Developing a Set of Environmental Indicators for Economic Analysis in MENA Region

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ARTICLES

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Abstract:

In the Middle East and North African (MENA) region, environmental concerns are expanding and the debate over adopting environmental policies appropriate for sustainable economic development is escalating. The need to study, construct and implement a set of environmental indicators that match the special resource endowments and economic conditions characterizing the various countries in the MENA region is also intensifying.

In this paper, we attempt to develop and apply an analytically comparable set of environmental/economic indicators for the Arab countries in the MENA region. The set of indicators should help as a guide to policy makers in fields closely related to "managing the water and land resources", "promoting sustainable agriculture", and "stabilizing the state of the atmosphere". In addition to exploring the economic significance of analyzing the "atmospheric change indicators", we propose certain "pressure indicators" and "indices" to overcome the shortcomings and biases of some common indicators used in conducting international comparisons of the environmental performance. Part of our concluding remarks may persuade future regional actions and cooperation in this area.

I - Introduction:

The "UN Conference on the Environment and Development in Stockholm 1972" has stimulated the international anxiety regarding the "Environment" and its relation to "Sustainable Development".

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The enthusiasm concerning the planet's future continued throughout the 1980s and was culminated by the Earth Summit in Rio De Janeiro in 1992, which established the links between improved environmental management and economic development as the core for its agenda (Dixon et. al., 1994). Ever since the 1970s, a number of studies and international reports have emerged to formulate several sets of environmental/econmic indicators for the Great Seven (G7) countries and many of the developed countries (OECD, 1992), (OECD, 1993), (World Resources Institute, 1992), and (Notter & Liljelund, 1993). Environmental monitoring and protection is now considered a priority in most OECD member countries, and their environmental policies are closely linked to the general economic development policies and schemes for improving the quality of life (UN Economic Commission for Europe, 1988).

In the Middle East and North African (MENA) region, as in most of the developing countries (DCs), the environmental concern is expanding and the debate over adopting environmental policies appropriate for sustainable economic development is escalating, Nonetheless, this has not been accompanied - yet - with a comprehensive study to construct and implement a set of environmental indicators and indices that match the resource endowments and the special economic conditions characterizing the various countires in the MENA region.

In this paper, we intend to accomplish the following objectives:

1 - Define and explain what is meant by "enviromental indicators" and "environmental indices", and their connection to various economic indicators (Part II of the study).

2 - Utilize the available data to determine, construct and analytically compare a set of environmental/economic indicators that are appicable to most of the countires in the MENA region, especially the Arab countries*(1) (Part III). That set of indicators should help as a guide to policy makers in fields closely related to:

    a - Managing the water and land resources (Part III-A).

    b - Promoting sustainable agriculture (Part III-B).

    c - Stabilizing the state of the "atmosphere" (Part III-C).

3 - Examine the shortcomings of the common "pressure indica-

tors" used in conducting international comparisons of the environmental performance; specifically the atmospheric status (Part III-C-7).

4 - Propose solutions to overcome the shortcomings and biases of some common environmental "pressure indicators" (in Part III-B-3 and Part III-C-8).

5 - Provide a number of concluding remarks (Part IV).

II - The "Environmental Indicators" Concept and its Limitations:

An **environmental indicator** is a normative responsive measure that contains summarized information that could help in assessing, forecasting and comparing the environmental conditions and its courses on national, regional and global scales. Normally, an indicator - economic or environmental - should be able to signal early warnings regarding changes in general trends. Accordingly, examining such indicators is required as an initial step for formulating the appropriate strategies and steering adequate actions towards the eventual goal of securing sustainable development. It would be best if such indicators are easily linked to econometric models to serve as a planning tool and to integrate environmental concerns into economic policy (Bakkes et al., 1994).

Environmental indicators are usually categorized under three groups (UN, 1996-a):

- "**Driving Force Indicators**" or - as commonly known - "**Pressure**" or "**Stress**" indicators. They embody all the direct and the indirect environmental pressures. The direct environmental stress evolves from discharges and emissions of different pollutants. The indirect environmental pressures are usually measured in association with certain economic indicators, such as population growth rates, economic growth rates, various measures of energy consumption, etc.
- "**State Indicators**" - sometimes called "**Impact**" indicators, describe the current conditions of the environment and its quality (soil, water, air, flora, fauna, etc.). This group of indicators includes

- among other evidences - measures of land degradation, material corrosion, soil salinity, etc.

- "**Response Indicators**" include all kinds of economic and non-economic reactions implied by the existing state of the environment, such as the level and channels of environmental expenditure, environmental legislation, environmental policy options and actions.

Both groups of "pressure" and "state" indicators should augment the government's awareness of the danger surrounding the country's economic resource base and environment. Hence, they make the government more receptive to proceed towards implementing some reaction devices, i.e., "response indicators".

Sometimes it is more useful and practical to aggregate a number of those indicators into one environmental index. An "**environmental index**" is a mathematical function based on at least two or more variables. These variables are usually indicators of the same or different subjects combined into one single index (Ott, 1979). An index is usually easier to interpret and visualize by decision-makers and non-specialists, because it is a summary yardstick of a number of indicators that are often technical in contents and jargon. Moreover, as indices are usually weighted, they tend to give a better representation of the measured phenomenon and - consequently - confer analytical interpretive value.

Developing a wide array of environmental indicators for economic analysis requires a system of data and information that is adequate in quantity and accurate in contents and quality. since such system does not exactly exist in most of the MENA countries, we will be bounded by the data availability in determining and constructing a comparable set of environmental indicators. Several indicators and indices may have their own limitations, which will be discussed later as we go along with the analysis.

III - Constructing A Comparable Set of "Environmental Indicators" for Selected Countries in MENA Region:

Most of the indicators that we would be able to develop for the

MENA region are "driving force" and "state" indicators. Information concerning "reaction indicators" may not be readily available for the following reasons:

1 - Many of the MENA countries are still in their early stage of environmental planning and management.
2 - The reaction indicators would vary from one country to another depending on the distinguished circumstances and capacities characterizing each individual country.

However, whenever conceivable, we will note to the anticipated "response indicators" that would serve as proper reactions to the constructed "pressure" and "state" indicators.

In this core part of the study, we will concentrate on constructing indicators for:

a - Managing the the water and land resources.
b - Promoting sustainable agriculture.
c - Stabilizing the state of the "atmosphere".

III-A. Indicators for Managing the Water and Land Resources:

Theoretically, water and land resources of a country are renewable resources. In real life, unfortunately, over-use and mis-employment of such resources could render a considerable portion of these resources to be non-renewable. Manipulating measure and indicators that signal the increasing pressure on such indispensable resources, and others that manifest its current conditions is essential for prescribing the corrective economic policies and tools.

