An Environmental Economics Perspective of the Aswan High Dam Of Egypt in a Multidisciplinary Approach

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Introduction:

The issue of dams is a very compelling one. While the great majority of the world's large dams and all of the major dams have been completed within the last six decades, some of the environmental effects of a dam may not be realized for hundred of years after construction.[1] A dam can thus be regarded as a huge, long –term and largely irreversible environmental experiment without a control.[2]

Egypt's pre-occupation with the Nile River has a long history. Water development projects were built across the Nile over the centuries in an attempt to regulate its flow. One such development project is the Aswan High Dam.

The main aim of this paper is to show the environmental consequences of the Aswan High Dam and its subsequent effect on the Egyptian economy. This is achieved through constructing a bridge between conventional economic analysis and an environmental assessment analysis. Agriculture has always been the backbone of the Egyptian economy. Food self-sufficiency has ranked as a top priority for several decades. With a growing population, a crippling economy and political instability, Egypt now stands at a unique point in its history. With food imports representing a large share of government revenues and with a small percentage of land under cultivation , Egypt is in continuous quest for appropriate water levels to meet its developmental needs.

This paper examines whether constructing the Aswan High Dam brought Egypt water security and thereby food security. It is divided into four chapters. Chapter One discusses the economics of dams and provides the theoretical framework for the paper's economic analysis . The main emphasis is on the environmental aspect of dam

[1] McCully (1996), p.31.
[2] Ibid.

construction . The human and socio-economic factors will also be discussed in order to show the multi-disciplinary approach required in the study of dams.

In order to identify the main sectors significantly affected by the construction of a dam, the economic characteristics of the country under study are crucial. The second chapter, therefore, surveys the Egyptian economy since 1952. This specific time period was selected because the 1952 revolution led by the Free Officers opened a new chapter in Egypt which had a tremendous effect on the Egyptian economy for many decades to come. This period saw considerable economic and political transition and the construction of the Aswan High Dam .

Chapter Three focuses on the characteristics of the Aswan High Dam and the decision-making process that led to its construction. Perhaps no other dam has stirred more controversy than the Aswan High Dam. Its construction had internal, regional and international repercussions .The direct and indirect objectives are also assessed in terms of their feasibility and impact. These objectives were to provide Egypt with the necessary infrastructure and the appropriate growth levels to meet its economic development aspirations . Chapter three outlines the expectations sought from the construction of the dam.

In the final chapter, a cost /benefit approach to the Aswan High Dam is adopted. This chapter would outline the results of the construction of the dam and would determine if expectations were met. The methodology of environmental economics outlined in the first chapter will be used to analyze the environmental consequences of the dam and to examine whether the dam achieved its stated direct and indirect objectives .

In conclusion, it will be shown that the achievement of any sustainable level of agricultural development in Egypt depends on the efficient management of already water and land resources. Otherwise, the gap between food production and population growth would keep on increasing, hampering any form of economic development.

Chapter One: Economics of Dams.

> One day , every last drop of water which drains into the whole valley of the Nile...shall be equally and amicably divided among the river, people ,and the Nile itself...shall perish gloriously and never reach the sea .
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> Winston Churchill,1908.[3]

Ecologists have long maintained that the environment possesses a unique "carrying capacity " to support humans, and that unless this capacity is exceeded, humans can live in harmony with their surroundings. Once this capacity is exceeded, disastrous consequences can be expected on all living things.

The environment has been suffering for decades but only recently has it received the needed attention by the various academic disciplines. With the advent of technology, the relationship between the environment and human beings has changed. Since the beginning of civilization, adapting to nature provided the basis for human survival. However, as a result of the technological revolution taking place in different parts of the world, people are managing nature rather than adapting to it. As a result, societies are degrading their environment that helped sustain life for millions of years and are altering the various ecosystems, leading to ultimate irreversible damages.

Constructing dams is one way in which people manage their environment to meet their needs and requirements. Dams are the main providers of electric power, water and food. They also prevent floods, green the desert, and guarantee national independence. For the better part of this century, they have constituted the largest single structures built by people and have symbolized progress. [4]

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[3] Ibid., p.18.
[4] Ibid., p.1.

When analyzing the effects of dams, one has to understand the importance of rivers, and thus go beyond narrowly describing them as just water which ultimately flows into the sea. One needs to touch upon the benefits of rivers , important sediments, dissolved minerals, and the nutrient-rich detritus of plants and animals, both dead and alive, which enrich the soil. Therefore, rivers provide societies with the water they need to sustain life.

Dam construction has received much attention throughout history and various disciplines deal with it. Indeed, dam construction is not likely to stop, the main reason being population growth , industrialization, and the continuous quest for water to meet the demand for food, energy and industry. All of these factors translate into an increase in the demand for domestic, agricultural and industrial water use.

The effect of dam construction involves an interdisciplinary assessment of the specific dam under study. Many fields in the social sciences are relevant to the study of dam projects because of the overwhelming effect a dam has on people, the economy, and the environment. Dams are built to satisfy one or more primary growth objectives of a nation. These objectives include hydroelectric power generation, water storage for irrigation, industry and domestic use, flood control, or regulation of river flow for navigation. Other benefits may include the development of the fishing industry and the potential for industry and agricultural expansion around the lake shore.

However, problems that can offset these benefits are likely to arise during the construction phase. All aspects of dam construction are related to the national economy in such a way as to determine how the dam can best contribute to the country's growth and prosperity. Hydroelectric power generation can provide the impetus for industrialization and growth. Water storage for irrigation can expand agricultural production to generate a productive and efficient labor force. Also, globalization requires water storage for irrigation to provide for the expansion of cash crops and ,therefore, a government's foreign exchange earnings. Flood control saves billions of dollars in costs that would otherwise be incurred as a result of damage, loss of harvest, or loss of cultivated land. Moreover, the development of a fishing industry may complement and strengthen an already existing fishing industry by providing more jobs in that sector. Finally, increased tourism and better recreational facilities around the lake shore may provide a further boost to the economy.

Although these economic benefits sound rewarding, the social and environmental implications associated with dams can make them less appealing. The social impact of dam construction is a consequence of the relocation of people whose land is replaced by the dam. The relocation , with its psychological and monetary aspect, can be overwhelming.

Section 1.1:Environmental Economics.

Change is inevitable when the natural course of a river is disturbed. The worst kind of change is irreversible in its environmental impact. Irreversible damages are central to the study of environmental consequences and impact assessment, which should go hand in hand with the formulation of national economic policies . For obvious reasons, the economic advantages of having a large dam would be minimized if the quality of water and the erosion of the coast (on which all the benefits depend on) deteriorates as a result of the construction . In this event, short term benefits are replaced by long term costs.

Therefore, for sustainable development to occur, environmental economics has to be used to facilitate the effective incorporation of environmental considerations into the decision making process. Environmental economics is the bridge between conventional economic decision making and the emerging, and hence more environmentally conscious, approach to decision making.

Conventional decision making depends mainly on the economic, financial and techno-engineering analysis of projects. The techniques of environmental assessment , on the other hand, trace out the environmental impact of degradation resulting from human activity, whether it occurred in the international, national, sectoral, or subsectoral socioeconomic structure. Afterwards, environmental economics is used to map these environmental assessment results onto the framework of conventional economic analysis. Once this is done, projects have to be redesigned in a way that the environmental impacts are minimized, giving way to sustainable economic development.

Until recently, the inclusion of environmental impact assessment was ignored during the project appraisal stage in the project life cycle. The two main reasons were that it is hard to integrate natural resource and environmental issues into the economic analysis of projects and that the cost of environmental consequences are hard to quantify in monetary terms. This is because economic theory treats natural resources as free goods and the costs associated with them as social costs instead of private costs. The environmental benefits of abstaining from a destructive activity accrue to the whole society; whereas pursuing the activity generates material benefits for a well defined and often vocal group.[5] Therefore, the material benefits are more easily perceived than the environmental costs.[6]

To integrate natural resource and environmental issues into the economic analysis of a project or policy , two steps should be taken. The first step in incorporating environmentally sound economic analysis lies in defining the environmental impacts of the project. To determine these physical impacts we compare the "with project" and "without project" situations. This comparison should provide us with a basis for identifying the physical impacts.

The second step in incorporating environmentally sound economic analysis involves valuing and measuring these physical impacts .This step helps in assessing the extent of the physical impact on factors affected by the impact. An environmental impact may lead to changes in production and/or to alterations in environmental quality. To be able to assess this impact , a number of concepts of value and valuation techniques have to be used to trace the welfare impacts of these changes. [7]

As Chart1 displays, the basic concepts of economic value form the total economic value of a resource. The total economic value of a resource is divided into its use and non-use values. In turn , the use value consists of the direct , the indirect use value and the option value .On the other hand , the non-use value consists of both the existence and the bequest values. As we move from the use to the non-use values , tangibility of value to an individual decreases.

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[5] Paranjpye (1988), p.128.
[6] Ibid.
[7] Munasinghe (1993), p. 29.

This is an indication that use values are more tangible and more obvious to individuals than the non-use values. It is here , in the context of non-use values, that environmental consequences are considered since they are intangible .

These concepts of value are going to be used to evaluate the extent of the environmental impact of the construction of the dam. Therefore, elaboration on these various concepts is worth noting.

