Towards Sustainable Desert Development for Egypt

Adli Bishay

CAIRO PAPERS
IN SOCIAL SCIENCE

ENVIRONMENTAL CHALLENGES IN EGYPT AND THE WORLD

Edited By

NICHOLAS S. HOPKINS

Volume 15, Monograph 4. Winter 1992

TOWARDS SUSTAINABLE DESERT DEVELOPMENT FOR EGYPT

ADLI BISHAY

Introduction

The Brundtland Commission defined the concept of sustainable development as "The path for human progress which meets the needs and aspirations of the present generations without compromising the ability of future generations to meet their needs." In other words, each generation must meet today's needs without incurring debts it cannot repay, and without compromising the lives of future generations.

Currently, Egypt's debts are not only financial,[1] but are also demographic (high rate of population growth -- 2.6%), social (insufficient investment in people), and environmental (exhausting natural resources and increasing pollution). Unless drastic improvements are implemented, Egypt's development efforts will continue to be unsustainable.

One other measure for sustainable development is the use of the Human Development Index (HDI) adopted by UNDP.[2] According to the 1992 UNDP Development Report, the HDI for Egypt is only 0.385 as compared to 0.976 for USA, 0.981 for Japan, and 0.982 for Canada. This ranks Egypt as 110th compared to USA (sixth), Japan (second) and Canada (first) on a list of 160 countries investigated.

It is gratifying to note, however, that major economic, social and legal measures have recently been adopted by the Government of Egypt based on structural re-adjustment steps initiated in cooperation with the World Bank and a number of developed countries, including USA, Japan, and Europe. In addition, half of Egypt's foreign debt of $50 billion has been forgiven outright or rescheduled on favorable terms since the Gulf war.

Framework for Sustainable Development

The major goal of Sustainable Development is to satisfy human needs and attain social welfare over time, while maintaining the human and natural resource base and avoiding environmental degradation. Accordingly, in order to achieve sustainable development (and self reliance), a balance should be reached between economic and social development, resource management, and environment protection. This is a dynamic system which would require appropriate management (especially under micro/macro crisis conditions),

[1] Based on the 1992 UNDP Human Development report, Egypt received the highest development assistance in the world (5,584 million U.S. dollars, corresponding to 17.2% of its GNP).

[2] The index is a constructed figure based on equal weights of income (GNP/Capita), life expectancy at birth and adult literacy.

necessary finances, and research and development with special emphasis on optimization between ecological and economic dimensions of development (see Fig. 1). Public participation (social and political) and necessary infrastructure and support services are of utmost importance in implementing the different activities proposed for achieving sustainable development.

Sustainable Desert Development

Egypt suffers from continual population growth and dwindling resources. With Egypt's population concentrated in the Nile Valley which constitutes only 4% of the total area of the country development of her deserts to make them productive and habitable is an urgent need that is widely recognized. The Egyptian Government, in order to solve the problems of food, housing and unemployment for the continuously increasing population, has decided to expand horizontally (in the desert) as well as continuing the present successful vertical improvement of its cultivable land.

In order to ensure the sustainability of this expansion in the desert, a balance should be reached between resource management, environmental protection and socio-economic development. Figure (2) identifies the components and sub-components relevant to sustainable desert development. I have chosen a few sub-components which are particularly relevant to sustainability of desert development and food security.

A) Resource Management and Environmental Protection

1) Population. Egypt's population is 57 million in 1992. It is expected to reach about 70 million in the year 2000 and about 95-100 million around 2025-2030 at which period population stabilization is expected. Only 1% of the present population is living in the 96% of Egypt's area which is desert. What is needed is: (a) to reach an earlier population stabilization as a result of improving family planning through education, improvement of women's status, and raising socio-economic level; and (b) to achieve a better population distribution (approximately 10% of the population should be living in the desert) through creating incentives for migration to the deserts and dis-incentives for migration from rural areas to cities.

2) Land and soil. To- date, there is no national land-use plan for Egypt. Accordingly, there is need to map soil resources for a comprehensive land-use plan. Implementation of such a plan should be monitored through a central authority. With the very high population density in the valley, major efforts have been made to construct new desert cities and reclaim desert land for agricultural production. However, both the cities and reclaimed lands are facing enormous difficulties. Soil degradation of the reclaimed lands can be attributed to mismanagement and lack of control of widely spread chemical, pathological, and biological sources of pollution. Optimum inputs of fertilizers and pesticides should be determined and introduced when and where needed.

