urbanization, with the exception of Djibouti, which was mostly urbanized because of trade. Furthermore, the new structural adjustment programs adopted by most countries of the region have brought new frontiers in industrial development in the last ten years.

The continuous increase in population in large cities led to the formation of principal and mega-cities, which became one of the most important features of urbanization. Most of the national product and the societal services as well as the infrastructure are centered in these cities. In addition, they have gained a key political and administrative role. As a consequence, they play a vital part in the economic development as they provide investment and employment opportunities, and impose their power over the small and medium more rural cities. In 1950, only two cities were inhabited by one million people or more (Cairo - Alexandria). In 1970, this number increased to 5 cities (Cairo - Alexandria - Algiers – Casablanca-Baghdad). In 1990, the number increased again to 15 cities (Cairo - Alexandria - Giza - Algiers - Casablanca - Rabat - Tunis - Tripoli – Khartoum-Amman-Beirut-Damascus-Kuwait-Jeddah-Riyadh). By the year 2010, four more cities will be added to this list; Benghazi, Mogadishu, Abu Dhabi and Arbil.

Rural migration and industrialization have been the main driving force for rapid urbanization in Arab countries. Consequently, this has given rise to significant environmental and health problems. This growth has created an increasing urban poverty, emergence of informal and slum areas, shortage in basic urban services, in addition to the urban encroachment on the agricultural land. In crowded cities, the social environment deteriorates and the social and economic gaps between areas widen while there is a significant increase in number of motor vehicles, traffic congestion, high demand for food and increasing consumption and production of industrial and domestic wastes. This has caused a decrease in income, spread of illiteracy, decline of health standards and quality of water supply, increased air pollution, lack of green spaces, a deterioration of cultural heritage, and ultimately a low standard of living.

(2)- Transportation

Transport is a significant source of air pollution and, for some pollutants, the main contributor. 90 per cent of total emissions of Carbon monoxide (CO) in Arab countries are due to vehicular transportation; Arab countries emit 16 million tons/year* of CO (World Bank, 1994). CO can also indirectly contribute to the increase of "greenhouse gases" which are the cause of global climate warming. The Arab world's motor vehicles emit 1.1 million tons/year* of Nitrogen oxides (NO_x) (40% of total-60% originates from the energy and industry sectors). A combination of Nitrogen oxides and Sulphur oxides (SO_x) contributes to a large extent (about one-third) to acid deposition on soil, vegetation and water, thus causing damage to crops, forest, fish, etc. Most importantly, NO_x are a cause (or "precursor") of the photochemical smog often observed in large conurbations, particularly during the summer.

Hydrocarbons (HC) result from incomplete fuel combustion or from evaporated unburned petrol from fuel tank and carburetor; Arab countries emit 3 million tons/year* of HC from vehicle emissions (World Bank, 1994). Benzene is the best-known hydrocarbon. Between 70 and 80 per cent of total HC emissions originate from transport and play an important role in the formation of photochemical oxidants. Lead**,** used as an additive in petrol, still accounts for more than half of total lead atmospheric emission in the Arab countries and virtually 100 per cent in urban areas. Fortunately, lead emissions are decreasing thanks to the limitation of lead content in petrol, in particular the promotion of "unleaded petrol" required for cars equipped with catalytic converters. This decrease has been particularly marked in the Egypt and Tunisia. Diesel engines also emit Sulphur dioxides (SO_2) and fine particulate**:** the latter, which are extremely small, penetrate easily into the respiratory system. Egypt emits 69 micrograms/m3 of SO_2 (compared to the WHO standard of 50 micrograms/m3, World Bank, 1999). Carbon dioxide (CO_2), an important contributor to global climate changes (the "greenhouse effect"), has become a major concern. Gulf countries emit about 50% of total Arab countries (254 million metric tons of carbon) emissions of CO_2 (Energy Information Administration, 1997). Chlorofluorocarbons (CFCs) contained in air-conditioning systems and foams also contribute to the depletion of the stratospheric ozone layer.

(a.) Noise Pollution

Noise is one of the most resented nuisances caused by transport and is indeed a major public health issue. Noise affects activities such as communication and sleep and, long-term exposure to high traffic noise levels (i.e. above 65 dB (A)) can accelerate the loss of hearing usually caused by aging. Transport is the main cause of environmental noise. A substantial percent of the population are exposed to "unacceptable" noise levels caused by road, rail and air traffic (i.e. above 65 dB (A)). This level of 65 dB (A) corresponds to the noise currently prevailing alongside busy roads or streets; however, traffic noise levels can attain 80 dB (A).

(b). Traffic accidents

The cost to society of damage caused by transport, such as air-pollution-induced mortality, adverse effects of noise, visual intrusion, etc were subject to a monetary value of these negative environmental effects. The true value of Gross Domestic Product should be calculated "net of environmental damage (hence the concept of "green GDP" – Pearce et al., 1989). The damage cost of air pollution – excluding CO2 – emitted by transport (mainly damage to health, materials and agriculture) is calculated on the basis of health expenditure, working days lost, crop losses, etc. and amounts to 0.4 % of GDP (Quinet 1990). The damage cost of transport noise (mainly in terms of annoyance, health and loss in work productivity) is calculated as the loss in value of properties exposed to noise – for instance dwellings along busy roads or in the vicinity of airports, is 0.1 % of GDP. Accidents are 2 % of GDP, time spent is 6.8 % of GDP and user expenditure (including infrastructure) is 9.0 % of GDP, giving a total of 18.3 % of GDP (Quinet, 1990).

Faced with rising transportation demand and growing negative impacts, urban areas require new approaches to addressing their transportation needs. Cities cannot continue to expand their urban transportation systems forever. Although some expansion is necessary, the economic, social and environmental costs of doing so are prohibitive. Instead cities need to reexamine urban transportation demand and devise new strategies that provide maximum access at a minimum total cost.

(c). Policy for emissions control from traffic

A number of policy tools are available to reduce excessive travel demand and create more sustainable transportation systems, from road pricing to increasing the efficiency of existing systems, to expanding public transit. Most of these tools will have a limited impact if they are used in isolation. Instead, improving urban transportation systems will require a combination of policies that reinforce each other and help to avoid adverse side effects. Intervention strategies for environmentally sustainable urban transport are to support sustainable development by:

- Land-use planning
- Improving public transport
- Utilizing traffic management
- Implementing the use of clean vehicles

(i). <u>Land-use planning</u>

A sustainable urban transport system also implies land use planning. Land use planning involves other sectors than the transport sector. The base for an ecological city is the agricultural sector. An ecological city must use support systems that are environmentally sound and have low energy consumption. This can enable short distance transportation and distribution of basic necessities with an emphasis on public transport. Land use planning should also contain a concept of integration of settlements with local small-scale manufacturing. New links, which bypass sensitive areas, also, can be of local environmental benefit, especially if they are in tunnels. Therefore it is clear that there is a close connection between transport needs and land use. If there is no strict physical planning which addresses also explicitly the transportation needs of new residential, industrial or commercial areas, urban sustainability is not likely to emerge. Thus a strict coordination between urban transport policy and urban land use policy is badly needed; a strategy in which also public transportation would have to play a critical role.