For the use values, direct use value is the output derived from the resource which can be consumed directly(e.g. biomass, food, health ,etc..). The indirect use value , on the other hand, reflects functional benefits derived from the project (e.g.storm protection, ecological functions, etc..) . Option value incorporates both the future direct and indirect use values(e.g. biodiversity, conserved habitats, etc..).[8] It refers to the value that we put on the area for future use even though we may not currently use it.[9]

For the non-use values, bequest values refer to the value of leaving the use and non-use values for consumption by future generations.(e.g. irreversible impacts done to the environment). Finally, existence values reflect the value of the area in its conserved form as perceived by the people who do not make or expect to make use of it(e.g. preserving endangered species, etc..).

Since it is often difficult to assess the impact of an environmental consequence in monetary terms , a need for measuring techniques specific to such impact arises. Therefore, to quantify these concepts of value, a variety of valuation techniques are adopted, all of which share the basic concept of economic valuation which is the willingness to pay of individuals for an environmental service or resource. Each

[8] Ibid.
[9] Pearce and Barde (1992), p.3.

valuation technique is used under specific circumstances and is classified according to which market it relies on. The different markets are conventional, implicit and artificial. In order to value benefits and to estimate costs, some of these techniques depend on market prices of goods and services, and others rely on survey based approaches to derive values.

Valuation using conventional markets includes five types of techniques: changes in productivity , replacement cost, loss of earnings, shadow project and preventive expenditure .These techniques are directly based on market prices or productivity. They are used to value effects that change quantity or quality of outputs that are eventually exchanged on the market .[10]

The *change in productivity technique* can be seen as an extension of the conventional cost benefit analysis .However, calculations have to be supplied with meaningful data on underlying ecological relationships through for example Environmental Impact Assessment.[11] The reasoning behind this argument is that many environmental impacts can affect directly production or productive capability. For example, water quality can damage agricultural production, and pollution may affect fish production, etc... Thus this technique traces the impact of a development project on production and productivity levels (whether it be positive or negative).

The *replacement cost technique* goes further to evaluate the cost of environmental improvement that has to be incurred to replace the already damaged asset. The *loss of earnings method* traces the effect on human health that occurs as a result of a change in environmental quality rather than evaluating a change in output of

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[10] Dixon and Sherman (1990), p.35.
[11] Bojo ; Maler; Unemo (1992), p.72.

some good. This can be done by measuring the medical costs attributed to the increased level of environmental damage .The *preventive or actual defensive expenditure technique* reflects expenditures required to reduce or prevent environmental damage. The *shadow project technique* entails the design and costing of one or more "shadow projects " that provide for substitute environmental services to compensate for the loss of environmental assets under the ongoing projects.

Valuation using implicit markets use market information indirectly .These methods include travel cost, property value and wage differential techniques. In essence, these approaches use observable market prices for one good to estimate the value of an environmental good that does not have its own price.[12] The *travel cost approach* assess benefits provided by recreational sites and records what people pay in travel costs to get to these sites . In the *property value technique*, the prices of land and property reflect the valuation of environmental quality. This technique is also referred to as "hedonic price" technique where hedonic prices are implicit prices of the characteristics of a property or piece of land e.g. size, location and environmental quality.[13] Finally, the *wage differential method* is based on the theory that the supply of labor depends on the working and living conditions in an area. Therefore, for people to relocate to more polluted areas or to undertake harsher or riskier working conditions , a higher wage has to be paid for them in return.

Finally, valuation using constructed markets includes both the contingent valuation and artificial market techniques. They are used when there is a lack of market prices or when inferences about consumer preferences are not available .With the

[12] Dixon and Sherman (1990), p.35.
[13] Bojo ; Maler; Unemo (1992), p.77.

contingent valuation technique, consumers are asked to reveal their preferences through direct questions about their willingness to pay. In the *artificial market technique*, markets are constructed to determine the consumer's willingness to pay for a good or service.

After introducing the various valuation techniques , it is obvious that our choice of techniques lies mostly in the change in productivity method. Other methods that depend on the conventional market are also widely used . Valuation based on constructed markets is not used because we cannot always question consumers about their preferences . Also, we always try to introduce everything in the market through prices making information readily available .

<u>Section 1.2:Environmental Consequences of Dams.</u>

We must identify the changes associated with the construction of any dam before considering their welfare impacts. Loss of sediment, water-logging, loss of fish , erosion, evaporation and seepage are just a few of the environmental consequences that can occur as a result of the obstruction of a river by a dam. Some of these consequences can be mitigated with careful policy considerations. Other consequences, however, cause irreversible damage, and thus the only way to mitigate their adverse effects is by not causing them in the first place. Loss of sediment due to its entrapment on the bottom of a reservoir would result in silt-free water discharges that contribute to the erosion and the degradation of river banks. Water-logging and increase salinity occur as a result of water overuse and because of poor drainage. This occurs as a result of the increase in the water supply available in the reservoir all year around. This is conducive to poor water management and the non-efficient use of the resource. Furthermore, evaporation, and seepage will result especially in those arid regions where water stored in the reservoir is simply lost due to evaporation that occurs at the surface level of the reservoir. Also as a result of the change in the water course created by the construction of the dam, the water velocity, temperature, and streambed configuration will definitely change. These characteristics differ in degree from one water course to another. These basic changes can produce significant impacts, especially on water quality, making it an unfriendly host to the already existing fish inhabitants. Also, the spread of water weeds and algae in man-made lakes will inevitably affect the fish population and the water quality, and consequently human health. Attention must also be given to the possibility of changes in the microclimate (air humidity, fog, etc.). Some climatic changes which can take place are increased rainfall, reduced temperatures, and increased humidity.

Although dams are an accepted part of man's technological arsenal to control nature for his advantage, only a handful of assessments have been carried out to trace the full impact of construction. [14] Since the conventional cost/benefit approach, depends largely on physical and economic variables ,it is therefore insufficient to account for the socioeconomic, political, and psychological aspects of water projects which are hard to quantify[15]. Adding to this list of unaccountables are environmental consequences. Therefore, in conclusion by introducing the environmental economics framework we provide the theoretical basis for the economic analysis present in Chapter Four and we establish the bridge between conventional analysis of projects and an environmental assessment analysis. To understand the reasoning behind the construction of the Aswan

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[14] Fahim(1981),p.3.
[15] Ibid,p.4.

High Dam , it is important to recognize what the Egyptian Government faced in the late 1950s. Chapter Two studies the Egyptian economy in the aftermath of the 1952 revolution. It was during that period that the main economic and political transitions took place, leading to the construction of the Aswan High Dam.

Chapter Two:The Economy of Egypt since 1952.

This chapter presents an overview of the Egyptian economy since 1952. The focus is on the agricultural sector in Egypt since it is the most relevant sector to the construction of the dam. This period that began with the 1952 revolution was chosen because it encompasses the necessary foundation of policies and decisions that lead to the construction of the Aswan High Dam.

Egypt sits in a geographically strategic area: it lies in North Africa and is surrounded by the Sudan to the South , the Mediterranean to the North, the Red Sea to the East and Libya to the West(Map). By 1952, it was a predominantly agricultural country with nearly three quarters of its population (70 percent) living in rural areas. Hence, most of its exports(90 percent) and a large share of its national income (30 percent) were drawn from the agricultural sector, which employed 63.2 percent of its active population and absorbed 66 percent of the national capital .[16] Moreover, a single cash crop , namely, cotton, dominated the economy by occupying 21.45 percent of the cropped area. Other cereal crops such as wheat, maize, rice, and barley, occupied 43.4 percent of the cropped area.[17]

Industry played a minor role in the Egyptian economy and was restricted to those functions that supported agriculture. The scarcity of tapped mineral resources and the absence of a cheap source of energy had until then condemned Egypt to concentrate on the agricultural sector, which was completely dependent on cotton cultivation and, consequently, exposed to the violent fluctuations of the world cotton market.[18]

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[16] Saab (1967), p.1.
[17] Ibid., p.4.
[18] Ibid., p.1.

Land was always an integral part of Egypt's economic aspirations. The first task set by the free officers of the 1952 revolution was the reform of land tenure. In order to break away from feudalism, new land reforms dismantled Egypt's large private estates and imposed a ceiling on land ownership.

Egypt's economic development problems almost always had their roots in the characteristic of its agricultural economy. In 1952, around 2,760,661 landowners owned 5,964,000 feddans, with an average of 2.2 feddans per landowner .[19] The very big landowners (over 200 feddans) representing less than 0.1 % of the total land owners, owned 20% of the cultivated area, while the medium- sized landowners (over 5 feddans) who represented slightly less than 6% of all landowners and who numbered less than 162,000 persons, owned 65% of the cultivated area.[20] On the other hand, the small landowners (under 5 feddans) making up the vast majority of landowners (94.1 percent), possessed only 35% of the cultivated land area, although they were 2,600,000 strong.[21] Therefore, before 1952, political and economic power laid in the hands of large landowning groups which resisted any kind of social reform, since it did not serve their interests to do so.