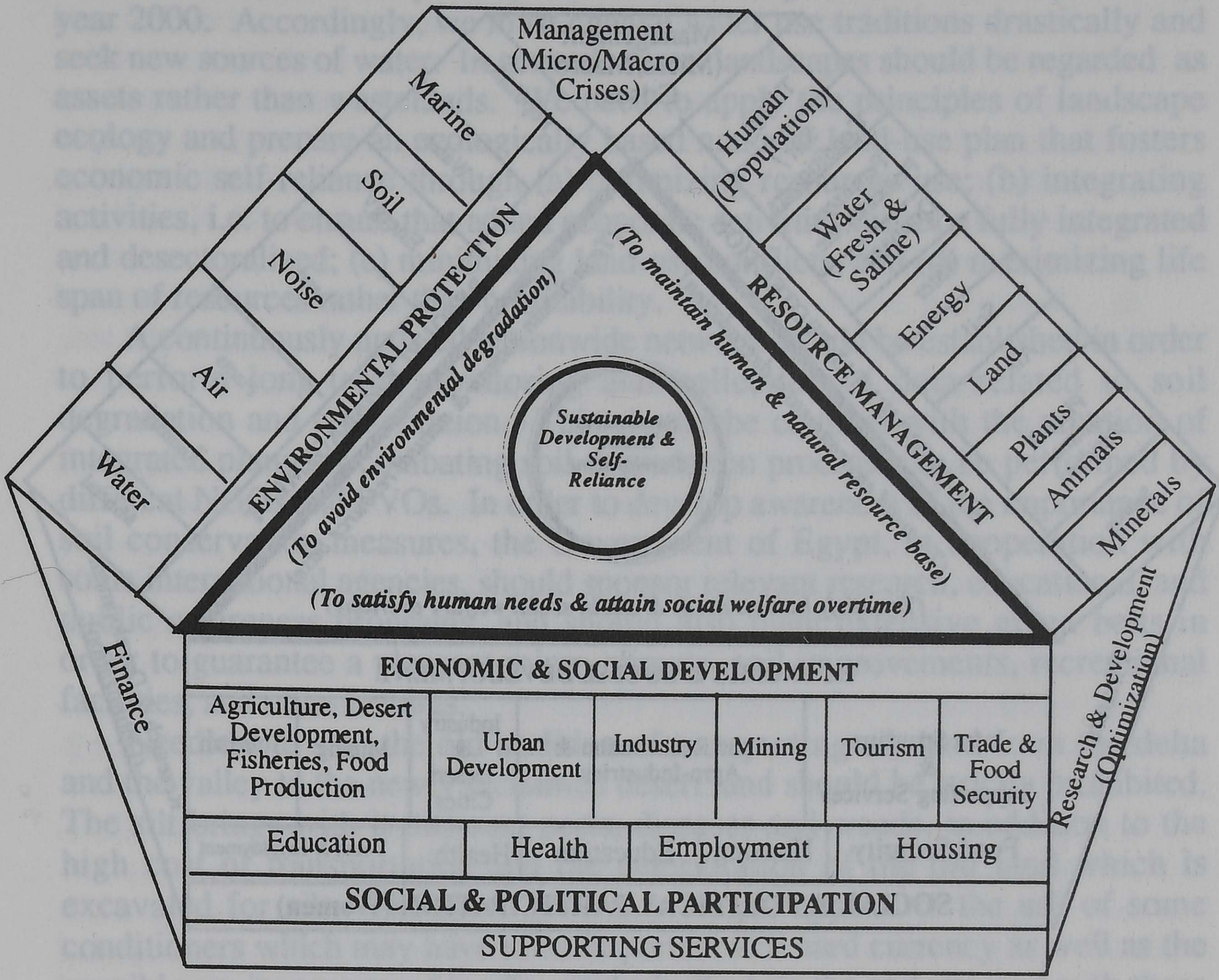

FIGURE 1

FRAMEWORK FOR SUSTAINABLE DEVELOPMENT IN EGYPT

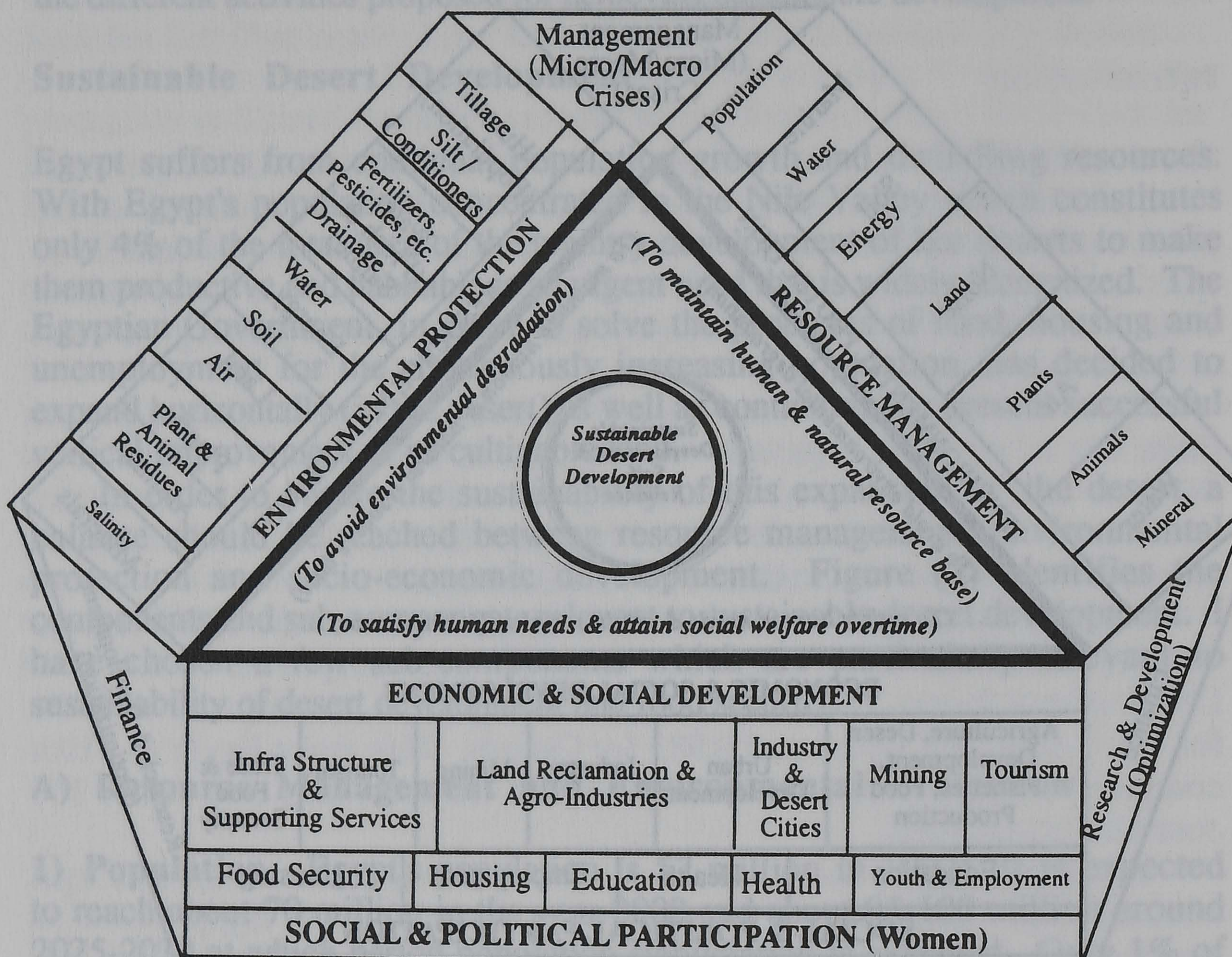

FIGURE 2

SUSTAINABLE DESERT DEVELOPMENT IN EGYPT

In the absence of limitations imposed by water scarcity, energy cost and soil quality, an additional 5-6 million acres of newly developed desert land would be needed to accommodate expected excess population by the year 2025 (nearly double today's population). This is impossible as will be shown in the discussion below, especially when considering water availability after the year 2000. Accordingly, we must change water use traditions drastically and seek new sources of water. In general, desert landscapes should be regarded as assets rather than wastelands. We need to apply the principles of landscape ecology and prepare an ecologically based national land-use plan that fosters economic self-reliance through (a) optimizing resources use; (b) integrating activities, i.e. to ensure that added economic activities must be fully integrated and desectoralized; (c) minimizing land-use conflicts; and (d) maximizing life span of resources rather than profitability.

A continuously updated nationwide network should be established in order to perform long-term monitoring and collection of data related to soil degradation and conservation. This should be coupled with the creation of integrated plans for combating soil degradation processes to be performed by different NGOs and PVOs. In order to develop awareness of the importance of soil conservation measures, the Government of Egypt, in cooperation with some international agencies, should sponsor relevant research, educational, and public awareness programs, and should also plant extensive green belts in order to guarantee a pleasant micro-climate, soil improvements, recreational facilities, and other features.

Needless to say, the old tradition of transporting silt land from the delta and the valley to the newly reclaimed desert land should be strictly prohibited. The silt brings with it different pests, diseases and weeds, in addition to the high cost of transportation and the deterioration of the old land which is excavated for silt. The same general principle applies to the use of some conditioners which may have to be imported with hard currency as well as the possible environment-unfriendly residual effect on the soils treated with these conditioners.

It should also be mentioned here that minimum tillage is recommended for certain desert soils, thus minimizing energy use for soil preparation, as long as limitations are imposed on application of herbicides.

3) Plant and animal resources. Ecosystem impoverishment may occur as a result of desert land reclamation, which can be attributed to negative attitudes towards loss of wild plant species, leading to the loss of useful associated invertebrates (habitat destruction). The environmental importance of the latter is rarely surveyed. Also, insects are not properly mapped in the desert. Many land reclamation projects neglect use of proper crop rotations and some apply an excess of fertilizers and pesticides. Domestic animals are overstocked on the northwest coast of Egypt, due to a profitable export market for sheep and goats; not surprisingly, they overgraze. On the other hand, local varieties of these animals are threatened by the invasion of imported varieties which are not promising on a sustainable basis.