Land-use planning also plays a role in creating a balanced eco-system in which the natural environment is enhanced by the city's existence in dealing with city deficiencies such as improper solid waste disposal and high-energy utilization. To achieve this goal the city should be planned so that its by-products benefit the natural environment.

(ii). Public Transport

Development of the public transportation system by making it inexpensive, simple, clean and efficient would be an important aspect. The basis for this system would be:

- Concentrating high-density residential development near stations along public transport corridors. The motivation underlying such strategies has not necessarily been solely the minimization of car travel, but also the preservation of open space and improvement of accessibility.
- Creating or preserving a high density of trip-attracting activities in central areas and other locations well served by public transport: It is also associated with policies for restricted parking in the centers of cities.
- Discouraging commercial development where access by public transport was poor.
- Using developer contributions to finance new transport infrastructure: impact fees are levied on new development

Integration of different public transport facilities such as metro, buses, railways so that they complement each other as well as integration with other means such as walking, cycling, etc.

(iii). Traffic Management

The best strategy to use traffic management and inspection and maintenance programs in an efficient way is along these 3 intervention lines:

- restrictions of access to city centers to private traffic or heavy traffic, which is the source of high congestion and heavy toxic emissions;
- Traffic restrictions in urban areas are an efficient policy tool if only a small part of the town is planned as car-free zone: large car-free areas, in fact, act against the possibility of optimizing accessibility in urban areas. In this respect, car restricted urban areas should be coupled with more parking facilities (underground parking space), in order to optimize access to dense traffic areas, such as the city centers.
- Reorganization of urban freight movements; the second area of intervention policies is a reorganization of urban freight distribution, through the implementation of new logistics and combined road/rail transport. With the aim to reduce gas and noise emissions at sources; counteracting policies have been the location of goods traffic centers in industrial areas, and the expansion of the use of pipelines. The distribution of goods to local shops in cities remains in any case a problem, which is partly solved by the delivery on small scale trucks with efficient energy saving motors. Road pricing may also be an efficient tool in this sense.
- Fuel pricing; removing subsidies and increasing taxes in order to reduce fuel consumption increase government revenue and improve public transport services.

(d). Cleaner vehicles

Improving the efficiency and cleanliness of existing vehicles to help reduce fuel consumption and air pollution is necessary. Catalytic converters and fuel saving techniques may well be exploited to decrease air pollution and the exploitation of non-renewable resources. Unleaded and natural gas are already being used in many countries and increasing their use will lead to lower polluting emissions.

Evolving environmentally sustainable urban transport development is an expensive and complex undertaking. It requires much time and resources in undertaking the diagnostics of the present situation and evolving appropriate measures. Present indications are that few governments are ready to willingly undertake that task due to the pressure for immediate results by their constituents and by resource constraints.

However, some governments in the Arab world have begun to feel the burden of not taking immediate action. In Egypt, a new traffic law has been passed and put into force recently requiring motorists to wear safety belts and vehicle emissions to be periodically checked. It also puts restrictions on the use of older vehicles and registration procedures as well as restricting the use of horns unnecessarily. While this law provides for a transition period for some of its requirements, it is hoped that ultimately it will begin to reduce congestion, air and noise pollution as well as cut down on traffic accidents.

Some examples of Arab countries responding to the challenge of transportation include:

In Bahrain: there is currently a joint effort to implement an Action Plan to reduce car emissions and introduce unleaded petrol, in coordination with the Directorate of Traffic and licensing and the Bahrain National Oil Company (BANOCO). A program called "Fume watch" was introduced in Bahrain in 1994, to report vehicles that were emitting smoke. This has resulted in noticeable improvement.

In Egypt: a recent study commissioned by the Egyptian Environmental Affairs Agency (EEAA) calculated that the lower limit of the cost of air pollution in Cairo is in the range of US$ 1-2 billion per year or between 3-6 % of gross domestic product (GDP). As a result the Egyptian government has recognized that compressed natural gas (CNG) will provide environmental, social and economic benefits and has endorsed and promoted CNG as the preferred transportation fuel. Environmental benefits are found in that exhaust from CNG vehicles typically contain about 85 % fewer pollutants than from gasoline powered vehicles. Improved air quality translates into a reduction of pollution-related health problems. Economic benefits are that at 0.45 Pounds per cubic meter, it is less than half the price of gasoline. The typical vehicle conversion costs the customer L.E. 5000. Fuel savings alone allow owners of high fuel use vehicles to recover their conversion costs in as little as six months. Hence, the council of Ministries has decreed that all taxis in the greater Cairo area must convert to CNG in the next three years or they will not be re-licensed. In addition, no diesel powered school or public transit buses are now allowed to be imported. There is also a strong likelihood that all new public transit buses must be CNG powered. Also all new taxi microbuses must be gasoline powered so that they may be converted to CNG. In addition, a program has been set up with the Government's Social Development Fund to finance the cost of microbus conversions where customers pay back in monthly installments.

(3). Industrialization

Industrial development is a vital component of the development processes of the Arab region providing an important source of national income through trade, creating jobs and adding to the value of the primary products. Industrial development is pursued for socio economic, political and strategic national goals. It can enhance self-sufficiency, import substitution and natural resource exploitation.

Nationalism and the Second World War gave great impetus to the foundation of industrial projects. A large share of the industrial base in the Arab world was developed in the sixties; thus the capital stock of most industries is old and highly polluting from the seventies. The situation is further complicated by protective trade regimes and foreign exchange constraints, while public sector industrial dominance with largely soft budget constraints have limited the access to and provide little incentive for adopting more efficient and cleaner industrial technologies. Few enterprises have air emission or water treatment equipment installed. Further, lack of maintenance and spare parts impede the performance of exiting treatment facilities (World Bank, 1995).

(a). Industrial Development

Industry in the Arab world has witnessed significant fluctuations lately mainly because of two major reasons; the domination of petroleum and gas industries and some mineral industries which rely on exporting production which in turn depends on global price fluctuations. The second reason is the weakness of non-petroleum industries that are basically food, textile and clothing industries in addition to a few transportation and mechanical industries (Unified Arab Economic Report, 1999).

The Gulf region witnessed a rapid development in oil exploration, exploitation and refinery industries. Oil revenues have become the major source of national income in several countries. In order to reduce their reliance on oil revenues, most of the count have embarked on major programs for industrialization through which new construction and rapid expansion of petrochemical complexes, fertilizer plants, refineries, cement factories, chemical plants, iron and aluminum smelters and several other energy intensive industries were established.