With the revolution came the Agrarian Reform Law of September 1952, which aimed at breaking the power of these groups by limiting land ownership to a maximum of 200 feddans per person. Tenancies could be held in perpetuity and passed on by inheritance.[22] In a crowded country , where scare fertile land is as valuable as gold, such

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[19] Ibid., p.9.
[20] Ibid.
[21] Ibid.
[22] The Economist (1997), p.45.

a policy represented major empowerment for the poor.[23] In addition, the revolutionary government of the 1950s and 1960s nationalized industry , provided free education and health care, subsidized staple foods, and guaranteed state jobs to all university graduates. These policies popularized the revolutionary government and placed Egypt in the forefront of the newly independent states, especially the neighboring Arab states.

Another important function performed by the free officers was dealing with the demographic transition that Egypt was going through. The agricultural economy was not able to keep up with the increasing demographic pressures. The situation worsened during the next decade, due to Egypt's population explosion and consequent food scarcity. Also, the government was no longer able to support its growing state sector and relied upon more foreign borrowing, exacerbating its balance of payments situation.

Section 2.1: Food self-sufficiency in Egypt.

Egypt ranks among the most food dependent countries in the world. As figure 1 shows, the gap between the consumption and production of wheat have widened drastically during the period of 1949 to 1980. This wheat gap had its political and financial implications since wheat constituted the basic staple of the Egyptian diet. Although this gap has widened over the concerned period of time, fluctuation in the size of the gap has occurred from one year to the next. This reflects the fact that the consumption and the production of wheat was affected by several factors such as the price on the international market, the availability of foreign exchange, the political

[23] Ibid.

situation (and thus aid) and government subsidies. These factors contributed to Egypt's food crisis .

As figure 2 shows, variations in consumption and production of wheat can be attributed to the change in the international price of wheat and hence the subsequent changes in both the producer and consumer prices which were set by the government. For example, besides the growth in population and income, a substantial part of the rise in wheat consumption during the later part of the 1970s reflects the fall in the real price to consumers(reflected in a downward trend of consumer prices in figure 2).Similarly, on the production side the producer price of wheat fell relative to competing crops discouraging production.

To avoid rising consumer prices as a result of the increase in the population , real incomes and urbanization the Egyptian government relied on the importation of wheat. As Table 1 shows, although wheat production has increased over the years 1949 to 1979, this increase was insignificant since wheat imports rose at a much higher rate.

Therefore, whatever Egypt could not produce domestically , it was forced to import. Since during this period of time nationalization was taking place, all foreign trade(and thus wheat imports)was under the control of the Egyptian government .These agricultural policies had their implications on the foreign exchange available to the government. There was an opportunity cost associated with such an agricultural policy. As Table 2 shows, foreign exchange that could be used to build a productive base for the Egyptian economy was instead spent on food imports. Consequently, this policy of wheat importation not only exhausted the government budget but made Egypt more susceptible to any change in the international prices of food commodities.

Wheat compromises the most important ingredient in the Egyptian diet. As a matter of fact , the Egyptian word for bread is 'aysh' which literally means life. Consequently, it was the responsibility of the Egyptian government to provide and to finance this commodity to avert any potential protest or rebellion on the part of the people. The Egyptian government wanted to make sure that the series of riots which price increases and food shortages had caused in 1977 would not be repeated. However, the government's attempt to avert such unrest has not been successful . Price increases in basic necessities have ignited riots and strikes every other year.

As a result, the impact of food shortages on domestic political and economic stability made food security the primary issue confronting the government. The Egyptian government realized that by providing and financing wheat it was achieving an important political goal and, hence, domestic stability rather than a public service. As a consequence, ensuring wheat supply remains at the top of its list of priorities. The government is responsible not only for financing the import of wheat , but also administering its domestic distribution. Until 1985, it banned any private trade in wheat . The main reason behind this ban was its fear that any speculation in the supply of wheat would affect its price. Therefore, the General Authority for the supply of commodities(GASC), an agency under the control of the ministry of supply, was made responsible for the importation and domestic distribution of wheat. To ensure a regular supply of bread and flour, the GASC spent millions of pounds subsidizing their price. This subsidization of food imports drained and exhausted the government's budget.

Because it is a major food importer and thanks to increased interdependence in world markets , Egypt is susceptible to changes in the international prices of imported goods. In the mid-1980s, there was an excess supply of wheat on the international market, driving its price down. For Egypt, this meant cheaper prices for wheat imports. However, this situation was not sustained, and by the end of the decade, there was no longer excess supply in wheat. The vulnerability of food imports to international prices adversely affected the Egyptian government's supply of hard currency to support its food subsidies. During the glut years , Egypt not only faced lower wheat prices, but also the financing of wheat imports was not very hard. Between 1975 and 1987 the United States gave Egypt $2.7 billion in highly concessional loans to purchase wheat and other American agricultural commodities .[24] However, these subsidies on the part of other countries were not always forthcoming and thereby food aid was not regarded as a secure source and thus the search for hard currency to finance the food imports pushed Egypt more deeply into debts. In 1987, in an attempt to deal with this situation, Egypt has adopted an economic reform program in the agricultural sector. This reform program would be later broadened , in 1991, to include structural adjustment policies in other sectors. These reforms changed agricultural policies by removing government controls, encouraging the private sector to step in and increasing the reliance on market mechanisms .Although these reforms achieved macro stability , the economic reforms have not yet been able to achieve rapid growth to absorb Egypt`s growing labor force or to raise the living standards of its population.[25]As Chart 2 shows, during the 1980s and the early 1990s there was an increase in the area share of wheat ,however at the expense of other competing crops. However, the estimated annual trend growth rates for 1987-1995 are 1.9 percent for the aggregate economy and 1.6 percent for agriculture, i.e.,

[24] Ibid., p.18.
[25] Serageldin and Steeds (1997),p.286.

below the population growth rate of 2.0 percent.[26] Chart 3 displays, the percentage of agriculture in the GDP which has been declining since 1975 and the large proportion of food in total imports .

In Egypt's case, hard currency comes from four main sources : oil sales, revenues from the Suez Canal tariffs, tourism industry and the remittances of workers from abroad. It is quite obvious that each of theses sources has an international political aspect contributing to Egypt`s vulnerability in the face of international politics.

Financing food imports drained hard currency revenues. By the end of the 1980s, Egypt had to fight three fierce battles in the face of rising world food prices, decreasing hard currency revenues, and rising debt service obligations. By 1989, the World Bank estimated that Egypt's total foreign debt (excluding military debts to the Soviet Bloc) had reached $50 billion and its debt ratio (estimated total debt as a share of exports of goods and services)was more than 400 percent-one of the highest in the world.[27]

Section 2.2:The origins of the Food Crisis.

The origins of the food scarcity crisis prevailing in Egypt can be traced to the international rise in world food prices and to the chronic budget deficit of the Egyptian government. Three factors exacerbated the crisis; population growth, land scarcity and modest agricultural yields. These factors contributed to Egypt's vulnerabilities in the face of changes in the international world prices and its chronic budget deficit.

[26] Ibid.,p.286.
[27] Sadowski(1991), p.20.

Section2.2.1: Population Growth

As Table 3 shows, Egypt's population has been growing steadily over the past decade. Also according to the Statistics Division at the United Nations ,an estimate of mid-year population in Egypt in millions in 1992 was 55.74,in 1993 was 56.49, in 1994 was 57.85, in 1995 was 59.23 ,in 1996 was 60.60 and in 1997 62.01. Not only does this growing population imply more strain on Egypt's resources, it also means more mouths to feed. When employment in the public sector was guaranteed in the 1960s to all university graduates, an increasing population translated into an overstaffed public sector. Yet even if the government chose a more determined approach towards the population problem, Egypt's food crisis would not end, since before family planning can effectively influence the size of a country's population, a full generation has to pass as females reach their reproductive age.

Therefore, controlling population growth in an attempt to resolve the food security crisis in Egypt would be ineffective if it is not conducted with other appropriate and necessary measures. For the foreseeable future, local food production or imports will have to grow by 2.6 percent every year just to sustain existing levels of consumption .[28]

Section 2.2.2: Land Scarcity

The second factor that underpins the food security crisis is land security. The great Sahara desert covers most of Egypt ; only the narrow valley of the Nile , a mere 2.8 percent of the country's land area is suitable for cultivation.[29] The problem of limited

[28] Ibid., p.24.
[29] Ibid.

amount of land available is compounded by the problem of population growth. In 1960, each hectare of arable land had to feed 10.3 Egyptians and in 1988 each hectare had to feed 21.2.[30]

As Table 4 shows, the area of land available to the average cultivator decreased as the number of people willing to hold an area of land increased. Land reclamation schemes have been adopted by the Egyptian government in an attempt to recover land which is otherwise not farmed because it is too far from water resources or because its soil is marginal. Most of these schemes operated along the fringes of the Nile valley. The Egyptian government claims to have reclaimed 912,000 feddans between 1952 and 1975 which is equal to one- sixth of the traditional cultivated area.[31] However, this amount was short of the target. The reasons behind this shortfall in the amount of reclaimed land was poor management, technical problems, and the long time- span required before any substantial recovery is detected. It takes years for these techniques to make the land fertile enough to support conventional crops; and even then, yields on reclaimed land remain significantly lower than on "old lands".[32] Also, reclamation cost per feddan was constantly rising since reclamation began with better quality soil. Also the cost of labor and energy required for pumping water was on the rise.