III-A.1. Indicators of Fresh Water Resources:

In table (1) below, we present a summary of two "driving force" indicators and a "State" indicator:

1 - **"Annual water resources withdrawals as a percentage of the country’s total renewable water"** highlights the real stress on the country’s ability to sustain its future development needs in all economic sectors, hence, it could be used as a "pressure indicator".

Tables (1):
Indicators Related to Freshwater Resources & Use (1996)

Country	(%) of Withdrawal to renewable resources	Freshwater resources per ca-pita (cubic meters)	Freshwater sectoral withdrawal		
			Agriculture (% of total)	Industrial (% of total)	Domestic (% of total)
Algeria**	32	483	60	15	25
Bahrain*	140	423	4	36	60
Egypt*	102	1,071	85	9	6
Iraq*	49	5,189	92	5	3
Jordan**	66	158	75	3	22
Kuwait*	152	155	4	32	64
Lebanon**	31	1,030	68	4	28
Libya***	374	155	75	10	15
Morocco**	36	1,110	92	3	5
Oman**	123	456	93	2	5
Qatar*	175	249	38	26	36
Saudi Arabia**	709	124	90	1	9
Sudan***	25	2,757	99	0	1
Syria**	206	483	94	2	4
Tunisia**	87	385	89	3	9
UAE**	1,407	59	92	1	7
Yemen**	72	260	92	1	7
World**		**7,342**	**68**	**22**	**10**

(*) Original data used in the calculation is taken from (Hirzalla, 1996) and (UN, 1996-b).
(**) Original data used in the calculation is taken from (Word Bank, 1998-99).
(***) Original data used in the calculation is taken from (World Resources Institute, 1995).

Examining the figures representing this indicator magnifies the immediate and medium-term pressures on existing fresh water resources in nine of the MENA countries. Five of these countires are in the GCC region, two in North Africa (Egypt and Libya), and the rest are in West Asia (Jordan and Yemen). In these countries the rates of water extraction and withdrawal exceed the natural annual rates of water stock renewal. In a country such as Libya, the rate of water extraction is almost four times as much as the rate of replenishing its stock of water resources.

One serious limitation of this indicator is that it does not show the speed at which the country depletes its renewable water resources.

2 - **"Sectoral share of fresh water supply"** is the second "driving force indicator" of water resources. This indicator signals the sectors that impose heavy burdens on the country's existing water resources and on its future prospects for economic development in that sector and in other sectors as well. It is obvious that the agricultural sector imposes the greatest pressure on fresh water supply in the majority of investigated countries. On average, the agricultural sector consumes over 70% of the fresh water resources in MENA region, whereas this share does not exceed 20% in the "Great Seven" (G7) and many other developed countries. About two thirds of MENA countries channel 74% to 99% of their water resources to irrigation. This pattern of water resources' employment exerts additional strains not only on the region's ability to sustain its future agricultural production but also to accelerate its industrial progress.

3 - The "state indicator" - in column 3 of table (1) - **assesses the annual per capita share of fresh renewable water resources** *(2). Comparing this estimate for a number of countries, or for the same country over a time span, clarifies its relative status regarding the sufficiency of fresh water

resources. In all of the selected MENA countries, per capita renewable water resources are much less than the world's average. Regardless of the quality of existing water resources or the efficiency of its use, only three of the selected countries; namely, Iraq, Syria, and Sudan, could have relatively adequate per capita renewable water resources, while the rest of the countries are facing real constraints with various degrees of potential shortage.

Per capita expenditure on water desalination, wastewater treatment and its percentage in total water supply, and changes in water use per unit of arable land are examples of useful "response indicators" for sustainable water supply. Expanding facilities of water desalination, the reuse of treated wastewater, and directing efforts to increase the efficiency of irrigation water, are dircet responses to avoid the effects of escalating relative scarcity of water resources on future economic development and people's welfare.

III-A.2. Indicators of Managing Land Resources:

The sturcture of land use and its changes over time exert significant repercussions not only on the productivity of this vital economic resource and all of its relevant employment opportunities, but also on the evnironmental quality (soil, water, air, wild life, etc.). Conversion of more lands to agricultural and urbanization uses is likely to have far-reaching implications and stress on environmental quality as well as on human health.

The proportional change in each category of land exploitation (cropland, forest, protected areas, etc.) over time extrapolates the type of pressure exercised on the land resources and, hence, it acts as a "driving force" indicator that ought to be closely observed. On the other hand, the **percentage share of each category of land use** indicates the "state" of land distribution among these uses at a certain period. Those two indicators by themsleves do not identify the causes leading to changes in the land use and its effect on future economic development in the country.

However, their significance could be enhanced if they were accompanied by other indicators, such **as urbanization growth rates over time** - which is another "driving force indicator" - and **changes in land quality** (state indicator) such as soil erosion, soil salinization, etc. Unfortunately, information on the last indicator is not readily accessible in serveral of the concerned countries.

Since **Cropland** is the most vital use of land resources in the MENA region, we concentrate on analyzing its "driving force" and "state" indicators. Other indicators related to land uses such a forests and woodland are of much less significance in most of the countries in the MENA region. So we do not miss much if we escape studying the pressure on these resources in the region. Studying the data on the "state indicators" summarized in the table (2) below, namely; the **% of cropland in total land use** and the **cropland per capita**, shows the following facts:

- Cropland occupies a very small percentage of total land area - compared to the world's average - in all selected countries but Lebanon, Tunisia and Morocco.
- The individual's share of cropland area in some countries such as Egypt, Jordan, Lebanon, Yemen, and most of the GCC states is very small relative to the world's average as well as to the rest of the countries of the region.

These two measures indicate the existing need for developing more land for agricultural uses in many of the MENA countries:

1 - first to ease the pressure on the existing cropland, and

2 - second to face the increasing demand for food products driven by the continuous population growth.

