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SUSTAINABLE ENVIRONMENTAL DEVELOPMENT PRACTICES OF SOIL AND WATER RESOURCES IN KUWAIT

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PURPOSE

Environmental quality is largely a result of man's actions. The need for soil and water resources management is an inevitable requirement of an advanced society that enjoys high standard of living. The arid environment of Kuwait is therefore, the sum of all external conditions (climate, demand, and economy), and it strongly influences the development plans of the nation. Environmental degradation and potential human risks associated with severe climatic conditions cause a verity of direct effects on mankind. An effective strategy for managing environmental quality crises, outlined in this paper, is heavily dependent on an information bank that includes among others, the current status of the environment, changes and trends in environmental conditions, and how these changes affect to society. The compiled data has been used to demonstrate the effect of present practices. Results indicated that the long-term planning has not been developed to prevent, anticipate, and deal with these problems before they get out of control.

Environmental problems evolve from population growth and wasteful use of resources. Iraqi invasion to Kuwait has left behind ecological, environmental and oils lake pollution. It is concluded that, environmental problems are interconnected and are growing exponentially with time. Measures should be taken to ensure the sustainable development and environmental protection..

INTRODUCTION

Soil and water resources are important factors in ecosystem development studies. At a local level, there is a growing demand on water needed for various applications and uses in addition to soil reclamation for agricultural purposes. These resources are, therefore, of great interest to development planners, for it offers substantial potential for economic betterment and environmental quality. The increased demand for water and soil conservation for agriculture makes the search for more sustainable forms of soil and water an urgent task particularly in arid regions. In the current study, definitional practices of soil and water and their sustainability are reviewed and some guidelines are presented to enhance sustainability in relation to development practices. Ecotourism, land reclamation, soil treatment projects as well as water resources available for development require a recognition of the multiplicity of institutions related to above activities. The way in which they operate individually or interact should also be considered.

The growth of interest in sustainability (Al-Sayed et al,. 1999) become a guiding concept in the consideration of development strategies. Governments can influence sustainability by the imposing economic instruments. Economists view the economic approaches to pollution control as more efficient than regulatory approaches.

WATER RESOURCES OF KUWAIT

There are three water sources in Kuwait namely: groundwater, desalination and sewage treated water (STW). The later is mainly used for irrigation of green areas..

Groundwater: The main source of groundwater is from the productive sedimentary formation mainly composed of sandstone, limestone, dolomite and silty layers. The Dammam formation is the most known aquifer for its groundwater production and of medium salinity. It is the most important formation from the economic point of view due to its shallow depth, easy drilling and its range of water quality between 2000 to 6000 mg/l Total Dissolved Solids (TDS.

Desalination Water: Kuwait is considered to be a leading country in the field of sea water desalination. Kuwait and other Gulf States have gained their reputation from their 45 distillation stations whith half of them built in Saudi Arabia (Al-Migren, 1992). The annual production of sea distilled water is about 200 million gallon per year in Saudi Arabia, 250 million cubic meter per year in Kuwait and 340 million cubic meter per year in United Arab Emirates (UAE). Waters from the desalination station are mixed partially with the groundwater and then used for drinking and other domestic purposes. There are verities of water desalination techniques that have been adopted in the GCC countries. Among all the multi - stages spark evaporation is the most important and heavily used method in the area. On the other hand the reverse osmoses technique (RO) is accounted as the alternative technique and is used in Kuwait, Saudi Arabia and Bahrain. The serious groundwater exploitation has urged the governments in the different GCC Countries to construct the stations illustrated in Table (1). In order to reach the consumptive demand, these waters have been known to be the best both in quality and quantity for domestic uses.

Sewage Treated Water (STW): Due to the insufficient groundwater for irrigation and after the expansion and development of newly urbanised areas, the access water disposed by consumers in the residential areas have increased the need for sewage treatment stations in some GCC countries such as Saudi Arabia, Kuwait, UEA and Qatar. In Saudi Arabia for instance, the irrigation department in Al-Riyadh provides the farming areas outside Al-Riyadh with nearly 180 to 190 cubic. meters per day (cu.m/d) of STW waters (Table 2). In Kuwait and UAE on the other hand, the STW is used in small irrigation plots in the residential areas and to some extent in crop production as the case in Kuwait. . The public awareness for the domestic supply of water has always been under estimated due to the fact that the supply and demand for fresh water is subsidised. The total STW production in the GCC countries is provided in Table (3).