During the 1980s, however, new technologies were developing which made land reclamation schemes feasible in terms of both cost and practicality. Also, despite the attempts of the Egyptian government to invest in such schemes, the cultivated area has remained constant. The reason is that old land was taken out of production and used

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[30] Ibid.
[31] Ibid.
[32] Ibid.

for urbanization. Farmland in Egypt is disappearing at a rate of 60,000 feddans a year.[33] To minimize this loss, the government placed penalties for the conversion of farmland into real estate or anything of that sort. The government's main aim is to lure people away from the capital Cairo by building a series of new cities –10 Ramadan City, Sadat City, El Amirriyya and 15 May – in the desert adjacent to the Nile Valley.[34] However, since these new cities still face a growing population , the cultivated area is not expected to increase.

For the next twenty years, Egypt as a result cannot expect any significant increase in the size of its cultivated area, nor any reduction of the population it has to support.[35] Therefore, the last resort to be used to promote its food security crisis lay in the third factor, namely agricultural yields.

Section 2.2.3: Agricultural Yields

Agricultural yield is the size of a crop that can be produced on a given unit of land. Changes in the cropping patterns may not actually increase the yield of specific crops, but they may maximize the economic return for each unit of land .[36] However, the composition of crops have always been debatable in the Egyptian society. Official policy called for efforts to achieve 50 percent self- sufficiency in wheat production and to promote the planting of high- value crops on land not needed for wheat.[37] Many techniques have been adopted by Egyptian farmers in an attempt to increase agricultural

[33] Ibid., p.25.
[34] Ibid., p.26.
[35] Ibid.
[36] Ibid., p.28.
[37] Ibid., p.29.

yield. One technique included the adoption of a new generation of high-yield variety(HYV) seeds. These seeds are engineered to increase agricultural yields.

Many techniques are readily available in Egypt. Yet they are not being adopted, or at least are only gradually being introduced. As a result, yields are not increasing nearly as rapidly as they could. [38]During the 1970s, the value of agricultural output in Egypt stagnated; food production actually declined by 7%.[39] In the 1980s output began to grow again but only by 2.7% annually –barely enough to keep pace with the growth in population.[40] As Table 5 shows, compared to other Arab States(at comparable levels of development) agricultural growth in Egypt has been modest.

Agriculture plays a pivotal role in the Egyptian economy. Most importantly, agricultural development is critical to resolving the food security crisis prevailing in Egypt. Food security problems do more than threaten hunger ; they hinder development in the nonagricultural sectors of the economy.[41] A 10 percent rise in the cost of imported foods decreases Egypt's industrial output by 1-2 percent, by consuming hard currency that would otherwise be available for the purchase of industrial inputs.[42] Although , as Figure 3 shows, at times, wheat was given in the form of concessionary terms, wheat imports exhausted the foreign exchange reserves and receipts . Conversely, if government spending on food subsidies could be decreased by 10 percent, thereby reducing the government's budget deficit, the value of the Egyptian pound would increase by 3 percent ,thereby reducing the inflation rate by 5 percent.[43]

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[38] Ibid., p.30.
[39] Ibid.
[40] Ibid.
[41] Ibid,p.43.
[42] Ibid.
[43] Ibid.

The Egyptian preoccupation with agricultural development was also a result of the ultimate effect that slackness in agricultural development has on social problems like unemployment and migration from rural to urban centres. However, food self sufficiency has been the primary concern of Egyptians over the last few decades. As a result, any plan that would have a positive effect on agricultural production was encouraged and adopted.

As will be discussed in Chapter Three, the Aswan High Dam was constructed as a means to providing water and thereby improve agricultural production and development and consequently deal with the food self sufficiency crisis. It was expected that as a result of providing water all year around ,agricultural production would increase putting an end to the threat of a food crisis that grew in magnitude with every passing year.

Chapter Three:The Case of the Aswan High Dam.

> "In antiquity , we built pyramids for the dead . Now we will build new pyramids for the living." Gamal Abdul Nasser.[44]

The Nile is Egypt's main source of water and it is the place that Egyptians (rulers, kings, ordinary people) have turned to for solutions in times of hardship. They tried their best to control and to use it efficiently. A long series of engineering projects were erected on the Nile to change the river flow and thereby increase the usefulness of its waters to the population of the Nile valley(Table 6). The Aswan High Dam is neither the first and nor is it going to be the last of such engineering projects.

Depending on the procedure of measurement, the Nile is either the longest or the second longest river in the world , draining 3.1 million Km^2 and parts of nine countries in its 6671 km course to the Mediterranean (including the Kagera river, a tributary to lake Victoria) .[45] Therefore, the Nile forms a river basin shared by nine countries: Ethiopia, Uganda, Tanzania, Kenya, Zaire, the Sudan , Egypt, Rwanda and Burundi. And it lies in three different climatic zones: tropical in the south, subtropical in the middle and arid desert in the northern sector.

Two sources contribute to the existence of the Nile :the first is lake Tana in Ethiopia(Blue Nile) and the second is Lake Victoria (White Nile). Only about 7% of the flow of the Blue Nile comes from lake Tana, but as it flows north through the Ethiopian mountains toward the Sudan, the Blue Nile continually combines both water and silt from innumerable small tributaries.[46] As the river flows North through the Sudan towards its junction with the White Nile at Khartoum, it receives water from its main tributaries: the

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[44] Fahim (1981), p.14.
[45] Whittington and Guariso (1983), p.1.
[46] Ibid., p.1.

Rahad and the Dinder.[47] North of Cairo, the Nile splits into two branches forming the Nile delta , which was created throughout the years by sediment deposition by the Nile making it extremely fertile.

Along the Northward course of the Nile, the amount of rainfall decreases. Around Lake Victoria and in some parts of the Ethiopian mountains, rainfall is in excess of 1800 millimetres annually.[48]On the other hand, the Sudan is mostly arid ; rainfall north of Khartoum negligible. The fertile plains of Blue Nile clays in the Eastern Sudan possess 200-800 millimetres of rainfall per year.[49]The vast majority of Egypt receives less than 25 millimetres of rain annually; many places can go for years without receiving any rain.

There is a great contrast between the riparian state which contributes almost all the water to the Nile but uses almost none (Ethiopia) and that which contributes nothing to the Nile but consumes most of its water (Egypt).[50] Egypt contains 9.9 percent of the Nile's drainage basin and although it contributes no water to the river, it uses most of its waters: some 55 billion m3 per year[51]. As the population of the riparian states grows rapidly, pressure is added on the waters of the Nile to provide the farming economies of these states with this extremely demanded yet scarce commodity.

Not only does the flow of the Nile varies from one month to another but also substantial variation occurs from one year to another. The river Nile run-off with an average annual flow of 84 km^3 fluctuates sharply and in dry years, the run-off can go down to 42km^3 exposing cultivation in the country to drought and in wet years, the run-

[47] Ibid., p.3.
[48] Ibid., p.3.
[49] Ibid., p.3.
[50] Kliot (1994), p.15.
[51] Ibid., p.30.

off increases to 151 km^3 causing floods and inundating plains. [52] Therefore, because of this capricious nature of the run-off, controlling the river Nile has always been important.

Figure 4 compares the discharges for the years 1912-89 with three mean values: from 1870-1959, mean discharge flow 102 billion m^3, from 1899-1971, mean discharge flow 88 billion m^3 and from 1972-1986, mean discharge flow 77 billion m^3. [53] One can detect a constant reduction in the mean discharge of the Nile during the three periods.

The reasons behind the climatic change in the Nile basin are unclear. Scientists disagree on this issue ;there is no single clear explanation . One group of scientists point to the inadequacy of the available data ,which supports various theories that point to global warming of the atmosphere as the major force behind the change in rainfall. Other scientists suggest that the greenhouse effect is responsible for the climatic change and the subsequent impact on rainfall. The advocates of this theory refer to the El-Nino years as the global atmospheric changes are tied to decrease rainfalls.

Whatever the reason, the architects of any Nile control engineering projects have always faced two problems. The first problem is how to change the seasonal distribution of the annual discharge in order to have more water for agricultural consumption in the spring and summer.[54]

[52] Materials for Final Engineering Report on the Aswan High Dam(1970).p.15
[53] Kliot (1994), p22.
[54] Whittington and Guarise (1983),p.7.

And the second problem is how to alter the variation in the annual discharge of the Nile.In other words, the aim was to save water from years of high floods for use in those years of low floods.

Section 3.1:Water Development Projects on the Nile.

Since the times of the ancient Egyptians, irrigation works have had a tremendous and integral role in the survival and success of any specific civilisations. Each civilisation attempted to regulate the waters of the Nile for flood control by building barrages, canals and dams . However, not until the 19th century, has there been real irrigation work on a large scale.

Basin irrigation was used in Egypt since Pharaonic times in an attempt to utilise the natural seasonal pattern of the Nile discharges. The basin irrigation system was thus designed to capture the flood waters for the cultivation of a single winter crop.[55]During the spring time, it coincided with the harvest of the grain crop and thus the basins were again empty awaiting the arrival of the next flood. Besides the winter crop grown in the basins, a summer crop used to be cultivated in specific areas where land was high so that crops would be protected from the floods and water could be lifted from the river or the well for irrigation. This system of basin irrigation provided sufficient amounts of food for the Egyptian population for centuries. As a matter of fact, Egypt at one point generated excess supply of grain that it fed people in the Middle East and the Mediterranean.

[55] Ibid., p.10.