In order to achieve sustainable development, management of plant and animal resources should be based on the following strategies:

a) Encouraging conservation of bio-diversity at the national level through a number of measures (e.g. natural parks and nature reserves and establishing a natural history museum).

b) Integration of tourism with national protection on a rational and sustainable basis.

c) Supporting and enhancing prevailing tribal systems in desert areas with respect to animal husbandry (e.g. encourage Bedouins to use rain water in the northern coast during winter (natural pasture) and irrigation water during summer (irrigated pasture), for instance, from the Nasr Canal in Mariut and El Salam Canal in Sinai.

d) Achieving proper management of already declared protected areas and developing more sound criteria for the choice of new areas to be protected.

e) Encouraging hybridization of foreign and domestic animal breedings using new techniques, including genetic engineering.

f) Encouraging controlled use of indigenous flora for producing food, fibre, and medical crops as well as soil fixation by establishing experimental farms.

g) Establishing a breeding farm for endangered plant and animal wild species as well as local varieties of domestic animals and crops and their wild relatives, associated with a germ plasm bank.

h) Encouraging crop rotations which would have optimum economic, environmental, social and sustainable impact on desert lands (e.g. cereal/legume).

i) Training of personnel in various aspects of biological conservation, landscape ecology, and environmental planning.

j) Establishing a Secretariat for Fauna and Flora to survey, inventorize, evaluate, and give advice on bio-diversity issues and on natural areas of special ecological importance, in order to protect these areas, which are 5-10% of land territory and waters.

4) Minerals and energy. The mineral wealth of the deserts of Egypt is reasonably well known; Egypt has a few occurrences of base metals, a limited quantity of iron ores, but it is rich in phosphates, evaporite, salines, limestones, building materials, glass sand, kaolin, and other earthy materials. These could represent the base upon which industry in Egypt should be established. However, relevant data on these minerals are mainly scientific geological data rather than information with direct commercial value. Manpower in the respective mines is mostly unskilled labor and mining regions are devoid of any on-site training facilities. What is needed is to secure environmentally sound and economically viable exploration and utilization of mineral resources and mining processing industries.

Energy is another critical resource. Traditional energy resources are limited. Except for small quantities of coal known in Sinai, fossil fuels in the forms of oil and gas are known around the Gulf of Suez and the northern reaches of the western desert. Egypt is now self- sufficient in petroleum and natural gas. However, this situation will not last long. Thus, while in 1991/92 Egypt's share of petroleum and natural gas production is 35.29 million tons, its consumption is only 28.65 million tons, leaving a balance of 6.64 million tons for export. On the other hand, it is expected that in 1999/2000, Egypt's production share will slightly increase to 39.97 million tons, while its consumption will increase at a much higher rate reaching 42.33 million tons, with a negative balance of 3.36 million tons which will have to be imported during that year. With increasing population, the situation is expected to become even worse in the year 2004/2005 when Egypt's production share is estimated at 41.78 million tons and its consumption reaches 54.02. This implies a negative balance of 12.24 million tons which will have to be imported, unless alternative energy sources become economically viable.

Egypt enjoys high rates of solar radiation over all its territory (average of 6 kwh/m^3/day), as well as favorable wind resources in coastal areas (5-8 meters/sec) and the existence of intensive biomass resources including agriculture, aminal and municipal solid wastes.

In addition, more than twenty locations for mini-hydroelectric power generation, and a few low/medium temperature geothermal locations have been identified on the Sinai and Red Sea coasts. These have the potential of producing about 250 mwh/year.

In recognition of the above, as well as the lack of sufficient energy resources the Ministry of Electricity and Energy (MOEE) through the Supreme Council of New and Renewable Energy Sources of Egypt, assisted by the UNDP, has formulated a National Strategy for the Development and Utilization of New and Renewable Energy and Energy Conservation. This includes development of an institutional structure for New and Renewable Strategy for Egypt (NRSE) activities to ensure project management and coordination of such activities within the country.

The overall goals of the New and Renewable Energy National Strategy are: (i) to supply 5% of the national primary commercial energy needed by the year 2005, and (ii) to reduce national energy consumption by 10% through implementing energy conservation measures.

Studies conducted by Egyptian experts regarding formulation of this strategy, as well as other feasibility and market studies performed by MOEE, have identified different applications for new and renewable energy derived from solar, wind, biomass, and geothermal sources.[3]

Strategies recommended. Energy is one of the two major constraints to desert development. Sustainable desert development necessitates conservation and rational use of energy resources and minimizing pollution

[3] T. El Tablawi and A.I. Hegazi, "New and Renewable Energy Strategy for Egypt (NRSE)", in Adli Beshai and Harold Dregne eds., *Desert Development: Socio-Economic Aspects and Renewable Energy Application* (Part II) (London: Harwood Academic Publishers, 1987).

hazards associated with its utilization. Strategies recommended for achieving these goals are, in a nonexclusive listing:

a) Increasing liquid fuel and electricity tariffs,

b) Conducting intensive exploration of petroleum and natural gas to increase reserves,

c) Reducing energy intensity rates,

d) Maximizing the use of new and renewable energy resources (including introduction of incentives),

e) Improving mass transport (to reduce use of individual cars),

f) Increasing awareness with strategy issues and renewable energy applications,

g) Converting oil burning systems to gas,

h) Conducting waste heat recovery in industry and agro-industry,

i) Using efficient and low pressure equipment for irrigation (such as the drip and sprinkler systems), and

j) Using efficient equipment for land preparation, harvesting.