Table 1. The sea water desalination stations and the annual production in the GCC countries

Country	**No of Stations**	**Stations under construction**	**Annual Production ($mi.m^3$)**
Saudi Arabia	22	4	656.9
UAE	8	2	340.4
Kuwait	6	---	230.0
Qatar	2	---	85.0
Oman	1 +14*	---	31.2
Total	**42 +10**	**6**	**1413.5**

* 14 small stations

Source : (Al-Meqrin, 1992)

PRINCIPLES FOR SUSTAINABLE DEVELOPMENT

Existing principles for environmental protection provide the basis for the formulation of a sustainable development strategy. The environmental application of these principles could contribute significantly towards enhancing sustainability. These principles are:

- Protection and management of biodiversity
- Minimisation of the depletion of non-renewable resources
- Conservative use of renewable resources
- Demand management
- Pollution prevention at sources
- Implementation of the precautionary principles.

Hence, the concept of sustainable water resources is based on the concern that water uses should not negatively impact the environment and the culture of the host community, but rather contribute to improve the environmental quality, protection, increased investment, and better services. Ecotourism, land reclamation, soil treatment projects as well as water resources available for development, require a recognition of the multiplicity of institutions related to above activities and of the way in which they operate individually or interact. Governments can only influence sustainability by the imposition of economic instruments and measures.

Table 2. STW consumption in Al-Riyadh. The 1992 statistics.

Areas	Consumption m^3 .day	Irrigation Area Acre
DERAB	5700	2000
DARIYA	5300	800
AMARIYA	8000	1200
Total	**190000**	**4000**
AL-RIYADH	20000	washing
Grand.Total	**210000**	**---**

Table 3. STW production in the GCC countries used for irrigation. 1992. (X 1000 m^3 /year)

Country	Annual Production	Utilisation
UAE	62000	Irrigation
BAHRAIN	29200	Irrigation
SAUDI ARABIA	76650	Irrigation/Industry
OMAN	10220	Irrigation
QATAR	23000	Irrigation
KUWAIT	N.A	N.A

N.A data is not available for 1992.
Source : (Al-Meqrin, 1992)

FRESHWATER CONSUMPTION AND POPULATION GROWTH

From the rate of growing of population in Kuwait, a noticeable increase in the rate of water use (consumption) was due to the vast development and progress in the building construction, industrial and agriculture activities. This certainly inverses a progressive increase in consumption. The available data from the Ministry of Water and Electricity (MEW) and as reported by Al-Sayed (1998) shows that the population growing rate is between 500000 to 2500000 within the period (1972 - 1991) as indicated in Figure (1). This also indicates a progressive growth in the rate of water consumption due to the waste and loess. This increased consumption became a problem for the planners to overcome the large demand for water. Despite the fact that Kuwait is considered an arid region, the consumption rate is not equivalent to the available groundwater or desalination water. This is due to the unawareness of the citizens about water quality and quantity

The rate of consumption per capita is assumed to reach 300 liter/day (66 gallon /day) for drinking water as indicated by the incomplete statistics. The daily rate of water consumption per capita in the GCC has exceeded the 5 milion.cubic.meter, (mcu.m). The consumption from the agricultural and industrial sectors are in the range of 75% of the total consumption .