The **percentage change in cropland** demonstrates - as a "driving force" indicator - that cropland has been growing at various degrees - during the period of (1982 - 1995) - in all of the selected countries except for Tunisia. Of course, the growth in most of the GCC countries was tremendous relative to the rest of the countries in the region and relative to the whole world as well. This could be explained by the surge in the general level of economic development

Table (2)
*"Pressure" and "State" Indicators Related to Cropland**

Country	% of total land in (1995)	Hectare per capita (1994)	% Change over (1982 - 95)		Country	% of total land in (1995)	Hectare per capita (1994)	% Change over (1982 - 95)
Algeria	3	0.29	9		Oman	0.30	0.03	44
Egypt	3	0.05	27		Qatar	0.60		133
Iraq	12.5	0.29	2		Saudi Arabia	2.00	0.21	68
Jordan	4	0.08	17		Sudan	5.50	0.50	4
Kuwait	0.3	0.00	114		Syria	32.0	0.43	5
Lebanon	30	0.10	3		Tunisia	31.0	0.55	-0.1
Libya	1.2	0.42	3		UAE	1.00	0.04	148
Morocco	21	0.36	14		Yemen	3.00	0.11	4
World	**11.1**	**0.22**			**MENA**	**9.40**	**0.23**	

(*) Estimates are calculated depending on data taken from (World Bank, 1998-99) and (FAO, 1994)

efforts in the GCC region since the mid 1970s. Though the growth of cropland area is - by itself - a positive economic development indicator, it is still considered an environmental pressure indicator, since it augments the strains on the water resources required for cultivating that land. Hence, it is a driving force for manipulating future actions to mitigate such pressures.

Information on **investments in land reform, percentage of reformed land to total cropland area, expenditures on research of securing additional sources of water for cultivation as well as for increasing cropland's productivity**, etc. are needed as "response indicators" of managing land resources.

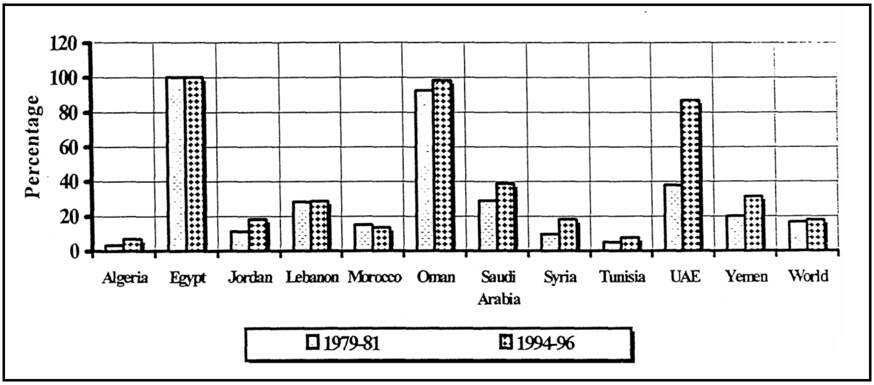
III-B. Indicators for Achieving Sustainable Agriculture:

It became almost certain - throughout the world - that expansion of irrigated lands, the increased use of chemical fertilizers and pesticides, as well as the use of improved seed stock, have enabled land already under cultivation to be farmed much more intensively. However, persistence of current production practices in the agricultural sector in many of the developing countries could degrade the agricultural land through soil erosion, loss of natural soil fertility, loss of genetic variability in crops, depletion and contamination of water resources (World Resource Institute, 1998). Some of the environmental indicators that could be manipulated to detect changes that may threaten the sustainability of agricultural growth in MENA are presented in this section.

III-B-1. Indicators Related to Irrigation Intensification:

The **share of irrigated land in the total cropland area** of a country is a "state indicator" that portrays the actual distribution of cropland according to the watering system. Figure (1) exhibits the estimates of this indictor in selected MENA countries during two periods of time (1979-81) and (1994-96). It is obvious that the reliance on irrigation has increased in the region throughout the investigated period. On average, the relative share of irrigated land in total cropland area has grown from 32% at the beginning of the last decade to about 41% in the mid 1990s. This average is more than double of the world's average (18%). In some countries such as Egypt, Oman and UAE, the reliance on irrigation is almost complete. This indicates that expansion of agricultral production in those countries would be very much restricted in the future by the availability of water for irrigation and the developments in cropland area.

Figure (1): Irrigated Land as a % of Total Cropland in Selected MENA Countries



The percentage change in the proportion of total arable land that has been depending on irrigation for over ten years is a "driving force" indicator. It shows the relative significance of irrigation as an essential factor of production that is hard to substitute, and meanwhile, as a large consumer of the country's fresh water resources. The estimates of this "pressure indicator" are presented in table (3). These estimates demonstrate that - in eleven out of the fifteen selected MENA countries - irrigated area was rising over time at a much higher rate than other states in the region have increased their irrigated lands by more than 50%. Knowing the problem of freshwater scarcity in the region and recalling that agriculture is the biggest consumer of freshwater, explicate the dilemma confornting the region's capacity to increase its basic food supply to staisfy the needs of the steadily growing population in the imminent future.

Table (3)
Percentage Change in the Share of Irrigated Land in Total Cropland Area During (1981 - 1996)*

Country	% change	Country	% change
Algeria	103	Suadi Arabia	34
Egypt	21	Sudan	7
Iraq	52	Syria	89
Jordan	64	Tunisia	47
Kuwait	60	UAE	132
Lebanon	1	Yemen	56
Libya	120	World	12
Morocco	-1	MENA	53
Oman	5		

(*) Estimates are calculated depending on data taken from (World Bank, 1998-99) and (FAO, 1994).

III-B-2. Indicators of the Intensity of Using Fertilizers:

The extensive use of fertilizers to enhance cropland productivity and increase production can also give rise to undesirable environmental side-effects (contamination of groundwater and surface-water sources, soil acidification, hazards to human health, etc.). Such environmental stress could be emphasized by a number of driving force indicators such as:

1 - The **average annual use of commercial fertilizers per hectare of cropland** (kilogram per hectare).

2 - The **index of fertilizers' use per hectare** at a certain year compared to base year.

3 - The **percentage change in fertilizers' employment per hectare** over a period of time.

However, certain constraints may still hinder the use of these pressure indicators, such as:

- There exists no optimal measure of fertilizers' use per hectare of cropland to be handled as a yard-stick in assessing the actural levels of fertilizers' application in any country, or at any time period.
- Those measures do not take into account the differecnes in the quality of soil and, hence, the soil's need for fertilizers.

The figures presented in table (4) profile those three "driving force indicators". We chose the year 1977 as a base year for calculating the index of fertilizers' use, for two reasons:

1 - The year 1977 symbolizes a year of normal economic performance in most of the countries under investigation.
2 - Several of the GCC nations have started - by this year - to take serious actions and forward steps to develop parts of their land for food production.

All three indicators disclose the tremendous growth in the use of fertilizers during the decade of the 1980s in all selected MENA countries. They signal the culminating dangerous pressure imposed by the growth of fertilizers' application on the quality of water resources as well as on human health. As revealed by the estimates of the first indicator, Egypt came on top of all selected MENA countries as the most intensive user of fertilizers during that decade. The rate of fertilizers' application per unit of land in Egypt has exceeded not only the world's average but also the rate of use in the G7 countries, during that period.