Two additional points should be taken into consideration: (i) rational use of fertilizers and pesticides is an indirect means for energy conservation, and (ii) encouraging labor intensive operations which will help in solving Egypt's major unemployment problem as well as increasing energy savings.

On the other hand, biotechnology should be adopted to recover energy and resources from waste through:

a) Sanitary landfills,

b) Digesters in villages, either centrally or for each family,

c) Digesters in national sewage systems (for new desert cities), and

d) Pyrolysis of agricultural wastes.

Research efforts should be directed towards developing a technology to turn sewage sludge from new desert cities into fuel oil instead of transforming it through fermentation as in digesters.

5) Water (Quantity and Quality). Water is the most important ecological factor in the desert and represents the most critical resource in Egypt. With increasing population and a higher standard of living, water will become an even more critical resource in the future than it is at present. Water, and not land, is the major constraint to expanding the total agricultural area in the deserts of Egypt. This expansion is necessary for the country's food security.

Rainfall distribution in Egypt is mainly restricted to two arid provinces with a mild winter and hot summer and a rainy season extending from November to April, but mainly concentrated in December and January. These cover (i) the coastal belt of the Mediterranean, with about 100-150mm rainfall per year, and (ii) the more inland province away from the Mediterranean, with about 20-100mm rainfall per year.

As will be seen from the review of the ground water potential of Egypt, the Nile represents the most important water source. It supplies Egypt with almost all its water requirements. The discharge of the Nile fluctuates from year to year, with an average discharge of 86 billion m^3/year, an amount which makes this longest river in the world go to the bottom of the list of major rivers with regard to discharge. Egypt's share of the Nile water is 55.5 billion m^3/year (or 1760 m^3/second), which is consumed around the year at the rate of 926 m^3/second during the winter months and 2660 m^3/second during the summer months. A number of studies have indicated that about 15% of the Nile water reaching the lands of Egypt can be saved without involving dramatic changes in the habits of the Egyptian farmer and his methods of flood irrigation of the old land. This surplus water in addition to the share (2 billion m^3/year) which will accure to Egypt in the year 2000 after diverting the Upper Nile through the Jongli Canal, to avoid the Sudd marshes in the southern Sudan, represents all the surplus that Egypt can obtain from the Nile. In addition, the present annual rate of re-use of agriculture drainage water is 4.7 billion m^3 and will increase gradually to 7.0 billion m^3 by the year 2000.[4]

According to Abu Zeid,[5] available ground water from the Nile Valley and Delta aquifers is 4.9 billion m^3 annually, 2.6 billion of which is now being used and an additional 2.3 billion m^3 will be used annually in the future. This ground water is another valuable resource for use in land reclamation projects.

The main deep ground water aquifer lies in the Western Desert and consists of a thick sequence of sandstones with clay lenses overlying basement rocks. The system is confined by a thick clay sequence in the oases and their vicinity. This produces artisan conditions and results in the free-flowing wells in the depression areas. The regional hydraulic gradient is from the southwest. Recent studies indicate that this water has been stored from the old rainy ages and accordingly should be considered as fossil water, i.e. non-renewable. In 1990, this deep ground water aquifer produced 0.5 billion m^3, and its annual production is expected to increase gradually to 2.5 billion m^3 by the year 2000.

For the last thirty five years, ground water extraction in the Kharga and Dakhla depressions has exceeded natural recharge with resultant head decline and falling free flow discharges. The ground water reservoir is immense, but the availability of water is essentially limited by the viability of the pumping head.

On the other hand, the ground water in the southern part of the western desert is considered to be enough to permit cultivation of about 189,000 feddans in East Oweinat and 50,000 feddans around the High Dam lake. However, although a solar/wind/diesel system has been used to pump water at East Oweinat, to date only 200 feddans have been reclaimed.[6]

It should be noted here that most of the land reclaimed to date in the western desert near the western borders of the Delta has depended mainly on Nile water from the Nasr canal. The Nasr Canal is already approaching the Alamein area, west of Alexandria. In addition, construction of El Bustan

---

[4] M. Abu Zeid, "Conservation and Management of Water Resources for Sustainable Development," *Desert Development Digest* (ed. Adli Beshai), Vol. 3:1, 1990 pp. 1-3.

[5] Ibid.

[6] S. Naghmoush, "History of Land Reclamation in Egypt," *Desert Development Digest* (ed. Adli Bishay), Vol. 2:1, 1989, pp. 11-13.

Canal will further increase the area to be reclaimed in the western desert. On the other hand, the Ismaileya Canal with its two branches (Suez and Port Said) has been widened and deepened, while the Salhya Canal, the Youth Canal, and El Salam Canal have been constructed or are in the process of being completed in order to supply necessary irrigation water to the eastern desert and the Sinai.[7]

Another source of water for land reclamation is the water released in the winter closure in January for electricity generation and navigation. There is a plan for saving this water in another lake to be used for irrigation for future land reclamation projects.

If the Water Master Plan is carefully studied, however, one would notice that in the year 2000 Egypt will need to consume about 70 billion m^3 which approaches the annual available water to Egypt expected from all resources. What will happen in the year 2025 when Egypt's population is expected to nearly double? Some drastic measures and ingenious innovations are needed as of now.