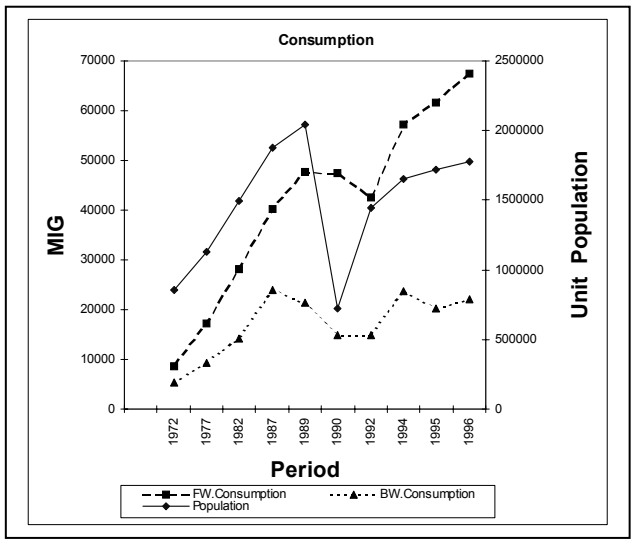

FIGURE 1. The water consumption and population increase in Kuwait (Units in thousands).

Consequently, this matter has urged the government in Kuwait to prepare a regional water use strategy to confront the future needs. The strategic plan also considered the emergency plan at least to ensure the basic needs of water. The cost of water production is an essential part of the water use strategic plan in Kuwait. This should be emphasized because the water resources are limited . Unlike other countries which depend on rivers and lakes, the desalination and groundwater are the main available resources beside the natural limited and low rainfall. Therefore, the automated water demand should be planned in order to meet the increasing water production and the expected high consumption for the period 2000 to 2050.

The cost of water production, however, is dependent on the water sources which requires certain operational such as: treatment , operation, maintenance, fuel, storage and distribution. In Kuwait for instance, the main problem is that the production and consumption are progressively increasing with the operational costs remained at fixed rate(800 fils / 1000 gallon) for very long time.

WATER TABLE RISE PROBLEM

The subsurface water rise and its impact (Fig. 2) are caused by a) local recharge from man-made sources such as a household, septic tanks, private garden irrigation, and leakage from sewerage and water distribution pipelines ; b) constraints to subsurface drainage due to natural and man-made causes; and c) the use of poor construction materials, improper construction practices, and the absence of basement insulation. Recommendations are provided for the implementation of preventive measures and long-term policies for protection of the critically affected buildings.

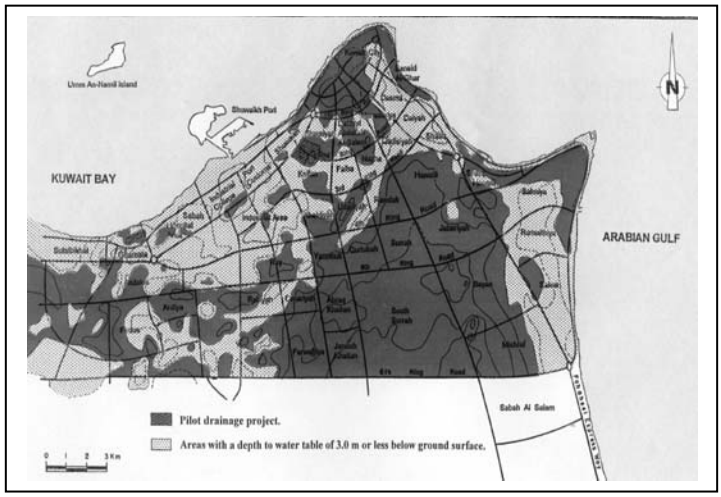

FIGURE 2. Map showing areas influenced by the water table rise problem in Kuwait City.

TOPOGRAPHY AND OIL LAKES

Topography of Kuwait is formed from a series of depressions which collects dust and water throughout the year. Bashara (1991) recognized that the topography helped the settlement of crude oil in a number of 250 depressions or (lakes) (Fig. 3). Oil lakes were then dried as part of an immediate economic plan to sell the crude oil. Therefore, a new soil type was emerged after the oil was removed. The implementation of active soil treatment process is needed to clean the various hydrocarbon contaminated soil. Further more, such soil accumulation is known to have potential hazard on the groundwater, aquifers, and the grazing animals in the desert (Al-Awadi, 1992).