Governments are now committed to this diversification of their economies as the World Bank estimates that non-oil exports from the Arab world, which has a population of more than 270 million, are less than those from Finland, which has a population of five million. While the financial stability of oil-producing countries has ebbed and flowed with the price of a barrel, so too have the region's non-producing states been dependent on the resource, affected substantially by remittances from expatriates living in Gulf States and the financial support of the oil-rich nations.

Industry contributes significantly to the gross domestic product (GDP) in Arab countries as it accounts for about 25 to 50 % of the GDP (on average). It is as high as 46, 43 and 38 % in Qatar, Kuwait, and Saudi Arabia, respectively (related mostly to oil and gas), and is as low as 9 and 13 % for Somalia and Comoros, respectively (Unified Arab Economic Report, 1999). Although the GDP is often used as yardstick of economic progress and as a basis for regional comparisons, yet it can easily conceal various levels of localized production or do not take into account the degradation and depletion of natural resources when calculating income. In many countries of the region economic development and specifically industrial development has been achieved through rapid exploitation of natural resource base. In these countries, industrial activities including mining are directly responsible for much of the pollution that degrades the environment.

The average growth rate of industry in the Arab world, according to recent estimates, indicates that during the period from 1980-1990, the average annual growth was 0.6 % while it has increased during the period from 1990-1997 to 2.3 % (World bank, 1999). During the period from 1990-1997, the highest growth rates were witnessed in Jordan (7.9 %), Yemen (6.4 %), Tunisia (4.4 %) and Egypt (4.1 %). In oil-producing countries, the average growth rates of revenues from industry during the same period were comparatively lower; 1.5 % for Saudi Arabia, and –2.2 % for Algeria (World bank, 1999) Growth rates fluctuations have occurred and are mainly attributed to international oil prices (ESCWA, 1997).

(b). Industrial Pollution

Industrial activities and combustion of fossil energies in the Arab world contribute vast amounts of air pollutants, toxic releases to water and air, and organic waste (BOD). Industry is the predominant source of toxic pollution, while most organic waste discharged to water is from industry and humans. Toxic intensity varies across the Arab countries. The highly polluting sectors of toxic substances are chemical industries and refineries, and in a few cases metallurgical industries. This is creating pressure toward more cleanup and pollution prevention programs in the Arab world.

Industrial activity in Syria is mainly managed by the government (heavy) and partially by the private sector (craft and medium sized industries). The craft industries are dispersed around and in the cities. It uses old and highly polluting technologies (Tanneries, Textiles). All the industrial activities are characterized by the absence of resources for pollution control. The industrial waste treatment plants are poorly managed and maintained. The emission control equipment is, in general, not compatible with the production processes.

While the same basically can be said about most countries in the Arab world, the nations of the Gulf have been concerned about the environment for some time. In Bahrain, European firms have already inked substantial contracts to cleanup municipal wastes and help light industries reduce their pollution output. The UAE, Kuwait and Saudi Arabia are also more attuned to ecological concerns. An Environment Protection Section of the Food and Environment Control Center has been established in Abu Dhabi City to reduce pollution in the Emirates. Kuwait's move to environmental consciousness began with the 1991 Gulf war. While the economy responded to the end of the war more quickly than most observers expected, the speed of the recovery has become a problem in and of itself. Kuwait is now becoming stricter in requiring firms to take measures to counteract any pollution that may be created during industrial processes.

As the Arab world faces many obstacles on the road to cleaner air and water, none are insurmountable once the hurdle of apathy is cleared. The countries of the Arab world have begun to understand the costs and challenges associated with environmental decay. This newfound awareness and commitment is a vital first step to creating a climate conducive to combating pollution. The governments of the Arab world are increasingly showing a real commitment to protecting the local ecology.

(4). <u>Shortage of awareness</u>

Awareness of Arab community of the impacts of air pollution is generally low. In the Arab world, ‘civil society’ is often used to express the traditional, religious, sectarian, tribal and family structures still dominant in society. This use of the term distorts it. ‘Civil society’ should refer to the modern voluntary associations that belong in the modern state and are based on citizenry and free association to promote collective interest. Democracy and participation cannot be reduced to voting.

Democracy means continuous involvement of wide social segments in decision-making processes and in supervision and execution of developmental projects. It requires a degree of decentralization beyond what exists in the Arab world.

(5). Shortage of institutional capabilities

Most Arab countries lack the existence of long-term ambient air monitoring data, although some may have compiled huge amounts of air quality monitoring data. Such data sets were collected intermittently, without proper quality assurance and quality control and were left raw without analyses, interpretation and plans for control. In some states there are several agencies involved simultaneously in collecting air quality data, nonetheless with little bilateral/multilateral communication.

However, most Arab States have already passed legislations to protect the environment. Numerous air quality limits have also been issued as guidelines or standards in conformity with international regulations of WHO or/and EPA. Nevertheless, several Arab countries are monitoring and collecting air quality data in major cities and urban centers through establishment of monitoring networks. The EIMP network in Egypt, for instance, monitors ambient air pollutants (SO_X, NO_X, CO, O_3, and PM_{10}) at 19 stations in Alexandria and Delta region and 23 stations in Cairo and Upper Egypt. Capacity building was an important aspect of the program and data collected was quality assured and quality controlled. Trained personnel were involved for upgrading control of some localized sources which are still contributing to problems at some localities. In some Arab Countries (e.g., GCC countries and Egypt at least), lead emissions are decreasing due to the promotion of unleaded gasoline. Notable achievements have been marked in reducing the usage of Ozone Depleting Substances (ODS), i.e., Chlorofluorocarbons (CFCs), in the region. In many countries cleaner technology approaches (Cleaner Development Mechanisms CDM) have been adopted for industrial development of new industrial facilities.

Air emission control equipment is becoming common in several Arab countries, especially in the new or upgraded industrial facilities. The concepts of resource conservation, cleaner production, and sustainable development are gaining momentum, and expected to have positive impacts on the environmental quality (including air) in the future.

4. Air pollution impacts

Impacts of pollutant gases, such as Sulphur dioxide, nitrogen dioxide and ozone, cause decreases in crop yields and impact health. The greatest impacts occur close to sources of pollution where pollutant concentrations are the highest. However, atmospheric transfer can lead to effects over a wide area. Ozone and Sulphur dioxide, in particular, are responsible for causing reduced crop yield. In the USA yield losses of grain crops due to ozone have been estimated at 5 per cent per year. The economic benefit of reducing ozone concentrations by approximately 40 per cent was estimated to be US$3 billion per year. The potential for crop yield losses has also been demonstrated by an initiative in Pakistan where a 40 per cent reduction in rice yields was measured and linked to the presence of gaseous pollutants in the ambient air.

Of equal significance is the acidification of soils, lakes and streams. Soils acidify when acidic inputs exceed their buffering ability. Once soils have become acidified, acidity and toxic aluminum may be transferred from catchments into lakes, making them progressively more acid. This change in water chemistry harms organisms. Animals, such as crayfish, are the first to disappear and, if lakes become even more acidified, fish die.