This trend has started to change its direction during the 1990s in several of the selected MENA countries, though it continued its upward path in some other countries such as UAE, Oman and Syria.

The second and third "pressure indicators" expose the profound growth in the use of chemical fertilizers in the MENA region during the past two decades. The index of fertilizers' use displayed in table (4) together with figure (2), extrapolate a strong growth in the general trend of using fertilizers in the MENA region relative to the rest of the world since the second half of the 1970s, particularly in the GCC states. That index has reached its peak by late 1980s and started to switch downward during the first half of the 1990s.

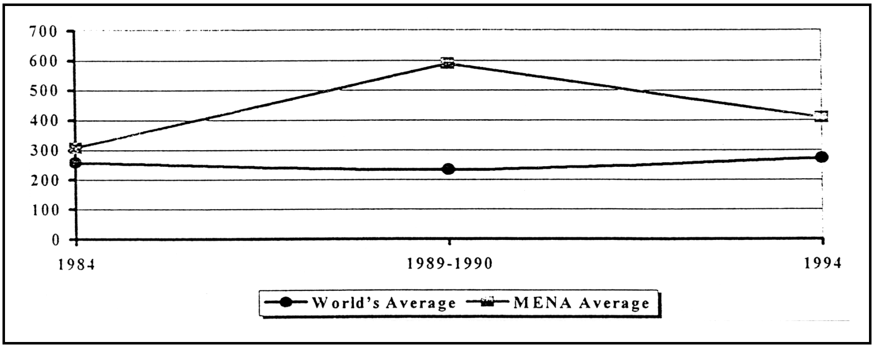
Table (4)
Driving force Indicators Related to the Use of Fertilizers*

Country	Kg/hectare of cropland in			Index of use (1977=100) in			% Change since (1970) in		
	1984	**1989-90**	**1994**	**1984**	**1989-90**	**1994**	**1984**	**1989-90**	**1994**
Egypt	341	404	264	237	281	184	160	208	101
Saudi Arabia	108	401		900	3,342		2,060	7,920	
UAE	118	162	432	270	370	987	140	230	780
Oman	20	111	159	161	893	1,279	140	1,233	1,809
Lebanon	170		114	331		222	26		-16
Jordan	43	77	35	221	396	180	378	756	289
Syria	39	45	59	282	325	426	457	543	743
Libya	48	37	32	339	261	226	700	517	434
Morocco	32	34	32	247	262	246	6	13	6
Algeria	27	28	15	225	233	125	69	75	-6
Tunisia	17	23	18	228	309	242	113	188	125
Sudan	3	4	4	225	300	300	0	33	33
World's Average	**107**	**97**	**113**	**257**	**233**	**271**	**118**	**98**	**131**
MENA Average	**81**	**118**	**105**	**306**	**588**	**402**			
G7 Average	**303**	**229**	**264**						

(*) Estimates are derived from data of (World Bank, 1995) for the year 1990, and from (World Resources Institute, 1998) for the years 1984 and 1994.

The country's **average use of fertilizers relative to the world's average** and **relative to the use in the G7 group** are two "state indicators". They clarify the actual status of each MENA country relative to the rest of the world on one hand, and the G7 group of developed countries on the other hand.

Figure (2): Index of Fertilizers Employment in MENA and the World (1977=100)



Three significant observations could be conferred by examining the figures (3-A) and (3-B):

1 - Egypt, the selected GCC countries, and Lebanon applied higher rates of commercial fertilizers than the world's average and the rest of the MENA countries during the period of investigation.

2 - While the selected countries in the MENA region - combined - have been utilizing - on average - less than one half of fertilizers' application in the G7 group, only Egypt, Saudi Arabia, and lately UAE have applied higher rates than the average fertilizers' use in the G7 group.

3 - While the trend of using fertilizers in Egypt and some other MENA countries has started to move downward during the first half of 1990s, it is escalating in many of the GCC countries.

III-B-3. A "Proposed Index for the Intensity of Using Fertilizers" (IIF):

In order to assess the enormity of fertilizers' employment in MENA, it might be easier to rely on one index instead of a number of pressure indicators. The index may also help to overcome some of the limitations attached to the aforementioned indicators. The **proposed index measures the ratio of the percentage change in fertilizers' application in a certian country to the percentage**

change in its food production with respect to a chosen base year. In other words. **It is the reciprocal of the elasticity of food production with respect to fertilizers' employment**. So, if we let (F) denote the amount of used fertilizers and (Q) denote the amount of food production, the suggested index could be expressed as:

$$\mathbf{IIF = \{(\delta F/\delta Q)\ .\ (Q/F)\}}$$

Figure (3-A): Use of Fertilizers in MENA Countries Relative to the World's Average Use (1984-1994)

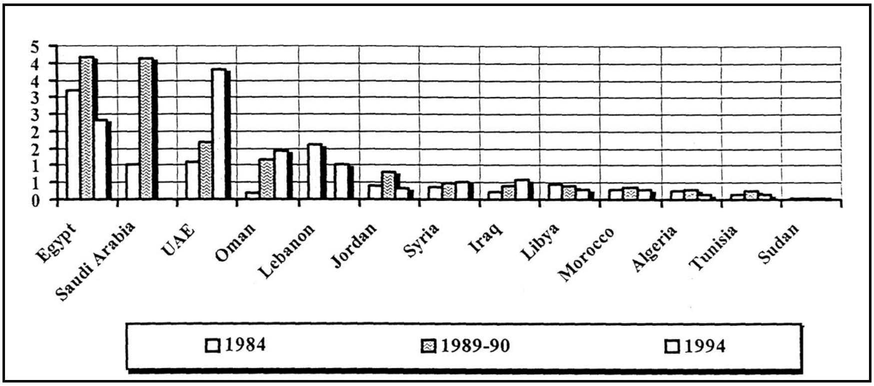
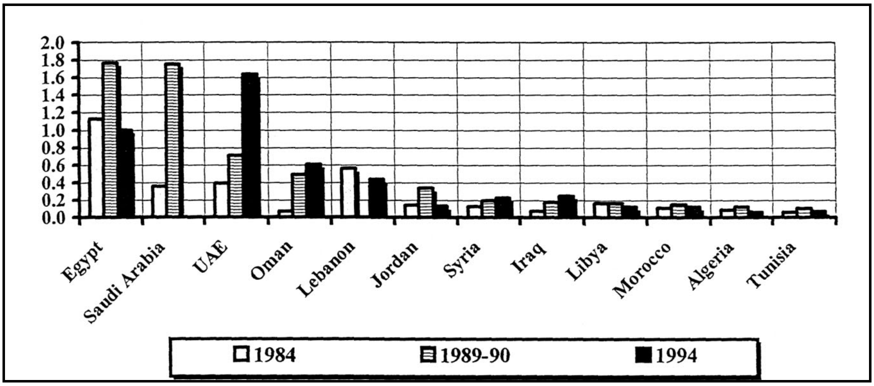