Proposed strategies to achieve sustainability through water conservation and rational use are:

a) Developing a water management action plan to ensure availability of adequate quantities of water of the right quality (based on EIA),

b) Use of drip and sprinkler irrigation whenever possible,

c) Encouraging desalination efforts,

d) After the year 2002, concentrating on improving crop yields and sustainable desert development (not on additional land reclamation) unless more fresh water becomes available through through increased supply, which is unlikely, or through greater rationalization of use.

e) Rationalizing water use through adopting water pricing systems (cost-recovery legislations), and

f) Encouraging other income generating activities which consume less water than in agriculture.

Needless to say, strategies for water use are also seriously affected by water quality. Deteriorated water resources in Egypt are caused by: (a) uncontrolled discharge of industrial and domestic wastewater, (b) uncontrolled use of pesticides, herbicides, and fertilizers, and (c) lack of adequate field drainage which leads to continuous rise of water table and serious land salination. This water logging contributes to nematode and root diseases. An additional hazard is caused by oil pollution of the Nile, Red Sea and the Mediterranean due to navigation, industrial activities and seepage from oil reservoirs.

Proposed strategies to achieve sustainability through implementation of water quality measures are:

a) Developing more realistic laws for water quality control,

b) Introducing low cost sanitation systems as part of rural or urban environmental management plans,

---

[7] E. Radi, *Desert Development Digest: DDC Tenth Anniversary Seminar* (Cairo: The American University in Cairo, 1989).

c) Adopting simple environmental management practices (improved house-keeping measures) to reduce pollution caused by industrial activities,
d) Treating waste water from domestic and industrial activities,
e) Introducing appropriate systems for sludge reuse and disposal,
f) Treating and reusing agricultural drainage as well as minimizing nutrient discharge into canals and waterways,
g) Developing alternative approaches to weed control, and
h) Creating public awareness of the critical status of water (quality and quantity).

B) Economic and Social Development

To achieve sustainable desert development, we need to satisfy human needs and attain social welfare over time. Infrastructure and supporting services, a socio-economic base, desert architecture and aesthetics, all are very important factors in attracting some of the inhabitants of the over-populated cities to desert communities. The socio-economic base of desert communities depends on one or more of the following activities:
a) Agriculture, including crop and animal production,
b) Mining, including oil, gas and other raw materials,
c) Industrial, including cottage industries, agro-industry as well as small and major industries constituting the economic base of new cities,
d) Tourism: This area of activity covers religious tourism (Saint Catherine in Sinai), historical tourism (East of Minya) and environmental "scenic' tourism (Red Sea, Sinai, Mersa Matruh).

In this paper, emphasis is given to "Desert Development Systems" where **agriculture** constitutes the major socio-economic base. Under this system, technological aspects are directed towards serving agricultural and domestic activities, and the community aspects deal with settlers' needs of an agriculturally based community. Figure (3) illustrates this type of Desert Development System.

It should be noted here that the concept of "Desert Development Systems (Agriculture)" gives equal weight to biological, technological, and community aspects. On the other hand, the concept of "Desert Farming Systems" puts emphasis on the biological aspects. Furthermore, a number of desert development programs may be based on more than one type of socio-economic activities, e.g. agriculture and tourism (Mersa Matruh and Sinai), mining and agriculture (Baharya oasis), or industry and agriculture (Sadat City area).

Future of Land Reclamation in Egypt and Its Sustainability

The "Land Master Plan" identified the desert regions to be reclaimed with the available water resources, based on a study of the type of soils and their production capacity. Priority was given to areas where water would not have to be lifted more than 40 meters. Although about 450,000 feddans have been reclaimed during the period (1987-1992), at least 30% of this land is still below the marginal productivity level.

In any case, the total areas still available for reclamation is about 1.5 million feddans. According to the Government's plan, 150,000 feddans will be reclaimed every year. If this plan is implemented, we will need 8 years to complete the reclamation of the 1.5 million feddans still unreclaimed. This means that no more land will be reclaimed after the year 2002 due to restrictions imposed by limited water resources, unless

a) New treaties are made with the Nile Basin countries, which is unpredictable;

b) We start immediately in implementing revolutionary measures to rationalize and develop water resources (water pricing, recycling, desalination, new irrigation techniques, new crops, as well as public awareness and public participation).

Food Security and Sustainable Desert Development

In Egypt, as well as many developing countries, the difference between food production and consumption is not necessarily equal to the difference between food production and the food needs because in most cases consumption is less than real needs. Therefore, the "food gap" or "self-sufficiency" must be based on the difference between production and real objective needs. Table 1 shows the apparent self-sufficiency percentage for some important crops for the years 1980 and 1989 in Egypt.