Soil acidification and concentrations of pollutant gases have been implicated in the 'new type of forest decline' which has occurred in Europe and parts of North America. In Poland 3-5 million hectares of forest and over 1 million in the Czech Republic have shown signs of extensive damage with 60-80 per cent of the trees having died. This forest damage has increased in Europe since the 1970s. It is linked to Sulphur dioxide and ozone concentrations in the air as well as changes in plant nutrient availability and increases in toxic aluminum in the soil caused by acidification. Where liming is not practiced, soil acidification may lead to crop yield reductions in areas with sensitive soils.

The accumulation of nitrogen in ecosystems has also led to damaging changes in the health and biodiversity of plant communities and to the fertilization of coastal and marine environments. Nitrogen deposition can acidify soil, fertilize sensitive natural plant communities (changing species diversity) and lead to imbalances that may destabilize ecosystems. The over-fertilization of coastal areas leads to algal blooms and damages sea-beds, fisheries and coral reefs.

Air pollutants come into contact with the body mainly via the respiratory tract, so that this tends to be the most frequently affected part of the body. Ozone, nitrogen dioxide and Sulphur dioxide, as well as fine particulates and smoke, lead to inflammation of the mucous membranes. This causes reddening of the eyes, inflammation of the pharynx and throat, reduced lung function, and reduced resistance to disease, which in their turn lead to respiratory infections. Existing illnesses can worsen, resulting in an increase in emergency consultations and hospital admissions for respiratory problems, and to premature deaths.

Not only the respiratory tract, but other organs, too, is affected by air pollution. Thus volatile hydrocarbons and carbon monoxide are transported to the brain and heart via the blood. Symptoms such as headaches, giddiness, nausea and pounding of the heart are the first indications of excessive exposure. Lead and cadmium enter the blood partly via the lungs and are deposited in the bones, teeth, liver and kidneys. Even at low concentrations,
Lead causes developmental retardation in children.

Serious corrosion of buildings and cultural monuments in major cities of Europe and North America has been caused mainly by Sulphur pollution. Effects on buildings include the loss of mechanical strength and failure of protective coatings leading to increased maintenance costs. Loss of detail in carvings has destroyed part of Europe's cultural heritage. These impacts provide some of the most striking evidence of damage related to the combustion of fossil fuels.

A. Climate changes and impacts

(1). Achievements and Predictions

Fortunately, the emissions in the very high emitting countries have dropped between 55 and 16 percent in the nineties. This was a direct result of national policies adopting programs for cleaner energy measures, employing new efficient technologies and setting standards for air quality.

(2). Constraints and Challenges

Water shortages are already a major problem in many countries of this predominantly arid region, and are unlikely to be reduced and may be exacerbated by climate change. Projected precipitation increases are small, and temperatures and evaporation are projected to rise. Rapid development is threatening some water supplies through salinity increase and pollution spread, and expanding populations (and urbanization) are increasing the demand for water. Extensive dams building and

redirection of water from feeder rivers to irrigated agriculture has led to a reduction in the surface area of and damage to the wetland systems and the species that depend on them. This may also aggravate the effects of climate change.

Because of projected increases in temperatures, higher evaporation is expected. Soil moisture is projected to decrease in most parts of the region, which may lead to increased areas of soil degradation. The projected small increase in precipitation is unlikely to improve land conditions in the next century, partly because soil conditions take a long time to improve and partly because human pressure on these systems continues to contribute to land degradation. Grasslands, livestock, and water resources are likely to be most vulnerable to climate change in this region because they are located mostly in marginal areas.

Human health in the region is variable, reflecting the economies of the countries. Some countries, where poverty is high, have high infant mortality rates and low life expectancies. The impacts of climate change are likely to be detrimental to the health of the population, mainly through heat stress and possible increases in vector-borne (e.g., malaria) and waterborne diseases. Decreases in water availability and food production would lead to indirect impacts on human health associated with nutritional and hygiene issues. Human activity can exacerbate the effect of climate change in this arid/semi-arid region, leading to long-term detrimental effects on ecosystems and human health. Records of annual temperatures during the period 1900–96 show almost no change for most of the Middle East (Arab) Region. There was no discernible trend in annual precipitation during 1900–95 for the region as a whole, nor in most parts of the region—except in the southwestern part of the Arabian Peninsula, where there was a 200% increase. This increase, however, is in relation to a very low base rainfall (<200 mm/yr) (IPCC 1998).

Climate models project that temperatures in the region may increase by 1–2°C by 2030–2050, with the greatest increases in the summer. Precipitation is projected to increase slightly in the winter throughout the region and in the summer in the southern part of the Arabian Peninsula. These precipitation projections vary from model to model and are unlikely to be significant. Because of the arid nature of the region, some sectors will be particularly affected by climate change. The impacts on are summarized below in the areas of ecological systems, water resources, food security and health sector (IPCC 1999).

The region is mostly arid and semi-arid and is dominated by deserts, meadows and some woodland. Vegetation models project little change in most arid (or desert) vegetation types under climate change projections. The impacts may be greater in the semi-arid lands of the region than in the arid lands, especially in composition and distribution of vegetation species. However, many countries in the region have been promoting planting trees, forests and green areas that can serve as a sink for CO_2 emissions.

Improved water-use efficiency by some plants under elevated carbon dioxide (CO_2) may lead to some improvement in plant productivity and changes in ecosystem composition. Management options, such as better stock management and more integrated agro-ecosystems could improve land conditions and counteract pressures arising from climate change. The potential impact of climate change combined with escalating human activity may also cause a loss of biodiversity.

Food and fiber production concentrated on more intensively managed lands could lead to greater reliability in food production and reduce the detrimental impacts of extreme climatic events, such as drought. Implementation of more flexible risk-management strategies (e.g., long-term and appropriate stocking rates, responding to variations in precipitation by changing animal numbers

annually)—along with the use of a wider variety of domestic animals, game ranching, and multiple production systems—would provide greater food security to the region.

In general, the impact of climate change on the Arab world is not fully examined and understood, but it could be especially significant. It should cover various aspects, including fragile land resources, ecosystem, water resources, coastal zones, human settlement, tourism and biological diversity. In dry lands, which are dominating most of the region, the population growth will push people to marginal land, which is strongly vulnerable to climatic changes. More frequent droughts are likely to occur, which could seriously impact the availability of food, as in the horn of Africa (including Somalia) during the 1980s and 1990s. In fact, climate change could aggravate that region's vulnerability to natural disasters, which include, in addition to drought and food shortage, floods, cyclones, and pest infestations. El Nino, an irregularly periodic climate phenomenon which alters the regular wind pattern and blows moist wind from east to west, has obvious impact on the whole region.