Figure (3-B): Use of Fertilizes in MENA Countries Relative to the Average Use in the G7 Countries (1984-1994)



Knowing tat ($\delta F/\delta Q$) is the reciprocal of the marginal productivity of fertilizers (MPF) as an input of agricultral production, and that (Q/F) is its average product (APF), the above expression could be rewritten as:

$$\boxed{\textbf{IIF} = \{(\textbf{APF})/(\textbf{MPF})\}}$$

Accordingly, whenever this quotient gets smaller than "unity" and closer to zero, it could be interpreted - other factors remaining constant - as a surpassing efficiency level of fertilizers' application. Similarly, as the value of this index gets higher and away from unity, it indicates diminishing marginal productivity of fertilizers and, probably, over expansion in its application. The index could take negative values in either of two cases:

1 - When the actual use of fertilizers at the period of concern had declined relative to the base year, while the food production continued to grow. In such a case, other factors could have been altered during that period to bring about such a change. For instance, an improvement in the state of technology affecting productivity (new improved seeds, modified types of fertilizers, revised cultivation techniques, etc.), or enhanced capital investment in the agricultural sector, or providing adequate education and training to farmers, or others.

2 - When the production level has declined - for any cause - with respect to the base year.

According to limitations on the data availability we were able to estimate this proposed index for some selected MENA countries for three periods of time, as shown in table (5). For the first two periods; namely (1983-95) and (1989-1990), we calculated the index of agricultural production taking (1977 - 1979) as the base year. Then we estimated the (IIF) index for the longer period (1984-1994) to contain the effects of changes in the trends of fertilizers' application in some of those countries.

Table (5)
Intensity Index of Fertilizers' Use (IIF)
in Some Selected MENA Countries (1983-1994)

Country	1983-1985 (1977-79=100)	1989-1990 (1977-79=100)	1984-1994 (1989-91=100)
Algeria	1.6	0.7	-1.2
Egypt	3.5	1.7	-0.57
Libya	0.9	1.2	
Morocco	2.4	0.8	
Tunisia	2.9	2.5	0.27
Iraq	2.4	4.2	
Jordan	2.3	2.9	-0.26
Lebanon	0.2	-0.3	-0.46
Saudi Arabia	14.3	6.3	-0.21
Syria	6.8	7.4	1.79
World' Average			**0.27**

Examining the estimated figures of table (5) verifies a change in the pattern of fertilizers' use throughout the period of 1984-94 in several of the selected MENA countries, specifically in the North African countries (except Libya). At The beginning of the period, fertilizers' use could have been generally described as "very intensive" expecially in countries such as Saudi Arabia, Syria and - to a less extent - Iraq, Egypt, and Jordan. This indicates that the marginal productivity of applied fertilizers have diminished in these countries to hit very low levels. In cases of Saudi Arabia and Syria, we can deduce that the use of fertilizers had dramatically over-grown the increase in the food production during the 1980s. Greater awareness of the various negative environmental effects on the soil quality, water quality and human health have helped to rationalize the use of fertilizers in agriculture and reduce the estimates of that index to approach zero or even acquire negative values in many of the selected countries.

Other "driving force" and "state indicators" could be suggested such as: the amount of pesticides used per unit of land (pressure indicator), the percentage of land affected by salinity (state indicator), and the yield per unit of corpland (state indicator). Government's expenditure on programs for training and educating farmers, amount of spending on research activities to improve land productivity, investment outlays for improving drainage systems and treatment of irrigation water, could be good examples of the "response indicators" for achieving sustainable agricultural development in the MENA region.

III-C. Indicators for the Atmospheric Change:

Developing procedures, indicators, and tools to monitor, stabilize, and protect the earth's atmosphere and lower the concentration of gases proven to be harmful to both human health and sustainability of various economic activities, have become prominent subjects in many fields of research; scientific as well as economic. It is a topic of main concern for policy makers at national and international levels (World Bank, 1992), (Erhum, 1992), (Tisdell, 1994), (Koechlin & Muller, 1992), (Dean & Hoeller, 1992), (Murley, 1995) and (WHO&UNDP, 1992). The international studies utilize rates of emission of Carbon Dioxide (CO_2), Green House Gases (GHGs), Sulfur Oxides (SO_x), Nitrogen Oxides (No_x) and the consumption of Ozon depleting substances, as the main "driving force indicators" for the climate change and air pollution (UN, 1996-a). The (OECD) publishes such indicators for the OECD countries (OECD, 1992), While others (Bakkes et. al., 1994) have included additional indicators on their list. Similar indicators should be developed for the MENA region and its individual countries.

III-C-1. What is the Economic Significance of Developing the Use of Atmospheric Change Indicators?

Developing and estimating such indicators is getting necessary for a number of reasons, such as the following:

1 - They are manipulated as defensive - or offensive - tools in evaluating the country's contribution to the concentration of those gases in the atmosphere. Accordingly, such measures are

usually used in the international debates on the expected roles of various countries in protecting the global environment. The outcomes of those debates usually have different long-term economic repercussions on the national grounds. Banning or limiting the production of certain commodities, providing for excessive human and capital investments in new clean production technologies, are examples of such national impacts.

2 - They are utilized in shaping the economic/environmental international agreements, such as those related to trading international pollution permits.
    They are also used as arguments for setting trade barriers as well as economic sanction on countries that do not abide by the international environmental and emission agreements.

3 - On the national level, the analysis of such indicators would, normally, facilitate several tasks for the economic decision makers, such as:
    a - Assessing and choosing among alternative uses of certain resources.
    b - Evaluating the economic rates of return on new investment projects.
    c - Appraising the various effects of atmospheric changes on the productivity of the agricultural sector and human health.
    d - Appraising the cost of dealing with potential risks such as droughts, conceivable rise in the sea level, the possible river flooding in vulnerable areas, the socio-economic cost of relocating people and industries to safer areas, etc.
    e - Selecting the best economic instruments for reducing pollution and anticipated environmental risks to preconceived levels.
    f - Allocating tradable pollution permits among different agents.
    g - Assessing the effectiveness of governmental expenditures to curtail environmental pollution.

4 - Those indicators could be employed in determining the future course of actions and the economic policies that support the country's human capital and advocate the strategies for achieving sustainable economic development.

The list of atmospheric change indicators is long, however, in our attempt to develop similar indicators for the MENA region, we will focus only on the indicators of the (CO_2) emissions.