CONTAMINATED SOIL TREATMENT

Al-Awadi, et al (1992) proposed a clean up method for the contaminated soil that accounts for total petroleum hydrocarbon, TPH, as a guideline range from 100 mg/kg to 10 mg/kg. However, the aromatic composition in the soil was given a specific guideline that follows the WHO standards. TPH determination was carried out by the calibration measurements of the total extractable matter, TEM (mg/kg), to a specific mixing concentration, where, different analytical approach were involved (Gas chromatography).

Al-Saad, et al (1993) has made a progressive efforts in combining the previous giudelines with the remmidiation process utilizing different bacteria to degrade the oil contaminated soil. An attempted was also made to monitor the benzene, toluene, ethylbenzene, and xyillenes, BTEX, and polycyclic aromatic hydrocarbon, PAH, concentrations to determine the risk levels and the degree of clean up for oil contaminated sites. The BTEX and PAH are known as the most toxic materials that influence environmental quality.

The experimental site south Al-Ahmadi (in great Burgan field) was used for agricultural purposes. The treated contaminated soil was used in sixteen plots each of 12 m^2 divided into two parts, the heavy and light hydrocarbon sites (Fig. 4). The contaminated soil was treated with 4.3 mg/g light PAHS and 17.5 mg/g of heavy PAHS. After 12 months the light PAHS decreased to 3.97 mg/g and the heavy PAHS decreased to about 8.25 mg/g.

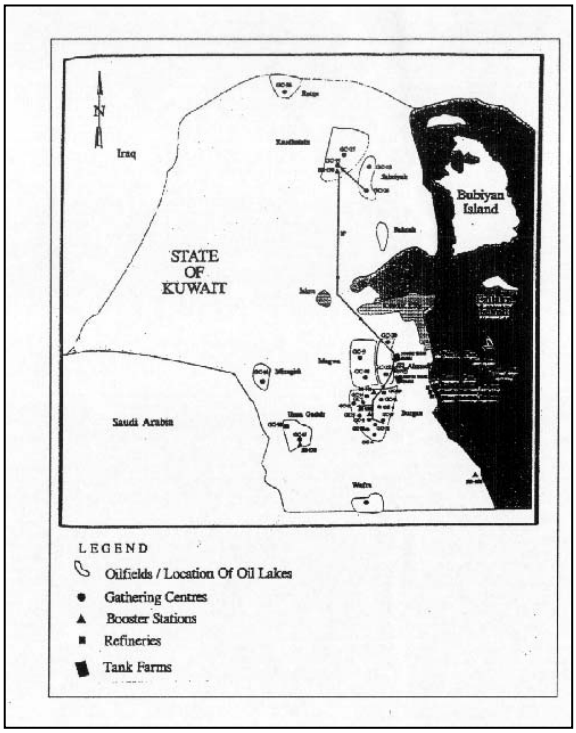

FIGURE 3. Oil Lakes Location In Kuwait Oil Field.(After: Bashara, 1991)

FIGURE 4. Landfarming Bioremediation Plots in Burgan Site.

CONCLUSION

This paper presents on some three important projects related to soil and water management that have been practiced in Kuwait during the past 10 years in order to reduce the high fresh water consumption and enhancing the agricultural activities. Therefore, it is recommended for planning sustainability in water resources conservation significantly to divide the whole society into several consumption slices in order to overcome any socio-economic and environmental problems that effects the supply and demand.

Conservation is considered the key factor for any sustainability programs. Soil conservation has never been given the required focus by the governmental sectors until the oil lakes were used to enhance the agricultural activities. The problem of hydrocabon existed to remain drawing a severe challenge to soil development plans and environmental sustainability.

The bioremediation treatment is theoretically coaslt , on the other hand, it ensures complete destruction of the pollutants. This technique is applied in Kuwait after the 1990 crises. The in-situ bioremediation has added a great advantage of minimizing of soil contamination (Balba, 1995). However, the limitations of bioremediation technology is due to the following factors: its products are the huge concrete fences, scrap metal, and building derbies (Balba, 1995) the large-scale areas of contaminated soils , which impose pressure on the ecosystem.

The slow governmental responses to bioremidiation funding explains the difficulty in cleaning the whole country and limits the environmental sustainability. It is recommended to include the environmental and social norms, climatic conditions in researches involved soil and water conservation.

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