Because of the effect of surfaces and waste heat on the urban heat balance and the resultant alteration of the atmospheric environment, heat or thermal energy is considered a form of air pollution. Heat islands in urban areas have a significant effect on weather and local climate as well as global climate. Urban Growth is considered as an important factor in dealing with the environment. The impact of climate change due to increased pollution by GHG on the Arab region actually involves all sectors of development. Generally, it could include:

- ***Impacts on dust storms and sand dune movement:*** Most of the area of the Arab region is desert with already high temperatures and prevailing dust storms and sand dune movements. Under expected increase of temperatures, soil fragility is expected to increase making available very fine particles liable to move with winds which are also expected to increase in severity and frequencies of occurrence. This results in increased air pollution with particular emphasis on fine particles leading to increased health impacts
- ***Impacts on water resources:*** Increased temperatures are expected to increase evaporation, reduce the amount of available water. Increased movement of sand dunes are also expected to impact scarce water resources in the region
- ***Impacts on Agricultural productivity:*** Impacts of climate change on agriculture will involve excessive evaporation from soil increasing rates of soil salinization and will also involve increased transpiration and need for water resources. In addition, climate change will lead to changes of the crop distribution pattern and a general loss of productivity.
- ***Impacts on coastal areas:*** Sea level rise due to climate change which is expected to reach at least 50 cm over all coastal areas over the present century will inundate parts of many of the important economic centers; especially on low land areas of deltas (see e.g. El Raey, 1995). This may lead to immigration of large percentage of population in these areas, hence increased unemployment rates and socioeconomic implications.

B. <u>Risk of nuclear hazards</u>

The Israeli nuclear reactor of Dimona is vulnerable to meltdown, like the Russian reactor of Chernobyl two decades ago, which caused a humanitarian and ecological catastrophe. If Dimona melts down, it would affect an area 500 aerial kilometers in radius, reaching Cyprus and the entire neighboring region". With thorough investigation into Dimona Israel's nuclear plant, one can observe the severe shortage of a contingency plan in the region in addition to the shortage of awareness.

5. Monitoring

A. Ground-based networks

Many municipalities of the region have already implemented ground based monitoring networks for ambient air quality monitoring and assessment. In Egypt, an air quality monitoring network has been implemented over the whole country including Cairo and Alexandria cities through the Ministry of Environment EEAA/EIMP program. EEAA/EIMP operates presently about 40 measurement sites. Stations are specifically located at selected sites so as to represent various categories of air pollution sources Figure (5). Measurements inside urban areas and close to industrial sources have occasionally recorded air pollution levels exceeding the Air Quality Limit values as given by Environmental Law no. 4 for Egypt. The greater Cairo area also during the Autumn 1999 experienced several air pollution episodes with air pollution levels reaching very high concentrations due to a combination of emission from a number of different sources and adverse weather conditions. Figure (6) represents results at one of the hot spots in Cairo and indicates that Air Quality Limits (AQL) has been exceeded most of the time.

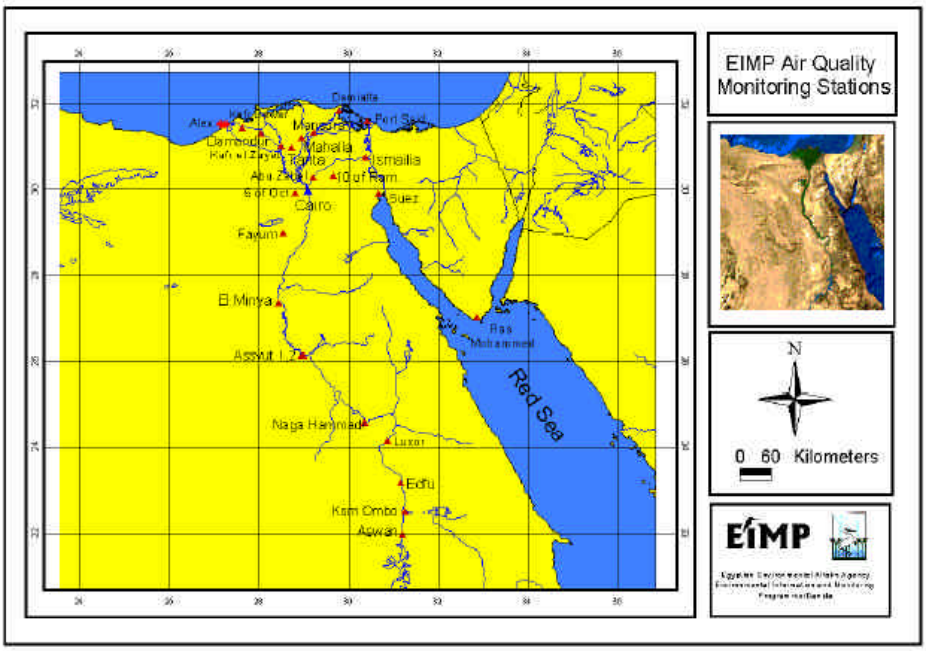

Figure 5 - Air quality monitoring network over Egypt.

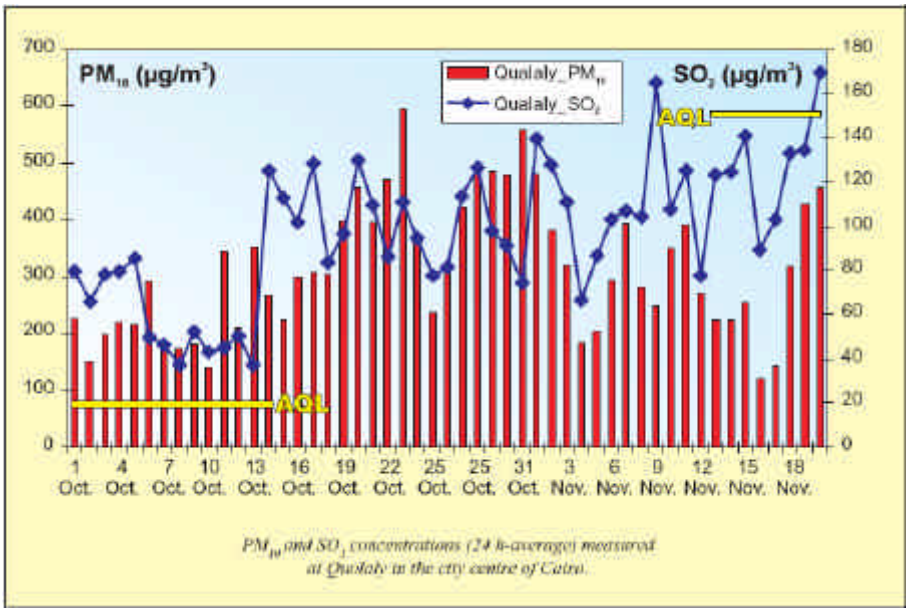

Figure 6 - An example of air quality network of levels of SO_2 and PM10 at one of the hot spots of Cairo