III-C-2. The Significance of (CO_2) Emissions in Atmospheric Change:

Man-made (CO_2) emissions are closely related to fossil fuels (coal, oil, and natural gas) and vegetal fuels combustion. It is considered the most influential Green-House gas*(3). It is responsible for about 60% of the GHGs' concentration effect on the "global warming" that took place since the preindustrial era with its potential drawbacks on the climate, the sea level, and the world's agricultural production (OECD, 1991) and (World Resources Institute, 1995). This explains why **(CO_2) emission is used, sometimes, as a proxy indicator for all GHGs' emission** (Bakkes et al., 1994). In the MENA region, (CO_2) accounted for more than 77% of the GHGs' emission in 1991. The anticipated results of massive levels of carbon emissions in the entire world motivated 154 countries to set up an international system for the governments in order to report on the annual changes in carbon emission (Laster, 1993) and (Turner & Pearce, 1994).

III-C-3. The "State" of (CO_2) Emissions in the MENA Region:

The gas concentration in the air is a "state" indicator of the changing composition of the atmosphere and its potential global warming effect. Total (CO_2) emissions in the MENA region accounted for about 4% of the world's emissions in 1995. The (CO_2) emissions, which have doubled in the MENA region in the six years period elapsing between 1989 and 1995, still do not exceed 15% of the USA's emission rate in 1995, and 75% of Japan's (CO_2) emissions in the same year.

Table (6) exhibits the escalation in (CO_2) emissions from fossil fuels burning and cement production in the various MENA countries between 1970 and 1995, along with the world's and the G7's average emissions during that period. Examining the estimates presented in the table shows the following facts:

- Almost all countries in the region have experienced a continuous rise in the level of (CO_2) emissions since the year 1970. The population and economic growth in the region as well as the unprecedented rise in the oil and natural gas production, justify that upward trend.
- Saudi Arabia is the biggest (CO_2) emitter in the region, followed by countries such as Egypt, Iraq, Algeria, and the UAE. The big volume of oil produciton in those countries - except Egypt - partly explains this fact.
- The significant increase in (CO_2) emissions between 1989 and 1995 in countries such as Iraq, Algeria and Syria is hard to justify by economic reasons. Inadequate production technologies as well as absence or inefficient application of environmental protection measures could be satisfactory explanations.

Table (6)
(CO_2) Emissions in the MENA Region (1970-95)
(Million metric tons)

Country	1970**	1980	1989	1991	1995	% Change	
						1991-95	1980-89
Algeria	4.1	36.2	46.5	55.2	91.3	65	28
Egypt	5.8	45.1	79.5	81.7	91.7	12	76
Libya	8.8	26.9	37.8	43.0	39.4	-8	41
Morocco	1.9	16.0	22.1	24.2	29.3	21	38
Sudan	1.3	3.3	3.3	3.4	3.5	3	0
Tunisia	1.0	9.5	13.9	14.8	15.3	3	46
Bahrain	0.3	6.6		10.1			
Iraq	6.4	44.0		68.9	99.0	44	
Jordan	0.4	4.7	9.4	10.0	13.3	33	100
Kuwait	7.0	24.7	31.1	11.8	48.7	312	26

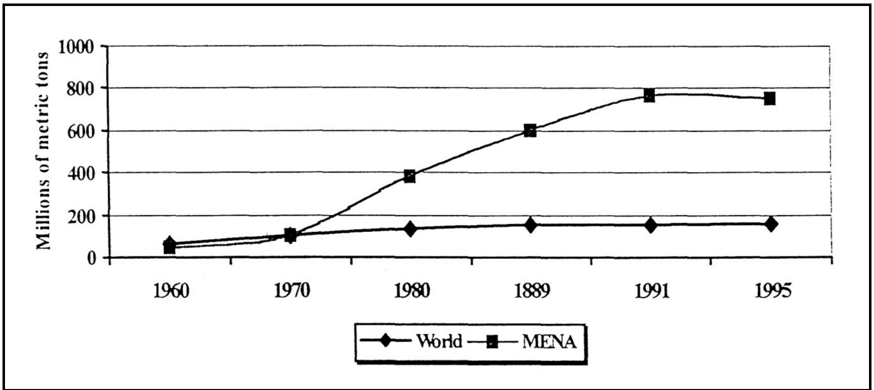
Table (6) cont'd

Country	1970**	1980	1989	1991	1995	% Change	
						1991-95	1980-89
Lebanon	1.1	6.2	8.7	8.4	13.3	58	40
Oman	0.1	5.9	10.3	11.7	11.4	-3	74
Qatar	2.1	12.9		13.1			
Saudi Arabia	9.8	130.8	173.8	214.9	254.3	18	32
Syria	1.7	19.3	28.2	29.8	46.0	54	46
UAE	4.2	36.3	50.9	59.5	68.3	15	40
Yemen	0.7	3.3	3.5	9.9	14.4	46	6
MENA	**56.7**	**431.7**	**519.0**	**670.4**	**839.2**		
World	**3,854.5**	**18,610.1**	**21,863.1**	**22,672.8**	**22,714.6**	**0**	**17**
The G7	**2,103.4**	**8,500.1**		**8,720.3**	**9,158.4**		

(*) Estimates rely on data from various issues (World Resources Institute, 1992, 1995, and 1998).
(**) Calculated form data in (UN, 1994)

Figure (4) confirms the sharp rise in the index of (CO_2) emissions in the MENA region - relative to the rest of the world - taking the emission levels of 1970 as a base for comparison.

Figure (4): Index of (CO_2) Emission in MENA & the World (1970=100)



III-C-4. "Pressure Indicators" of (CO_2) Emissions:

Two of the well-established "driving force" indicators that measure the relative intensity of the (CO_2) emissions could be estimated for selected MENA countries. These indicators would be the **(CO_2) emission per capita** and the **emission per unit of GDP evaluated in constant US Dollars**. The first indicator measures the individual's share in its country's (CO_2) emissions. The second indicator exhibits the share of each domestically produced unit of goods and services in the country's total emissions of the (CO_2), e.g., metric ton of emission per every 1000 US dollars of the country's GDP evaluated at the prices of 1990.

The estimates of these two "pressure indicators" are presented in Talbe (7).