However, in the early nineteenth century, as the Egyptian agriculture started to integrate with the world economy, this system of basin irrigation started to change.

When Egypt was ruled by Mohammed Ali Pasha (1805-1849) who consequently laid the foundation for the modernisation of Egypt , substantial works on the Nile was put into effect in an attempt to regulate it. As the industrial revolution was taking place in the West, Mohammed Ali was unable to afford the cost of an industrial revolution in Egypt and hence turned to the Nile in search for prosperity and wealth. Since Egypt's climate is suitable for cotton production, Mohammed Ali turned to cotton cultivation . However, this agricultural promise depended on the improvement in irrigation systems to support cotton production that matured during the spring and early summer. Accordingly, Mohammed Ali's agricultural policy was based on the improvement of existing irrigation systems through the construction of barrages and the digging of more canals that carried water to more lands.[56] In order to supply water for the summer cotton, deep canals were excavated in the 1820's in the Delta, which could carry water from the Nile at its low summer levels.[57]

Therefore, water utilisation in modern times began in 1834 when Mohammed Ali attempted to expand the area utilised for summer crops by creating a system of canals in the delta.[58]

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[56]Fahim (1981), p.9.
[57] Whittington and Guarise (1983), p.12.
[58] Kliot (1994), p.32.

This system of canals expanded agricultural production by making it possible to cultivate two and three crops per year. This was achieved as a shift from basin to perennial irrigation was taking place.

However, this new system of perennial irrigation was not void of difficulties. Primarily, inadequate drainage became a problem as the natural deposit of salt compiled through basin irrigation did not take place. The Nile silt was trapped in the canals rather than being deposited on the fields. This problem of silt deposition entailed huge costs.

Hence in order to avoid this massive task of canal clearing, in 1833 at the suggestion of M. Linant Bey, Mohammed Ali began the construction of the Delta Barrage at the bifurcation of the Nile and at the head of the delta.[59] The purpose of the delta barrage was to raise the level of water on the upstream side of the barrage . This would in turn help to supply water to the canals at a higher level than those of the deep water summer canals. During flood times, the barrage was opened allowing the discharge of the river to go through. On the other hand, during the summer and spring times, the barrage was closed allowing the level of the river to be raised and thus divert the water supply to the irrigation canals. In 1861, work on the delta barrage was finished and was followed by the British occupation of Egypt in 1882. The British worked on improving and restoring the delta barrage which marked the beginning of their involvement in engineering water projects in Egypt. Not only did they improve the drainage and irrigation system but also they supplemented such repairs with improved administrative arrangements for operating the systems. A number of other barrages were developed by the British in an attempt to raise water for perennial irrigation.

[59] Whittington and Guarise (1983), p.13.

However, these barrages soon proved inefficient as they provided insignificant amounts of seasonal water storage.

Therefore, until the middle of the nineteenth century, Egypt used basin irrigation for its farming which led to the extreme dependence of the population on the natural hydrological regime. However, with the first delta barrage it was becoming possible to extend the irrigated area and to provide irrigation water for perennial use. Although these delta barrages were built during the reign of Mohammed Ali, the British occupation that followed in 1882 was very influential in this respect. Also, during the reign of Mohammed Ali, the per capita agricultural production rose and hence lifted Egypt out of ages of economic hardships.

However, Mohammed Ali's dream of an industrial development supplemented by agricultural expansion was short lived as the British occupation in 1882 had a tremendous effect on the Egyptian economy for many decades to come.

Unwilling to see Egypt develop an industrial base, the British rule focused on policies that would serve their own interests; one of which is maintaining Egypt as entirely agriculture. Expansion in cotton cultivation was favourable to the British rule as they perceived its high economic returns. However, in order to support this expansion in cotton cultivation, appropriate water resources were necessary. However, these barrages soon proved inefficient as they provided insignificant amounts of seasonal water storage. Therefore, water storage proposals were the next step in the development of water management systems in Egypt. Damming the Nile within Egypt was one of the major flood storage proposals. The Aswan dam was to store part of the flood water for use in the following summer. In that sense the Aswan project, completed in 1902, was a single purpose project. Therefore, in 1902, the Aswan dam was constructed by the British to regulate the Nile in order to irrigate the cotton fields and export it to Britain or elsewhere in the Empire. The dam, stretched across the Nile cataract for a distance of more than a mile, at a height of 30.5 meters and with a storage ability of up to nearly 1 billion cubic meters of water in an artificial lake extending south for a distance of 225 kilometres. [60] The dam was raised twice, during 1912 and 1933, to meet Egypt's growing need for water and to avoid any possibility for a flood or famine. However, Egypt was still concerned about the possibility of a high flood causing drastic low flood leading to famine and starvation. Therefore, the Aswan Dam did not provide flood control neither did it address the problem of yearly variation in the discharge of the Nile .

The search for a comprehensive scheme of national insurance against flood and famine other than a third expansion of the Aswan Dam became a paramount issue[61]. Therefore, the issue of flood control was surpassed by the issue of water storage. Subsequently, during the nineteenth century, seasonal storage proposals aiming at storing summer water received the greatest priority. However, the threat of floods was not overlooked by the British engineers.

During the first half of the twentieth century, however, there was consensus in Egypt and the Sudan regarding the over-year water storage would have to be developed. During that period, H.E. Hurst developed the Century Storage Scheme that called for storing water from high years for use in low years.

The "Century Storage Scheme" introduced by H.E. Hurst envisaged storage of water on the Blue and White Nile from water abundant years for use during drought

[60] Fahim (1981), p.10.
[61] Ibid.

years. The idea behind the project was full Nile control. The plan had the advantage of being an integrated plan regarding the fact that the whole Nile basin was treated as one unit irrespective of its geographical location. However, not until a new chapter in Egypt's modern history was unfolded that a decision was made.

Section 3.2:The Aswan High Dam.

The idea of using the African great lakes for century storage was turned down by the revolutionary council, who came into power in 1952. Therefore, the plan was never fully implemented. Instead all the riparian states, especially Egypt, developed their own separate water projects, one of which was the Aswan High Dam.

The idea of the construction of another dam at Aswan was that of Adrian Daninos, a Greco-Egyptian engineer. Daninos put the High Dam proposal before the new regime in August, 1952, within one month after the free officers came to power, and planning and evaluation of the project began almost immediately.

The Aswan High Dam became a reality whereas the Century Storage Scheme was long forgotten. The reasons behind choosing the Aswan High Dam were threefold. The first reason pertained to water control politics and national security. Although both projects provided summer water, over- year water storage and flood control, the Aswan High Dam was entirely in Egyptian hands whereas the upstream riparian states, that would have subsequently formed part of the Century Storage Scheme, were under the control of Great Britain. Since Great Britain colonised Egypt at one point, this was to make a statement regarding Egypt's national integrity and independence.

The second reason revolves around the time that was required for the completion of the Century Storage Scheme which was twice as long as that required for the Aswan High Dam. This time factor was carefully assessed by the new rulers of Egypt, the free officers of the 1952 revolution, who were anxious to implement rapid economic growth for their growing and impoverished populations. This was to demonstrate that the new regime, unlike the previous one, was willing to engage in developmental problems previously neglected.

The third reason revolved around the goal of industrialisation that Egypt has long aspired for. Hence, Gamal Abdul Nasser, the leader of the revolution, figured that the Aswan High Dam unlike the Century Storage project, would offer the substantial quantities of hydroelectric power needed to run the industries.

Furthermore, Gamal Abdul Nasser undertook agrarian reforms with the objective of abolishing the system of feudalism. However, these agrarian reforms did not provide the solution for Egypt's economic problems. The threat of population growth became paramount causing agricultural land to become scarce. As a result of the perpetuation of the imbalance between the rates of population growth on the one hand and the land production on the other hand , the Aswan High Dam project appeared as a promising solution to this ever-growing problem. The Aswan project in general was considered very promising , especially in terms of adding new arable land, increasing the output of the existing cultivated land, and generating electric power that would promote the industrialisation that Egypt had long striven to achieve. In this sense it was conceived as a multi- purpose project.

With the Aswan High Dam, it really appeared that Hurst's century storage scheme was being implemented but only within Egypt's borders. Building the dam on Egyptian soil and under Egyptian control was to make a statement about Egypt's political and economic independence in the midst of economic and political turmoil in the Middle East at that time.

Perhaps no other dam has generated much debate as did the Aswan High dam at the time of construction. The decision making process that led to the construction of the Aswan High Dam had internal , regional and international repercussions. As for the internal Egyptian development, the free officers who led the revolution were confronted with social injustice, water shortages and a growing population. The revolutionary council turned to the Nile for a solution. The Aswan High Dam was to free Egypt from water shortages and thereby provide it with water security that Egypt has longed for all within its borders.

On the regional level, the Egyptian -Sudanese relations were marked by instability. The planning and the subsequent construction of the dam exacerbated the situation. Sudan and the other riparian states were not consulted as the planning of the dam was underway. In 1954, the Sudanese government was involved in the project but to no avail. As a matter of fact, the planning and some of the construction began even before the two countries were able to reach an agreement concerning the share of each country with regards to the stored water in the Aswan High dam. Only after the Sudanese army, led by the lieutenant general Ibrahim Abboud, took over the government of the

Sudan were the two neighbours able to reach an agreement since the new regime was friendlier towards the free officers regime in Egypt.[62]

The urgency with which the project was planned and implemented was related to the catastrophic inundations of 1946, the high rate of population growth and hence the critical level of food production and the decrease in the cultivated area available. Therefore, it appeared that the solution for this food problem was an increase in the irrigated areas. However, there was no water source but the Nile.