B. Satellite monitoring systems

A recent development of satellite technology has enabled large scale air quality monitoring to be carried out. So in addition to many satellites capable of identifying large scale storms such as MODIS, LANDSAT and SPOT, there has been a number of specialized sensors these include:

- **GOME (Global Ozone Monitoring Experiment), ESA-ERS, 1995-present:** This retrieves O_3, NO_2, H_2O, BrO, SO_2, HCHO, $OCLO_8$
- **SCIAMATCHY (Scanning Imaging Absorption Spectrometer for Atmospheric Cartography**), ESA-ENVISAT, 2001-present. This retrieves O_2, O_3, NO, NO^2, N_2O, H_2O, BrO, SO_2, HCHO, H2CO, CO,OCLO, CO_2, CH_4
- **MOPITT: http://www.eos.ucar.edu/mopitt/** . This retrieves CO and CH_4
- **HIRDLS is an (Infrared limb-scanning radiometer).** This is designed to sound the upper troposphere, stratosphere, and mesosphere to determine temperature; the concentrations of O_3, H_2O, CH_4, N_2O, NO_2, HNO_3, N_2O_5, $ClONO_2$, $CFCl_2$, $CFCl_3$, and aerosols; and the locations of polar stratospheric clouds and cloud tops.
- ***New NASA satellite missions:*** This is the most recent in the series by NASA Aura : http://eos-aura.gsfc.nasa.gov/news/index.html

A diagram illustrating measurements ranges and pollutants of Aura satellite is presented below in Figure (7). The advantage of use of satellites is that it eliminates the need for frequent calibration and maintenance of equipment. It is necessary to start building capacity on use and applications of these satellite sensors and integrating it with ground-based network capabilities for monitoring, assessment and control of air pollution

Figure 7 - A diagram illustrating capabilities & ranges of recently launched AURA satellite

6. Opportunities and needs

The most important and pressing need is to consider alternative non-polluting sources of energy on a strategic view. Considerations of solar energy which is the most abundant in the Arab world, natural gas fuel and hydrogen energy are necessary. Investment in these lines can be rewarding. Direct and immediate action for supporting transforming transportation systems to natural gas is necessary, especially to highly congested cities such as Cairo and Alexandria. Adoption of Clean Development Mechanism (CDM) in industry is also necessary prerequisite for improvement of air quality conditions in the region

There are some obvious research needs. Clearly, many basic physiological and ecological studies of the effects of changes in atmospheric and climatic conditions are necessary. The most pressing need over much of the region is for sound assessment of the monitoring programs to establish current baseline of actual conditions and identify rates of change.
On the side of institutional management regarding air quality and atmospheric pollution in the Arab Region are:

A. <u>Capacity building and Institutional capabilities</u>

It is necessary to start building institutional capabilities in air pollution monitoring for those countries which do not have this capabilities and strengthen those which already progressing. The institutional capability generally involves four factors:

- Government interest and support
- Regulations and standards
- Stakeholders awareness
- Availability of monitoring and assessment tools and periodic calibration
- NGO

Both ground based monitoring networks and satellite capacities are needed.

It is also necessary to upgrade capabilities of regulatory and inspection authorities in air pollution so as to become capable of identifying and inspecting industrial installations on regular basis. Both the number of personnel and their expertise should be enhanced. Varieties of well calibrated inspection equipment should be made available at inspection authorities

B. <u>Encouraging NGO</u>

Building a strong, effective and efficient Arab NGO sector would be necessary for effective upgrading of environmental quality of life in general and air quality in particular. Strengthening NGO will involve the followings steps (Krayem et al, 2000):

1. ***Development of an appropriate democratic and legal framework for Arab NGOs***. This framework has three interrelated elements. The first is legitimization of Arab NGOs based in UN conventions and international law, by allowing for freedom of association at all levels. The second is independence meaning the right of NGOs to define their own goals and missions, and respect by government and other institutions for the organizational and administrative independence of NGOs. The third is accountability, transparency, and monitoring of NGOs. These three elements are equally important in an appropriate legal framework for NGOs.
2. ***Development of a general conceptual framework for social policy.*** National public policy must be agreed upon between all effective forces in society, especially between the public sector, the private sector and NGOs.
3. ***Formulation of a model for professional cooperation between the national governments and the NGO sector***. This model should be based on the concept of 'full partnership' between national governments and Arab NGOs. A consultative mechanism should be institutionalized to facilitate this process. Government should recognize that the role of NGOs is not limited to providing services but it extends to the development of democratic principles and practices in local communities. In our view, the NGO sector has a comprehensive role to play in all spheres and sectors of society.
4. ***Development of a model for professional national and societal cooperation between NGOs and the rest of the civil society organizations***. Civil society comprises NGOs, political parties, trade unions, the media, and social movements among others. An institutionalized, organized and continuous consultative mechanism among all civil society organizations is needed. The relationship between NGOs and political parties needs special attention, since political parties often seek to dominate NGOs while NGOs seek to enhance their independence.
5. ***Strengthening, empowering and enhancing the democratic structure of the Arab NGOs***. This work must focus on three interrelated spheres. The first is sound management with a clear vision and agreed upon values, professional procedures and transparency mechanisms. The second is improvement and development of administrative and technical capabilities. Efficient administrative techniques are needed to improve the quality of NGO services and enhance their relations with local Arab communities. The third is human resource development and the development of work ethics. This should include important issues like knowledge, information skills and ethics. Capabilities should be built in accordance with new NGO requirements, that is, the move from the mere provision of social welfare to development. Professionalism should not be over-emphasized at the expense of neglecting voluntary work, however.

6. ***Co-ordination, cooperation, consultation and networking among the Arab NGO organizations***. One objective of the networks is to build a clear common and comprehensive vision of social and economic development in Arab societies. Another purpose is to develop strong local partners to national governments, partners who can participate in the management of the developmental processes in Arab countries and reflect local communities' perspectives in decision-making processes.
7. ***Achieving self-reliance and self-financing***. Exclusive dependence on external finance threatens the existence of NGOs. Self-reliance requires that NGOs enhance their relations with local communities. Relations with the private sector should be developed to create mechanisms to increase the role of the private sector in the processes of development. Relations with international NGOs must also continue to enhance mutual respect, common vision and real partnership, especially in issues of strengthening democracy, social justice and human rights.
8. ***Establishing relations with Arab local communities***. The suggestion for a new integrative, institutionalized and systematic strategy for relations between local communities and NGOs is an essential, important and decisive manner for the effective intervention and sustainability of Arab NGOs.