Table (7)
Pressure Indicators for (CO_2) Emissions in MENA*

Country	Metric ton per capita					Metric ton per 1000 US $ in 1990 prices				
	1970	1980	1989	1995	% change (1991-95)	1970	1980	1989	1995	% change (1991-95)
Algeria	1.1	1.9	1.9	3.3	53	0.27	0.54	0.84	2.64	97
Egypt	0.6	1.1	1.5	1.5	-3	0.26	1.29	1.17	2.32	-10
Libya		9.7	8.7	7.3	-20	0.68	0.48	1.16	2.16	116
Morocco	0.5	0.8	0.9	1.1	16	0.15	0.54	0.93	1.08	18
Sudan	0.3	0.2	0.2	0.1	-33	0.18	0.21	0.29	0.70	213
Tunisia	0.7	1.5	1.8	1.7	-6	0.21	0.69	1.33	1.02	-14
Bahrain	4.1	19.4	25.9				1.36	2.50		
Iraq	2.5	3.3		4.5	15	0.55	0.52		2.45	112
Jordan	0.6	1.6	2.4	2.5	3	0.21	0.77	2.02	2.61	4
Kuwait	34.4	18.0	15.8	28.8	88	0.76	2.64	1.31	1.43	180
Lebanon	1.6	2.3	3.3	4.4	32			4.50	1.43	-72
Oman	0.4	6.0	7.1	5.2	-30	0.07	0.13	1.18	1.13	-6
Qatar	68.7	56.1	28.9			2.36	1.04	1.97		

Table (7) cont'd

Country	Metric ton per capita					Metric ton per 1000 US $ in 1990 prices				
	1970	1980	1989	1995	% change (1991-95)	1970	1980	1989	1995	% change (1991-95)
Saudi Arabia	5.8	14.0	12.8	13.9	0	0.79	0.56	2.19	2.43	27
Syria	1.0	2.2	2.3	3.2	39	0.29	0.94	1.45	3.49	204
UAE	66.2	35.9	32.9	30.9	-15		0.78	1.89	2.10	14
Yemen	0.4	0.4	0.4	1.0	23	0.78	0.75	1.02	3.61	177

(*) Estimates are calculated from data taken from the following references: (UN, 1994), (IMF, 1994), (IMF, 1996), (IMF, 1998), (World Resources Institute, 1988), and (World Resources Institute, 1998).

Analyzing these estimates reveals that:

- The **per capita (CO_2) emission** indicator puts the UAE, Qatar, Bahrain and Kuwait ahead of not only the rest of the MENA countries but also the G7 countries individually and collectively. The relatively small size of population and the high level of oil production in these countries justify this.
- The second "pressure indicator" of **(CO_2) emission per unit of real GDP** alters the above ranking picture of (CO_2) emitters. It moves the position of countries such as Lebanon, Syria, Jordan, Yemen and Egypt to the top of the list of emitters. The relatively small size of the real GDP of these countries partially explains its high ranking on the list of (CO_2) emitters. Actually, according to this "driving force indicator", the whole MENA region emits more than three times as much as the G7 group emits per unit of real GDP.

III-C-5. Introducing a New "Pressure Indicator" for (CO_2) Emissions:

Adding the **(CO_2) emissions per hectare of total land area** as a "pressure indicator" - not used in the usual studies related to the developed world - alters the ranking of (CO_2) emitters once more.

Since small as well as vast countries share the global atmosphere, this suggested indicator could reveal a chart of emission pressures that differ from those exposed by the aforementioned pressure indicators. In other words, the size of the country - measured by its land area rather than its population or GDP - could modify its placement on the list of the atmospheric polluters, and hence, it may improve its bargaining power in the future international controversy and settlements.

As depicted from talbe (8), countries such as Kuwait, Lebanon, UAE and most probably Bahrain, jump up to the top of the list, whereas large emitters but relatively wide countries such as Algeria, Libya and Sudan stay at the bottom of the list.

Table (8)
(CO_2) Emissions Per Unit of Total Land Area

Country	Metric ton per hectare			% change (1991-95)
	1970	1980	1995	
Algeria	0.02	0.15	0.38	65
Egypt	0.06	0.45	0.92	12
Libya	0.05	0.15	0.22	-8
Morocco	0.04	0.36	0.66	21
Sudan	0.01	0.01	0.02	8
Tunisia	0.06	0.61	0.99	3
bahrain	4.84			
Iraq	0.15	1.01	2.28	
Jordan	0.04	0.48	1.37	33
Kuwait	3.93	13.86	27.33	56
Lebanon	1.08	6.06	13.00	59
Oman		0.28	0.54	-2
Qatar	1.91	11.73		
Saudi Arabia	0.05	0.61	1.18	18
Syria	0.09	1.05	2.50	55
UAE	0.50	4.34	8.17	15
Yemen	0.01	0.06	0.27	45

III-C-6. What type of "Response Indicators" should we look for?

A number of measures could be used as useful "response indicators":

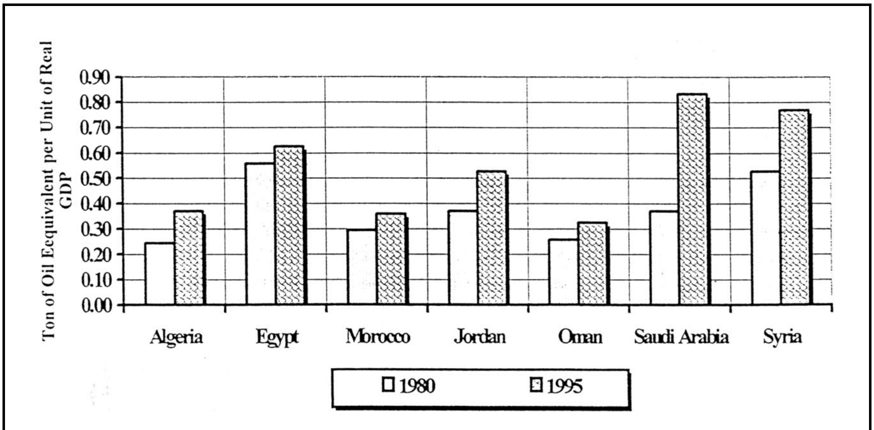
1 - **Investments in air pollution control and abatement facilities per unit of output** in the manufacturing and transport sectors of the economy.

2 - **Expenditure on new technologies** that are needed to improve efficiency levels of energy utilization in these sectors.

3 - **Changes in energy intensity** (energy use per unit of real GDP) over time.

Manipulating available data helps us to portrait that third "response indicator" for selected countries in the MENA region in figure (5). In fact in none of the selected countries has energy intensity improved over the period 1980-1995. The energy use per unit of real GDP has increased in all countries. The rate of increase was more than 100% in Saudi Arabia and close to 50% in a non-oil producing country like Syria. Such results show the need for adopting more serious actions and measures to curb the continuous expansion in the levels of (CO_2) emissions to protect the surrounding atmosphere and avoid its negative long-run effects on human health, productive resources, and national heritage as well.