Section 3.2.1:The Aswan High Dam: Funding.

On the international arena , one has to follow the steps that led to the formulation of funding procedures of the dam to understand the international repercussions that followed. The new regime consisting of the free officers had goals and principles to which they wanted to abide by. On top of their list was the encouragement of prosperity for the population by designing an equitable distribution of economic goods among the Egyptian society. What bound them together was an overriding concern with Egypt's independence, in all its political, military and economic aspects, an independence they rightly viewed to be contingent on the emergence of a materially secure and educated citizenry.[63] The new regime hoped to lessen Egypt's dependence on the agricultural sector and thereby push towards an industrial footing. This was seen by the new regime as a saviour to Egypt from the dependency on the international community and from the economic backwardness.

[62] Kliot (1994),p.41.
[63] Waterbury (1979),p.98.

Within two months of the July revolution, the Aswan High Dam project was under serious and favourable consideration by the Revolutionary Command Council (RCC).[64] The political and economic advantages of the Aswan High Dam were not overlooked by the regime. Politically, it served as a monumental victory to Egypt; it was gigantic, within natural borders and a case of modern hydrological engineering. Egypt would no longer be hostage for its economic survival to the upstream riparian states. Economically, the project would expand the agricultural sector, provide a cheap source of energy to fuel industrialisation and most importantly it would take only a decade for its completion as opposed to at least twice as long for the previously suggested Century Storage scheme. The new regime placed the Aswan High Dam project on top of its priority list and pursued its implementation and design.

West Germany agreed on financing an engineering feasibility study of the Aswan High dam. Feasibility studies were carried out by two German firms, Hochtief and Dortmund Union, which endorsed the plan of building the Aswan High dam. By 1955, all that stood in the way of beginning construction were the problems of hard currency funding and the need to reach an agreement with the Sudanese government on allocating the Nile waters after the dam became operational.[65]

In that respect, the IBRD (International Bank for Reconstruction and Development) was Egypt's hope to finance the construction of the dam with a Western aid package. The IBRD was very cautious. Its president at the time, Eugene Black, was involved in tireless negotiations with India and Pakistan for the development of the Indus valley. Also, the World Bank was always restricted in its aid policies on

[64] Ibid.,p.99.
[65] Ibid.,p.102.

considerations of the foreign policy goals and economic interests of its main depositors. The United States, a major financial contributor, had a major role in the IBRD decision-making process. As far as the High Dam project was concerned, these considerations inevitably drew the scheme into the context of the Arab-Israeli conflict and superpower rivalries .[66]

Therefore, Western aid for the construction of the dam was reflected in Black's reluctance to push forward the IBRD examination of the project until Egypt and Great Britain reached an agreement over the destiny of the 70,000 British troops stationed at that time in the Suez Canal zone. Wanting to carry out its own feasibility study , the IBRD disregarded the recommendations of the two German firms. In October 1954, two bank- appointed engineers were dispatched to Cairo, along with an economist who was to assess Egypt's ability to meet loan obligations and to mobilise domestic savings towards construction. [67]At the same time, Egypt and Great Britain reached an agreement entitling the evacuation of the British troops from the Suez Canal zone. The report prepared by the IBRD stated that the Aswan High dam was generally favourable, technically sound, economically beneficial (with minor reservations about some proposed land reclamation sites), but of such size that it would require strict fiscal discipline and "a rigid limitation on the Egyptian government's commitments to other projects".[68]

Also a twist of events occurred at the same time as the IBRD was preparing its feasibility study of the Aswan High dam.

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[66]Ibid.,p.103.
[67] Ibid.
[68] Ibid.,p.104.

The February 28, 1955 Israeli attack on the Egyptian army posted in the Gaza Strip exacerbated the Egyptian-Israeli relationship. For Gamal Abdul Nasser, the attack was seen as a sign to rearm and remobilize Egypt's forces. However, after the Arab-Israeli war of 1948, the United States, France and Great Britain applied partial embargo on the sales of arms to the attacking parties. Therefore, Egypt diverted its attention to the Soviet Union as a main provider of arms. For the first time, Soviet arms had entered an Arab country, and it remained for the leader of the free world to decide how best to retaliate.[69] Also, there was persistent rumours that the Soviets have offered to help in the financing of the Aswan High dam. At that point, there was an incentive for the IBRD to act quickly towards concluding an agreement for the Aswan High dam. Therefore, negotiations between the IBRD and the Egyptians concluded that the United States, Great Britain and the IBRD were to jointly provide the necessary foreign exchange for the construction of the dam.

The total cost of the project, including the power station, was estimated at $1.3 billion, with $400 million in foreign exchange. [70]The IBRD agreed to lend Egypt $200 million at 5.5 percent interest, while the United States and the United Kingdom promised grants of $70 million, ($56 million from the United States and $74 million from the United Kingdom) toward the first stage (diversion tunnels and coffer dams), along with the agreement that the two countries would loan Egypt a further $130 million at a later date .[71]

[69] Ibid.
[70] Ibid.,p.105.
[71] Ibid.

However, there were conditions imposed on the disbursement of the aid. The main condition was to assure Egypt that this was a one shot deal ; all or nothing deal. The IBRD would go ahead with its loan disbursement only when the United States and Great Britain also went ahead. This meant that the deal was contingent upon Egypt coming to terms with whatever differences it had with the United States and Great Britain . The suggested terms were severe. Egypt had to concentrate its development effort on the dam, diverting one third of internal revenues to the project over ten years. Also, the relevant aspects of the country's economy was to be subject to periodic IBRD review. Furthermore, the contracts must be awarded through open biding with a prohibition on any agreement being awarded to a communist country. Moreover, Egypt would have to avoid incurring new foreign obligations (such as acquiring more arms), and any new loans or credits would require prior approval by the IBRD. And finally, no disbursement would take place before Egypt reached a new agreement with the Sudan over the allocation of the Nile's waters.[72]

These stringent terms were met with criticism by the Egyptian population and Nasser. It was assumed by Nasser that such terms would be used to put Egypt under pressure to settle its differences with Israel and co-operate with the emerging system of western military alliances such as NATO. Most importantly, Nasser saw the terms as putting Egypt's economic aspirations in western hands by the time the second round of funding is available.

To soothe Nasser's fears, Eugene Black convinced him that such terms are common and standard practice adopted by the IBRD. In the same month the IBRD

[72] Ibid.

issued a report about the High Dam which estimated that after completion, the dam would generate annually an internal rate of return of 28.5 percent.[73]

Yet despite this progress, Egypt had not reached an agreement with the United States and the United Kingdom, nor had they formally approved and appropriated their shares of the $70 million grant.[74] Also, in 1956, enthusiasm on the part of the involved Western countries died out. A number of incidents contributed to the reassessment: Nasser's implacable hostility to the Baghdad Pact (CENTO) sponsored by the United States; his attacks on Jordan when Britain tried to coax that Kingdom into the pact; and the conclusion of a second soviet arms deal worth $200 million.[75]

Debate in the United States Congress followed and it was apparent that Congress would not accept any wavering down of the conditions attached to the disbursement of the first stage.

After deliberations between Eugene Black and the Egyptian ambassador in Washington, Nasser finally agreed to the existing offer. However, the Americans despised the fact that the Nile valley was playing a part in the cold war as the Egyptians once made clear that the Soviet Union would be willing to finance the project. Therefore, the United States backed out by withdrawing its offer presumably because of its assumptions that the Egyptian economy could not withstand the strain of building the dam. That was a surprise since the IBRD itself conducted a feasibility study of the dam and concluded that it is " technically sound, and economically beneficial".

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[73] Ibid.
[74] Ibid.,p.106.
[75] Ibid.

However, one of the main reasons that lead the Americans to back out was Egypt's purchase of arms from the Soviet Union, and its conflict with Israel. Great Britain came out with the same decision the next day. As soon as Nasser received the news, he considered it an attack on the regime and its credibility. Afterwards, Nasser announced the nationalisation of the Suez canal in the main aim of providing the necessary funding for the dam.

Consequently, as a reaction to Nasser's move, the British, the French and the Israelis invaded Sinai and the canal zone in October 1956. However, as a result of world pressure and consequently a United Nations resolution, the invading troops were compelled to pull out in December 1956.

The dam was regarded now as a symbol of Egypt's will to stand in the face of imperialist powers aiming at bringing the new regime down. It was believed that if the USSR were to come to Egypt's rescue, it would demand that the High dam become a showcase for Soviet technology and engineering .[76]

On October 23,1958, Khruschev informed Abd-El Hakim Amer (Egypt's chief of staff and Nasser's close friend) that the USSR was prepared to offer a credit of 400 million rubles (ca.$100 million) toward the first stage of construction. [77]A formal agreement was signed December 27 providing for repayment after completion of the first stage over 12 years at 2.5 percent interest.[78] This action on Egypt' s part, gave the Soviets an upper-hand in Middle Eastern affairs and dragged politics in Egypt into the Soviet mainstream.

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[76] Ibid.,p.108.
[77] Ibid.,p.109.
[78] Ibid.