TABLE 1

APPARENT SELF-SUFFICIENCY % FOR SOME IMPORTANT CROPS FOR THE YEARS 1980 AND 1989 IN EGYPT

Crop	Apparent self-Suffiency %*		
	1980 %	1989 %	
Wheat	23.4	32.4	
Rice	112.3	107.7	net exporter
Corn	64.0	73.9	
Vegetables & Fruit	101.0	102.0	net exporter
Sugar	55.4	61.0	
Vegetable Oils	38.1	39.0	
White Meat	62.8	96.4	self-sufficient
Red Meat	74.6	67.7	
Milk	99.8	100.0	self-sufficient
Eggs	99.5	99.9	self-sufficient

* Self-sufficiency % = (Production/need) x 100

Percent of apparent self-sufficiency = (Production/consumption) x 100

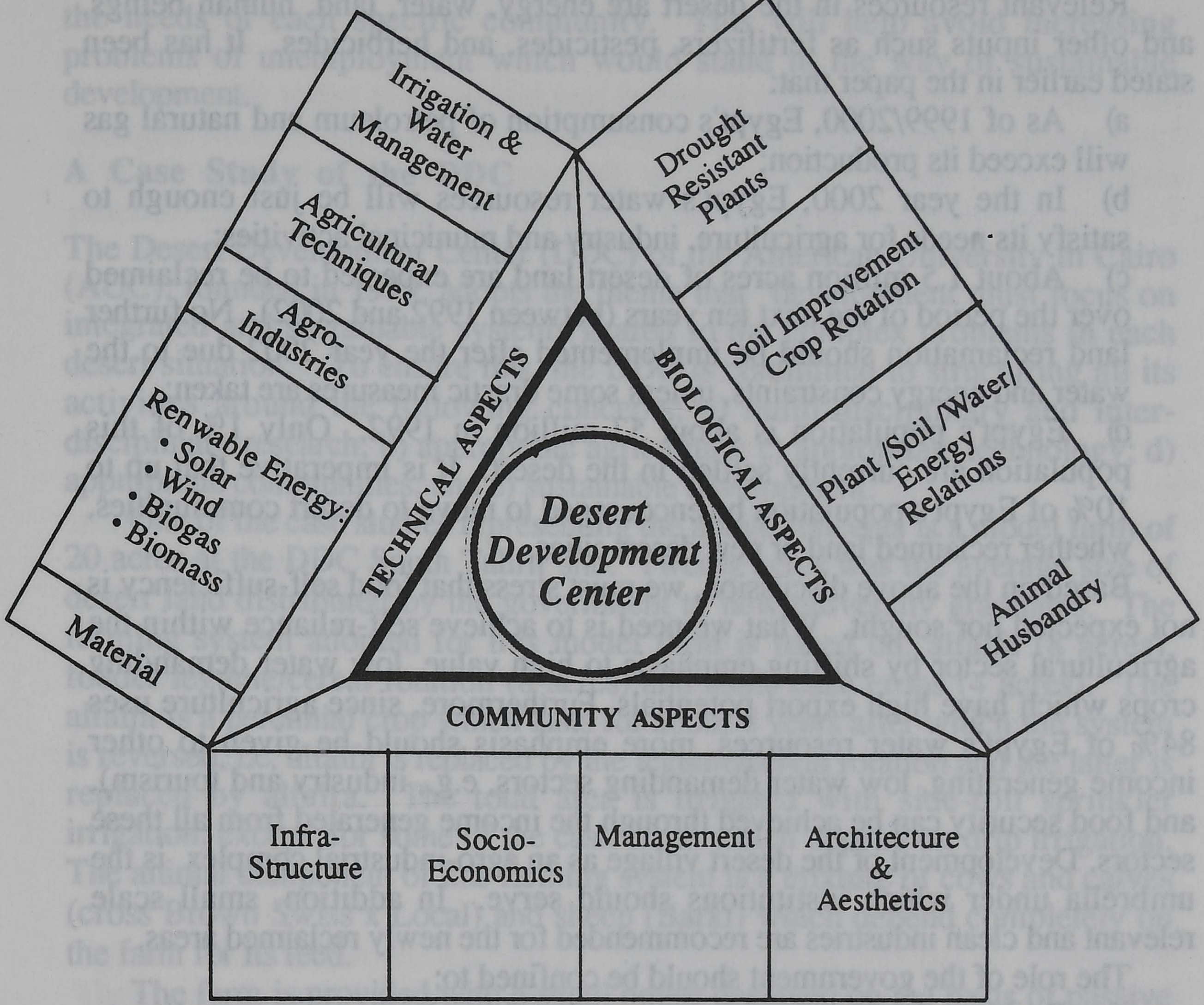

FIGURE 3

AUC SUSTAINABLE DESERT DEVELOPMENT

For sustainable development, it is food security rather than self-sufficiency which is required. To achieve food security, we have to put forward an overall strategy based on an efficient allocation of resources, with production taking place according to comparative advantage.

Relevant resources in the desert are energy, water, land, human beings, and other inputs such as fertilizers, pesticides, and herbicides. It has been stated earlier in the paper that:

a) As of 1999/2000, Egypt's consumption of petroleum and natural gas will exceed its production;

b) In the year 2000, Egypt's water resources will be just enough to satisfy its needs for agriculture, industry and municipal activities;

c) About 1.5 million acres of desert land are expected to be reclaimed over the period of the next ten years (between 1992 and 2002). No further land reclamation should be implemented after the year 2002 due to the water and energy constraints, unless some drastic measures are taken;

d) Egypt's population is about 57 million in 1992. Only 1% of this population are currently settled in the desert. It is imperative that up to 10% of Egypt's population be encouraged to move to desert communities, whether reclaimed land or new desert cities.