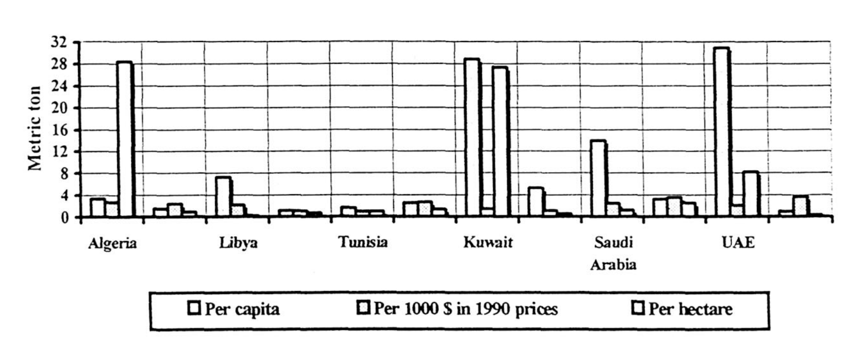
Figure (5): Energy Use Per Unit of Real GDP (1987=100)



III-C-7. Shortcomings of the Existing "Pressure Indicators":

The "per capita" and the "per unit of real GDP" are economic measures applied to environmental aspects. These measures are frequently used in comparing and ranking various countries according to different themes of environmental performance. However, as we noted earlier, these measures could sometimes give prejudiced classification of some countries regarding their environmental status. The verification is displayed in figure (6).

Figure (6): Pressure Indicators of (CO_2) Emissions in 1995 in Selected MENA Countries



Gererally, the "per capita" measure would favor countries with large population such as many of the developing countries (DCs). Whereas, the "per unit of real GDP" indicator would normally ease the international pressure on the well developed and/or rich economies, which are usually big emitters of GHGs but enjoy relatively high levels of GDP, stable exchange rates, moderate levels of inflation, and somewhat steady long-run economic growth path. The large size of real GDP in those economies underestimates their ranking position - compared to the DCs - as major emitters of GHGs.

The "per unit of total land area" indicator is not biased towards any of those two groups of countries, because it does not rely on the economic status of the country or the size of its population. Nonetheless, it would often draw a much auspicious portrait for the land abundant countries where population density becomes humble, such as in Algeria, Libya and Saudi Arabia.

III-C.8. Forming an "Index" of GHGs Emission as a Solution for the Bias Problem:

Keeping in mind the aforementioned shortcomings, conducting international comparative analysis of the GHGs emissions should not be judged by a single indicator, especially when a wide gap in the economic condition persists among the economies subject to comparison. Since each pressure indicator has its source of bias, an "index" of the three measures combined might be an impartial compact tool for evaluating the country's contribution in raising the pressures on the atmosphere.

The immediate question that arises now is about the procedure of forming that suggested index. **A qualified index should be a weighted average of those three indicators**. Nevertheless, assigning the appropriate weight to each of those measures is not a matter of educated guesses. Rather, assigning such weights should be the outcome of empirical studies and/or international intellectual discussions. On the practical grounds, a number of non-economic variables are expected to influence the appraisal course.

IV - Concluding Remarks:

We attempted to apply some of the internationally established environmental indicators to the Arab countries of the MENA Region. We also constructed additional measures to be used as environmental "pressure indicators and indices" to bestow a new analytical dimension to the international comparative analysis.

Our investigation reveals a chronic shortage in the availability of accurate published data and information required to formulate the "driving force", "state" and "response" indicators. The lack of available reliable-comparable data limited the number of indicators that could be developed for the various contries in the region. Data related to "response" indicators is almost absent. So, in many cases, we had only to suggest the appropriate types of "response" indicators that we should be looking for. Additional efforts are needed to correct for this sort of deficiency. **We believe that such efforts would be more successful if they were organized, directed, and supervised by one main accredited regional body**.

The focus of the study is directed to three main categories of the economic renewable natural resources (water, land and the atmosphere) which impose great influence on the future sustainability of economic development. Hence, Our attention was directed to construct and analyse the environmental - economic indicators that are related to three different, however correlated, aspects of great significance to sustainable economic development in the MENA region, namely; managing water and land resources, promoting sustainable agriculture, and stabilizing the state of the atmosphere.

Our prolonged analysis delineated a number of facts:

1 - Sustaining the per capita supply of fresh water resources resembled a fast moving challenge that faces several of the MENA countries. In the selected MENA countries, the individual's share of renewable water ersources did not exceed 11% of the comparable figure for the whole world in 1996. The "pressure indicators" show that the scarce water resources in the region are over-consumed by the agricultural sector and the continuous growth of irrigated land. Delays in responding and implementing serious actions to rationalize the existing patterns of water consumption, could spell out its negative consequences not only on future food production in those vulnerable countries, but also on the general process of the economic development and its sustainability.

2 - Tremendous growth in the use of fertilizers in seven of the MENA countries signals a culminating environmental pressure on the human's health, on one hand, and on the land's natural fertility and quality, on the other hand.

3 - The linkage among several of the "pressure" and "state" indicators is obvious in the fields related to managing water resources, land resources and agricultural production.

4 - All measures affirm the relative rise of (CO_2) emissions in most countries of the region and the weakness of the "response" measures taken to control that path.

5 - Evaluating the status of any country relative to others regarding its contribution to atmospheric pollution is very much influenced by the type of indicator used in the assessment. The "emission per capita" indicator favors the heavily populated nations, whereas the "emission per unit of real GDP pressure" indicator is biased towards the rich and/or well-developed countries. Unlike these two common indicators, the suggested driving force indictor, "emission per unit of land area", is neither affected by the size of the country's population nor influenced by the level of its real GDP. Nonetheless. this propsed indicator - like others - still carries its own sort of bias, where it usually favors countries that are relatively abundant in land endowments.

6 - A proposed "weighted index" overcomes - or at least moderates - the effect of such biases on the country's relative position when compared with other GHGs emitting nations in the region or in the world. However, the right mathematical formula for assigning the proper weights to the different individual indicators used in calculating that index has - still - to be developed.

Notes

(1) Both of Iran and Israel are not included in the study.

(2) On reviewing different sources of data for renewable water resources in the MENA countries, we found a big discrepancy in the estimates among the different sources such as (Hirzalla, 1996), (Saad, 1995) and (World Resources, 1995).

(3) The sack of Green-House Gases (GHGs) include in addition to (CO_2), methane (the second most important gas), cholofluorocarbons, nitrous oxide and other gases. Those gases are by-products of basic human activities such as combustion of fossil fuel resources, changes in land use practices and deforestation. Therefore, their emission levels are estimated by using information on the activities that cause them.

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