On the other hand, the Soviet Union's position rekindled interest in the dam by Western powers. But these considerations were overlooked by Egypt, and on August 27,1960 an agreement was signed with the USSR for $120 million in credits toward the second stage .[79] Also an agreement was reached with the Sudanese government in December 1959, regarding each country's share of the waters of the dam and hence work at the dam site began on January 9,1960, almost eight years after the free officers had endorsed the project.

Nasser did not live long to witness the completion of the construction of the dam in 1971 when the official opening ceremonies took place under the auspices of Anwar Sadat, Nasser's successor. Afterwards, Egypt-Soviet relations deteriorated especially after Anwar Sadat expelled all Soviet military and technical advisors in 1971.

Section 3.2.2:The Aswan High dam: Physical characteristics.

Construction began on the High Dam in 1960 under the direction of the Soviet Hydro-project after almost a decade of technical review and planning.[80] The project echoed Soviet technical expertise throughout the Third World. In this regard, few have questioned from an engineering point of view the fact that the High Dam is a skilfully designed and superbly built structure.[81]

Egypt's Aswan High Dam is located only 6.5 kilometres upstream from the old Aswan dam and 850 kilometres south of Cairo and it is a rock-fill dam, 110.70 m high above the river bed, 980 m wide at the base, and with a length of 3,820m.[82] The reservoir

[79] Ibid.
[80] Whittington and Guarise(1983),p.38.
[81] Ibid.,p.38.
[82] Kliot(1994),p.41

extends over a surface area of 6,276 square kilometres of which 16.6 percent lies in the Sudanese section and is called lake Nubia; the remainder, 83.4 percent lies in the Egyptian territory behind the dam.[83]

At the Egyptian side, the reservoir is refereed to as lake Nasser or the High Dam's lake. Lake Nasser- Nubia is 450 km long and 10 km wide and is designed for the storage of 162 billion m^3. [84]Forty three million m^3 of materials were used in its construction; the structure is 17 times larger in volume than the Great Pyramid of Giza.[85]The Aswan High dam reservoir is the second largest in the world ;the hydropower station is the eighth largest.

The limited height of banks in the vicinity of the existing Aswan Dam hindered the erection of a larger reservoir at the site of the old Aswan dam.[86] The new dam's site was chosen because it had favorable geological conditions and transportation facilities. Both banks of the Nile rise steeply from the riverbed, making the chosen spot favorable for the construction of a rock-filled dam.[87] Also, behind the chosen site was a deep and wide valley on the upstream portion of the dam making it a favorable spot for storage capacity.

Section 3.2.3:The Aswan High Dam: Objectives

The objectives specified for the Aswan High dam can be divided into direct and indirect objectives.

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[83] Fahim(1981),p.8.
[84] Kliot (1991),p.41.
[85] Whittington and Guarise (1983),p.38.
[86] Materials For Final Engineering Report on the Aswan High Dam (1970).p.15.
[87]Hussein (1981),p.14.

The direct objectives are those that were supposed to be met immediately after construction of the dam was terminated. Most importantly the direct objectives included; protecting Egypt against fluctuations in the flow of the Nile by guarantying water supply for domestic , industrial and agricultural uses. The dam would protect Egypt from floods and famines by storing the excess water during the high flood years to be used during the low flood years and thus provide over year storage. The dam would finally cushion Egypt from the water fluctuations of the Nile. As for agriculture, the dam was to achieve multiple objectives ;expand the cultivated area by 1.3 million ha and extend it beyond the limits of the Nile valley, expand farming by multiple cropping along the Nile valley, since irrigation water would be available throughout the year, convert 294,000 ha(700,000 feddans)from basin to perennial irrigation, and guarantee the cultivation of 294,000 ha of rice every year.[88]

Other direct objectives included ; the generation of 10 billion kwh of electricity per year , the improvement of navigation conditions below the dam, the development of fishing in Lake Nasser and the conversion of the dam into a tourist attraction.

The indirect objectives are those achieved as by products of the direct objectives . The most important one being the increase in food production to keep pace with the accelerated population growth of Egypt. This is achieved through an increase in land reclamation, an increase in the productivity of the existing land as a result of the expansion in the cultivated area and an improvement in irrigation schemes . This anticipated increase in food production was to help Egypt face its food security crisis.

[88] Kliot(1994),p.43.

As Chapter four of the paper will discuss, although the dam did achieve its primary project goals such as flood control, water storage and increase in hydroelectric power generation, the issue of food security remains. Expectations of major increases in agricultural yields were not entirely met . It will also be shown that if the food problem is not dealt with adequately it will even become a more severe and persistent problem.

Chapter Four: Benefit/Cost Analysis of the Dam.

As was mentioned earlier , the first step in incorporating environmentally sound economic analysis lies in comparing the " with project " and the "without project" scenarios. This chapter examines the "with project "scenario where the economic ,social and environmental consequences of the dam are examined.

Section 4.1: The Aswan High Dam: Social consequences

The first immediate consequence of the construction of the Aswan High Dam had a social dimension .This major social outcome was the resettlement of the people of the inundated regions . Some 100,000 people, mostly Nubians, have had to be evacuated; Egypt paid the Sudan £E15 million in compensation for the displacement and relocation of 50,000-70,000 Nubians in Khashim El Girba but Egypt herself has also had to relocate 30,000-50,00 people in the Kom-Ombo region.[89] It was decided that the best site for resettlement of Egyptian Nubians is in the vacant plain of Kom-Ombo. This vast area of clay silt soil is potentially very fertile when water is lifted for its irrigation.[90] Before the end of 1964, resettlement of Egyptian Nubians was completed. Also, in the Sudan, resettlement of the Sudanese Nubians occurred from Wadi Halfa town to the Khashm El Girba area . The reasons behind this particular chosen spot include; the low density of population in the area, the fertile soil and the appropriateness of the site for constructing the dam.

Also, the area of the new lake contained historical and monumental treasures. The most famous and important monuments in Nubia were the two temples of Abu Simbel.

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[89] Ibid.,p.48.
[90] Materials For Final engineering report on the Aswan High Dam (1970),.p.111.

Realizing the great importance of safe-guarding these two temples, which were re-discovered buried in sand in 1813, the Egyptian Government assisted by a collective international effort dealt with that enormous task. [91]More than 50 nations have contributed to a UNESCO fund of about L.E.12 million to save the two temples.[92]

Section 4.2:The Aswan High dam: Economic benefits

The economic benefits of the Aswan High Dam had a pronounced effect on the Egyptian economy. To assess such an effect we use the breakdown by value method described in Chapter One. The total economic value of the Aswan High Dam is divided into its use values and non-use values. The components of the use value will include the direct economic benefits achieved through the construction of the dam, whereas the components of the non use value will reflect the environmental consequences that occurred as a result of the construction .

For the use value, both the direct , indirect and option values are considered. The direct use value arises from the increase in agricultural production because of the guaranteed supply of water. This represents output that was consumed directly as a result of the dam . The High Dam made possible an expansion of the cultivated area by 546,000 ha and a conversion of 294,000 ha from basin to perennial irrigation.[93] As a result of the spread of perennial irrigation, multiple cropping took place. On average, two crops were grown annually, and thus food production doubled.[94]

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[91] Ibid,.p.120.
[92] Ibid.
[93] Kliot(1994),p.47.
[94] Ibid.

Another direct use value was the development of a fishing industry in lake Nasser which counts as an important economic benefit. Some 7,000 fishermen have moved to lake Nasser , which has become an important source of fishing, replacing lost Mediterranean and lower Nile fishing grounds- but distance from markets hampers development.[95]

Other minor but significant impacts of the dam that also constitute direct use values include; improved navigation conditions and the conversion of the site into a tourist attraction with millions of tourists visiting the site each year.

Not only did the dam guarantee Egypt a continuous supply of water but it also acted as a flood control measure .This constitutes the indirect use value since it involves functional benefits such as flood control. This protected Egypt from the devastating droughts of 1972-1973 and the 1980s. Therefore, the Aswan High Dam put an end to the threat of the Nile's water fluctuations(in both floods and droughts). Because of the dam, Egypt was protected against three floods in 1964,1967 and 1975 that could have had disastrous effects on the Egyptian economy. This reduced the amount of expenses that would have been incurred in the case of such devastating circumstances.

Another important indirect use value is that the dam was a major driving force behind industrialization in terms of generating hydroelectricity for powering industry. The town of Aswan, which has grown by a factor of 5 as a result of the construction of the dam, has also become an important industrial center .[96] Therefore, electricity production was a major economic benefit of the Aswan High Dam. It is important to note that the Aswan High Dam was primarily built for agricultural purposes. Nonetheless,

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[95] Ibid.
[96] Ibid.

according to Fahim ,according to the 1974 statistics , approximately 53% of the total national annual power requirements comes out of the Aswan High Dam . Also according to Waterbury , as it is , the power generated at the High Dam reached 4.4 billion kwh in 1974, less than half of installed capacity , but slightly more than half of all power generated in Egypt. Not only is hydroelectric power dependent on the water flow into Lake Nasser but it also depends on the proportion of power demanded for agricultural and domestic uses.