C. Encouraging private business in air pollution

It is important to identify the need for more investment on the private scale in air pollution monitoring and assessment tools. Calibration equipment, training capacities and facilities are required

7. Conclusion and Recommendations

It has been well recognized that the Arab region is suffering from shortage of institutional capabilities for monitoring, analysis, assessment and control of air quality conditions at many aspects of its development. Transportation systems, excessive use of polluting fuels in industry, shortage of awareness of stakeholders and the rapid growth of urbanization constitute major factors responsible for low air quality. According to the Report of Arab Countries at Millennium of Sustainable Development Johannesburg; the following needs were recognized:

A. Patterns of Consumption

Actions at the National Level: Governments and the private sector are urged to change the unsustainable pattern of production and consumption of goods, services, and natural resources. Steps should be taken to encourage the use of traditional products and goods, to promote the concept of cleaner production and consumption, and to encourage reuse and recycling activities, including research and development.

Actions at the Regional Level: Collective efforts of the countries are needed to revive Arab and Islamic traditions and teaching as a distinct feature of the region, which can reflect positively on sustainable development.

Actions at the International Level: The developed world is urged to change unsustainable production and consumption patterns that deplete global natural resources and have a high ecological footprint. It is also urged to devote more resources to develop eco-efficient technologies and make them affordable to developing countries.

B. Climate Change

Oil producing countries need to take a fresh look at the scientific assessment of climate change. The Intergovernmental Panel on Climate Change (IPCC) in its Third Assessment Report projected average warming of the earth's temperature between 1.4 to 5.8° Celsius by the end of this century. This would add to the estimated warming of around 0.6° Celsius that has already taken place in the 20th century. The Gulf region as a major producer of hydrocarbons is also likely to be faced with several impacts of climate change that need to be welded into national policies and international agreements. It would be particularly useful if the countries of the region intensify research and development related to all aspects of climate change, so that knowledge and awareness can be created on actions that need to be taken in these societies.

Actions at the National Level: National monitoring strategies should be established to monitor the amount of CO_2 produced. Reduction of CO_2 emissions through elimination of flares, use of more efficient fuels and promotion of efficiency and Cleaner Production schemes in industry should be promoted. Afforestation and sink development should be encouraged.

Actions at the Regional Level: The most pressing need over much of the region is for sound assessment and monitoring programmes. Countries of the region should coordinate their policies and positions, including with respect to the socio-economic impacts of green house gases mitigation on developing countries, and oil-producing countries.

Actions at the International Level: The international community must also address the impacts of mitigation measures on developing countries.

C. Ozone Depleting Substances

Actions at the National Level: Countries should continue to phase out the use of ODS and continue implementation of the Montreal Protocol.

Actions at the Regional and International Level: Assist stakeholders in the region to ratify the Montreal Protocol and/or its amendments.

D. Air Quality

Actions at the National Level: There is a need to improve and establish air pollution monitoring and control programmes for mobile and stationary emission sources, and to continue assessment and analysis of ambient air data. It is necessary to use sound urban planning for cities with support systems that are environmentally sound and have low energy consumption. This can enable short distance hauling and distribution with emphases on public transportation systems quality and accessibility. Cities should also use modern efficient traffic management systems to reduce traffic idle time, which produce peak emissions. It is also necessary to continue efforts to eliminate leaded gasoline, replace aging vehicles and industrial production facilities, increase availability of cleaner fuel including natural gas stations and intensify forestation.

Actions at the Regional Level: Joint programmes are needed to address common priorities of the countries in the region domain of air pollution monitoring and control, assessment of health impacts associated with air pollution, and the exchange and dissemination of air pollution. Developing sub-regional/regional transportation networks and energy efficient systems and grids should be considered as a matter of priority.

Actions at the International Level: The international community is urged to provide technical and financial assistance to address the issue of air pollution, including transboundary air pollution such as haze clouds..

Several specific recommendations are outlined below to combat air pollution and improve air quality conditions in the region:

- Air Quality Regulations and enforcement mechanisms
- Financial resources to secure state-of-the-art air quality measurements equipment and qualified personnel
- Air Pollution Monitoring and Control of mobile and stationary emission sources
- Continual assessment and analyses of ambient air data in coordination with Regional compatible air quality standards or guidelines
- Incentives for the transportation and industrial sectors to tackle air quality problems
- Urban planning
- Training, Capacity Building and transfer of cleaner technologies
- Research and Development related to air pollution, health impacts and climate change
- Regional Coordination and Collaboration, especially in exchange and dissemination of air pollution information and experience.

E. Governance and Public Participation for Sustainable Development

Actions at the National Level: The need for good governance is strongly emphasized to include strengthening the legal and institutional framework, nurturing democracy, accountability and transparency, effective participation of the civil society, especially women and youth, and the private sector in the decision making process. Eliminating social, political and economical corruption is also considered essential to achieve good governance. Furthermore, adopting decentralization, and establishing linkages and coordination mechanisms between environment ministries, other concerned ministries and relevant sectors are of paramount importance in improving governance for sustainable development.

Actions at the Regional Level: The role of the League of Arab States (LAS) should be enhanced in terms of the cooperation and coordination between Arab governments. An Arab Council for Sustainable Development to meet at the level of Prime Ministers should be established. Cooperation and coordination regarding the implementation of MEAs and regional conventions needs to be strengthened and enhanced.

Actions at the International Level: It is of paramount importance to strengthen (institutionally and financially) and empower the UN to play a more proactive role in sustainable development, emphasizing the importance of the concentration of each agency on its respective area of specialization. Reform and restructure of the international institutions may be required in order to achieve better governance. Enforcement of international legal instruments, and the identification and settlement of liabilities must also be addressed, while giving consideration to the needs of developing countries.

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Appendix: Summary of Air pollution problems in some MENA Countries

1. Algeria

About 8.5 million tons of municipal wastes are generated in Algeria every year, more than 90 percent of which originates in the northern part of the country. Municipalities are responsible for waste management collection. However, most of the waste is presently disposed of in open dumps (a recent survey conducted by the Ministry of Land Use Planning and Environment showed that there are 2,100 illegal dumps nationwide, 360 of which are located in the 40 most important cities).

Much of the population faces serious health hazards. There have been reported outbreaks of disease due to the combined effects of lack of: waste treatment, fresh water, and waste collection and disposal capacity. Emission into the atmosphere of noxious gases and fumes from smoldering landfills has reportedly generated respiratory diseases, and inappropriate handling of waste by municipal staff and illegal scavengers has also led to skin diseases and other ailments. In addition, contamination of surface and groundwater due to improper landfill design and operation has been reported, as well as illegal dumping of waste in wadis and forests.

The past focus on development of publicly owned and operated heavy industries (e.g., chemical and metallurgical), often close to fragile ecosystems and population centers, has created serious risks to environmental quality, human health and the quality of life. The intensive and heavily subsidized use of energy sources such as diesel and leaded gasoline, the lack of enforceable industrial pollution control and the lack of proper management of solid and hazardous waste, are exacerbating factors. Poor vulnerable groups are particularly affected, as well as the country's cultural and archaeological heritage and coastal resources.