Based on the above discussion, we must stress that food self-sufficiency is not expected nor sought. What we need is to achieve self-reliance within the agricultural sector by shifting emphasis to high value, low water demanding crops which have high export potentials. Furthermore, since agriculture uses 84% of Egypt's water resources, more emphasis should be given to other income generating, low water demanding sectors, e.g., industry and tourism), and food security can be achieved through the income generated from all these sectors. Development of the desert village as an agro-industrial complex is the umbrella under which institutions should serve. In addition, small scale relevant and clean industries are recommended for the newly reclaimed areas.

The role of the government should be confined to:

a) Building basic infrastructure, undertaking basic survey studies to determine location of lands to be reclaimed and the provision of technical and credit facilities for the private sector,

b) Encouraging private investors and new graduates to take up, reclaim, and farm new lands (up to the year 2002-within the limitations of the Water Master Plan),

c) Preparation of precise detailed techno-economic land classification maps indicating viable future expansion regions and low producing regions,

d) Development of appropriate links between desert research and development centers and agricultural expansion units,

e) Encouraging settlement and construction outside the valley and developing an investment policy capable of achieving this goal, and

f) Developing and modernizing rural institutions and organizations in the new desert areas in order to increase their role in rural development.

To conclude, it should be emphasized that in order to achieve sustainable desert development, it is imperative to adopt comprehensive community schemes combating poverty and improving conditions in the new desert areas. This includes educational and health services (including family planning), with special emphasis on women and children. Special vocational training for youth should be available at a reasonable tuition fee and should be tailored to the needs of each specific community. This will help avoid increasing problems of unemployment which would stand in the way of sustainable development.

A Case Study of the DDC

The Desert Development Center (DDC) of the American University in Cairo (AUC), founded in 1979, adopts the theme that "development must focus on integrated and sustainable systems geared to the complex problems in each desert situation." To ensure this, the DDC is committed to structuring all its activities around the following concepts: a) multi-disciplinary and inter-disciplinary research; b) appropriate agriculture; c) appropriate technology; d) appropriate communities; and e) sustainable development.

One of the case studies representing the above concepts is a model farm of 20 acres at the DDC South Tahrir site. Twenty acres was the average size of desert land distributed by the government to new university graduates. The farming system adopted for this model farm is based on: alfalfa (8 acres), fodder legume/cereal rotation (8 acres) and some cash crops (4 acres). The alfalfa is a perennial crop which lasts for about 4 years after which the system is reversed, i.e. alfalfa is replaced by the legume/cereal rotation and the latter is replaced by alfalfa. The total area is irrigated with side-roll sprinkler irrigation, except for some of the cash crops which depend on drip irrigation. The animal component of this farming system is a mixture of cows and calves (cross Brown Swiss x Local) and sheep (Barki) which depend completely on the farm for its feed.

The farm is provided with a small house designed on the basis of passive solar architecture, adopting some old traditions (domes, vaults, courtyard). The choice of the house was based on the energy analysis of three alternative designs. A number of improvements were added to the adopted design; namely, double walls for the east and west facades, a Trombe wall for the south side, and a *malkaf* for the north side.[8]

The animal shed, adjacent to the house, is covered with a set of photovoltaic cells (1.2 kwp) to provide the house with all its electricity needs. A mechanical pump level on the east side is used to pump water from a well (static water level 16 meters). A solar water heater facing south is used to heat water for the bathroom and a small biogas digester, adjacent to the animal shed, is used to produce biogas which is connected with the kitchen for cooking. The biogas manure is an excellent fertilizer which is spread over the farm to improve the soil productivity.

---

[8] The Trombe wall uses solar energy for heating in the winter and the *malkaf* uses wind to cool in the summer.

The above example is used as one of the demonstration activities available to students and visitors and serves as a source of information on sustainable desert development programs.[9]

[9] A major part of the information included in this paper is the result of the contributions of a number of senior scientists participating in a task force (sponsored by UNDP) for proposing "Strategies for Sustainable Development for Egypt" coordinated by the author.

The scientists include Drs. Mohamed Sobhy Abdel Hakim (Population), Samir Ghabbour (Lands, Plants and Animals), Ismail El-Bagouri (Soils), Talaat El Tablawi (Energy), Mahmoud Abou Zeid and Fatma El-Gohary (water), Farkhonda Hassan and Ismail Abdou (Minerals and Mining), Milad Hanna (Housing) and Hassan Khedre, Adel Beshai and Ragaa El Amir (Food Security), Bahaa El-Bakri and Osama Salem (Urban Development).

This paper was originally given at the International Symposium on Land Degradation and Its Biological and Technological Rehabilitation in Drylands, held by the Arid Land Research Center, Tottori University, Japan, during 20-22 Oct., 1992.