2. Egypt

Air pollution is a serious problem in the major cities of Egypt, particularly Cairo. One of the major causes is the large concentration of polluting industries in and around the urban residential areas, particularly in the steel, cement fertilizer and chemicals sectors which contribute to high ambient dust levels and SO2 that may be between 2 and 10 times maximum safe levels. Vehicle exhaust gases also contribute. The concentrations of total suspended particulates in the air in urban centers are generally much higher than the WHO Guideline value and there is high incidence of asthma.

Urban solid waste burning, industrial waste generation, industrial heavy fuel use and diesel fuel consumption in the transport sector are the major sources of particulate air pollution. Agricultural burning also contributes on a seasonal basis. In addition to its health effects, air pollution impacts the cultural heritage by causing damage to priceless monuments.

The urban population of Egypt increased from 18 to 29 million between 1980 and 2000. Increased urbanization and expansion of urban and rural settlements has resulted in the annual loss of between 5,000 and 10,000 hectares of agricultural land.

Solid waste is a growing environmental problem in Egypt. Inefficient collection, storage and disposal of municipal and hazardous wastes results in the spread of disease and localized pollution. A major proportion of the solid wastes generated in the more affluent suburbs of Cairo (where waste contains relatively valuable components) is collected, manually sorted, and efficiently recycled. In the poorer city areas systems for collection and disposal are poorly developed, and often waste accumulates and is just burned on the streets. Solid waste is deposited in open dump-sites close to settlements in desert areas. In the Delta, waste disposal sites are harder to site, as land

values are high, and often waste is just dumped into canals or lakes. Even where suitable dump-sites exist, waste disposal is uncontrolled, and often accumulations of waste are set on fire to reduce volumes.

Egypt has difficulty removing and handling of the 20,000 to 50,000 tons of hazardous and clinical wastes from industry and hospitals. These wastes are currently either burned or incinerated, dumped on areas of vacant land or in canals or lakes. The increasing incorporation of hazardous wastes into the general bulk waste stream poses increasing health risks, particularly for waste collection workers and waste pickers.

Recent initiatives to control industrial pollution through increased monitoring and enforcement of standards at industrial facilities have led to overall improvements in the quality of the River Nile.

3. Jordan

Air pollution is a localized, but significant, issue in Jordan. Air quality is deteriorating in urban areas, such as Amman and Aqaba. Air pollution comes from both stationary and mobile sources, such as industry and vehicles, as well as natural sources such as sand and dust storms. The most damaging source, however, is due to the growing fleet of vehicles that emit high levels of pollutants. Poorly maintained vehicles consume poor quality fuels. Vehicle emissions regulations are poorly enforced, and air quality monitoring stations are few and poorly maintained and funded.

The urban population of Jordan has increased from 64% of the total in 1980 to 74% in 2000.

Migration from rural to urban areas may reduce pressure on some natural resources (fuel wood, for example) but increases pressure on urban environmental services, especially water resources and sanitation. The situation is compounded by population growth, due to natural growth and a large influx of Palestinian and other refugees. Nevertheless, progress seems to be being made in some areas. The World Bank reported that only 54% of urban wastewater in Amman was treated in 1998.

In 2002, according to UNICEF, Jordan achieved a rate of access to sanitation of 100% in urban areas and 84% in rural areas, although maintaining and upgrading existing facilities may be a challenge.

4. Lebanon

Industrial air pollution is a concern in only a small number of areas, arising for example from cement plants. Vehicular air pollution is a greater concern in Beirut, where traffic levels and congestion have increased rapidly.

Solid waste collection ranges from about 18% in the South, 45% in North Lebanon, 57% in Mount Lebanon, and close to 100% in Beirut. Most solid waste is disposed of in unmanaged dumps. Plans to set up landfills have often been hampered by disputes over location.

5. Morocco

Currently, a little more than half of the Moroccan population lives in urban areas, but this is increasing.

Urban problems are now affecting medium and small towns with an average of 15,000 to 20,000 inhabitants, not just the big cities. The rapid population growth in towns is causing high-density

development in city and town centers, and unplanned housing on the outskirts. In both these areas, provision of water and other environmental services is poor.

Morocco's extractive industries are potentially highly polluting, and pollution issues also arise in the petroleum refining, food processing, and cement and textiles industries. These produce a range of solid wastes and effluents, including hazardous wastes.

6. Palestine

Although air pollution may not be as severe an environmental issue as the pressures on water and land resources, this may to some extent be due to a lack of monitoring stations and therefore reliable data, and the institutional capacity to interpret data and take appropriate action.

Air quality in the region is on the decline, largely due to the same circumstances that threaten land and water: lack of proper solid waste disposal and the lack of control over industrial emissions. Another important factor is the growing population, using an expanding fleet of vehicles running on diesel and leaded fuel. Some parts of the West Bank are downwind from industrial zones, which further reduces ambient air quality

The area's high, and increasing, rate of urbanization is an important contributory factor to poor water quality and overall public health. In general, environmental service provision is poor. There is, for example, very little sewerage infrastructure in either the West Bank or Gaza, and most of the population use cesspits or latrines that overflow into surface drains.

Management of solid waste is extremely inadequate in most of the West Bank and Gaza. Solid waste dumping is open and uncontrolled at unplanned dumping sites that are not lined, fenced, managed or monitored. Wastes in the dumping sites are burned to reduce their volume, which contributes to air pollution and impacts on human health, particularly for the scavengers who collect recyclable materials at the sites. Scavengers are also at risk from the industrial, hazardous and medical wastes which form part of the waste mix.

7. Syria

Air quality is generally poor in the larger cities, due mainly to motor vehicle emissions, particularly the old fleet of cars and poor traffic management. Industrial emissions occur mainly in hotspots around industrial sites such as cement plants, quarries, power stations, and the refineries. Emissions from domestic heaters are also significant during the 4 month winter period. Air pollution is likely to have severe effects on the health of exposed populations, especially in urban areas and adjacent to highly polluting industry. In addition, air pollution has impacts on building materials, causing discoloration and physical damage to vulnerable historic buildings.

A major pressure in Syria is the growth of illegal settlement areas around all large towns, but particularly around Damascus and Aleppo. Proper sewerage systems and potable water distribution systems are often absent, with the result that waterborne diseases such as cholera, typhoid and diarrhea are prevalent in these areas.

Collection of municipal solid waste and transportation to the disposal site is the responsibility of the governorates, who report collection efficiencies of up to 90% in urban areas but only 64% in rural areas. These wastes usually include commercial wastes plus some waste from agriculture and small scale industries. Wastes from large-scale industry and slaughterhouses are usually transported

directly to landfill in privately rented vehicles. There is no segregation of hazardous materials from the waste stream.

The overwhelming majority of collected waste is disposed to land at open dump sites located on the outskirts of towns. Open burning of waste is common.

8. Tunisia

A large contribution to air pollution comes from nitrogen oxides, associated with transportation and inefficient techniques used in industry. The chemical industry has contributed greatly to air pollution, as well as water and soil pollution. The iron and steel sector is also a major polluter due to high emissions of suspended particulate matter.