According to the Aswan High Dam bulletin 10 (a series of bulletins on the materials for engineering report on construction conducted by the High Aswan Dam construction authority,1970) and under the benefit -cost ratio method , economic benefits of the project were calculated under the assumption that it will be possible to irrigate an additional reclaimed area of 1.3 million acres and to convert an area of 0.7 million acres from basin irrigation to perennial irrigation. Therefore, for each objective of the Aswan High Dam, its economic benefits (the corresponding rise in national income) was calculated and assigned a value.

For the dam's role in preventing floods, the losses incurred as a result of the subsequent inundations, and their effects on production could now be avoided. Before the construction of the High Dam, the government had to spend L.E.1.5 million on an elaborate system of levees and banks. [97]Moreover, during the flood season, not only did innundations damage production , drainage problems were exacerbated as a result of water seepage and filtration through levees and canal banks. These problems spoiled the

[97] Materials for final engineering report on the Aswan High Dam(1970),p.122.

crops. Therefore, it is rationally estimated that the annual gain in national income owing to all these factors will be about L.E. 10 million. [98]

Because of the construction of the dam -and ,as a consequence, the expansion of the cultivated area through the reclamation in land and through the conversion from basin to perennial irrigation- it was estimated that this would represent an increase of about 25% in the crop area existing before the implementation of the project. This would entail a total rise in the national income by L.E. 100 million. [99]Also a result of the guarantee of water requirements and of better drainage facilities for all existing and new reclaimed areas in the years of low water supply and of facilitating, the national income was expected to increase by 15% or about L.E. 75 million. [100]

Increase in the national income due to the improvement of navigation is rather difficult to assess in quantitative terms, but it could be claimed that, as a result of the contribution of inland waterway lines in the transport of heavy and bulky materials at a cost well below that of rail or road transport , it is likely that the total annual national economic benefit would be L.E.2 million.[101]

As for electricity production, estimating the benefits that the country is likely to reap as a result of this increase in power resources would ultimately depend on the price that this additional power would be sold for. It was assumed , at that time, that the generated power was sold at 5 milliemes (L.E 1 being 1000 milliemes) per KWH whole sale.

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[98] Ibid.
[99] Ibid.
[100] Ibid.
[101] Ibid.

Therefore, the resulting calculation of the economic benefits derived from the High Aswan Dam power project is reproduced as follows:

	(L.E.million)
-Economic value of generated power (10.000 million kwh*5 milliemes)	50.0
-Annual costs:	
a) operating cost	0.5
b) maintenance cost	0.3
c) depreciation of power plant and transmission network	2.7
-Total (a + b +c)	3.5
-Net annual economic benefits from power	46.5

102 Ibid.

To this must be added the saving in cost of producing fertilizers by electric power from the existing Aswan Dam hydro-electric power station , resulting from the effect of the High dam in firming- up the power to be generated at the existing Aswan Dam.[103] This saving is reasonably estimated to be about L.E. 1.5 million .[104] Therefore, the net annual economic benefit from the power project would come up to L.E.48 million (L.E.46.5 million +L.E.1.5 million).Finally, summing up the direct financial results of the project through its effect on the national income would yield the following results :

	(L.E. million):
1.Expansion in cultivation	100
2.Guarantee of water supply and improved drainage conditions	75
3.Improvement in navigation conditions	2
4.Flood control	10
5.Power resources	48

[103] Ibid.

Therefore, the total increase in national income would add up to L.E.235 million. Therefore, it was revealed that by the time the full impact of the dam is realized , the proportion of the annual proceeds, directly attributable to the project, to its total cost will be of the order of about 40 % of the total investment.[105] It is quite obvious that at that time environmental concerns , that eventually could affect the benefits were ignored.

An important aspect concerning any cost /benefit analysis performed on the dam was the discrepancy between the official preliminary estimate and the actual monatory cost of the total project. According to Fahim, in 1960, as the construction of the dam was underway, estimates put the total cost at L.E 380 million .The dam was expected to amortize itself over a period of between 2 and 3 years following its completion on the basis of an internal rate of return of 44% every year. In 1964, as the first stage of the construction of the dam was completed, the revised total cost was estimated at L.E. 420 million. Finally in 1971, as the dam was inaugurated , the disclosed cost reached L.E 560 million. Although the annual rate of the project was not as high as 44%, the actual rate of perhaps 8 or 9 % according to unofficial sources would seem to justify the undertaking of the Aswan High Dam project. [106]Whatever the case, any cost /benefit analysis of the dam can only be an approximate in its conclusions , as many of the costs are still vague and sometimes hard to treat in figures when related to human and ecological side effects.

When the immediate, local incentives are inconsistent with the long run,global best interest of both the individual and society , and with the maintenance of carrying capacity , a situation called social trap occurs. One of the most pervasive causes of such a situation is the tendency to discount costs that appear remote in time or space.

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[104] Ibid.
[105] Ibid.

Although , in principle , discounting is valid, two problems make discounting over a substantial period of time, several decades, inefficient in terms of welfare to future generations.[107] The first problem relates to the uncertainty in estimating future costs and benefits and the second problem relates to the uncertainty in choosing the appropriate discount rate. When future costs are uncertain risk –averse policy would require discounting less than if they could have been predicted with certainty.[108] This uncertainty may prove to be a gamble in the life of future generations.Also according to both Daily and Ehrlich , a recent approach to discounting includes discounting by distance in which the significance of events (including the magnitude of costs and benefits)occurring at a distance is discounted[109] .In our case this is reflected by the impact of the construction of the dam on other nearby countries such as Israel and Jordan who themselves face the problem of scarce water resources. This impact was clearly ignored or unrealized by the Egyptian government. This concept of an impact over geographical distances even exacerbates the situation even further in terms of costs and benefits. Also in this case, uncertainty in the relevant distance may have strong implications.Therefore , because of difficulties in assessing the environmental costs of dams in the long run and because of the uncertainty of the impact across geographical distances , the problem of discounting arises. Consequently , discounting over time and distance both encourage behavior that may reduce carrying capacity for future generations.[110]

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[106] Fahim(1981),p.38.
[107] Daily and Ehrlich (1992),p.767.
[108] Ibid.
[109] Ibid,p.768.

Section 4.3:The Aswan High Dam: Environmental consequences.

To disregard the major economic benefits associated with the Aswan High Dam is a mistake. However, in the past decade there has been a growing consensus regarding the costs in terms of the indirect environmental effects. Therefore, the emphasis on environmental factors has become greater in recent years. As far as the conventional cost/benefit approach is concerned, only the direct and the indirect use values were accounted for in the analysis. However, an environmental economics approach to the total economic value of a resource includes the non use value of a resource where environmental consequences are included under the bequest value.It is in this section of the paper that the various valuation methods discussed in Chapter One are made use of. These environmental impacts resulted in irreversible changes that consequently highlighted the issue of allocating resources for future generations. Also, it is in this context that "carrying capacity " is applied. As was mentioned earlier, the environmental factors constitute the non-use values because these effects are intangible and their effect on agricultural production is hard to quantify. However, by applying the various valuation techniques, the environmental effects will be more easily integrated into the economic analysis of the dam.

Environmental consequences should be considered for a number of reasons. Firstly, dams would contribute to economic development only when the benefits associated with such a project outweigh the costs, which in turn include environmental damage. Therefore, disregarding the environmental consequences is misleading as to the contributions of the dam to overall economic development. Secondly, environmental

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[110] Ibid.

consequences having an impact on economic development , should be viewed from a broad perspective and beyond the narrow realm of the dam and reservoir.

Overall environmental effects on economic development and specifically on agricultural production should be considered. Also, the emphasis on environmental factors has been greater owing to several other reasons; rapid increase in the number of dams constructed around the world and in population densities around the river valleys where the dams are constructed, scarcity of new land, and widespread pollution of river waters from agricultural and industrial chemicals. Therefore, environmental consequences are important in large part because they interfere with and can also adversely affect the objectives that are supposedly aimed to be fulfilled by the dam. Nevertheless, the environmental impacts of the Aswan High Dam Lake and river flow controls caused a variety of social, economic, and public health complications.[111]

As was mentioned above, the first step in incorporating environmentally sound economic analysis lies in identifying the physical impacts of a development project. Therefore, building the Aswan High Dam contributed to the following environmental impacts: *loss of sediment, erosion and degradation, evaporation and seepage, and poor water quality.* These physical impacts would not have occurred if the project was not built.

Turning to the second step in incorporating environmentally sound economic analysis , we have to quantify these non-use(bequest) values associated with the various environmental impacts using the different valuation techniques .

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[111] Fahim(1981),p.39.

By doing that we are facilitating the incorporation of these environmental costs into the economic analysis.

Section4.3.1: Loss of Sediment

Since it is rather difficult to calculate the value of the loss of sediment in terms of lost production, the replacement cost technique is used. In this respect, losses in soil nutrients are estimated and subsequently the cost of replacing them by commercial fertilizers is calculated instead. This measure would elaborate the impact of the loss of sediment that resulted from the construction of the dam. In this technique we measure the costs that has to be incurred to improve the already damaged asset which is in our case, the soil whose nutrients were lost. Therefore, one way to address these costs is to measure the cost of fertilizers that the Egyptian government used in order to make up for the lost nutrients.

In the past the Nile waters carried between 50 and 110 million tons of silt clay and sand annually either to Egypt's fields (12 percent) or to the Mediterranean (88 percent).[112] Today more than 98% of the Nile's sediment drops to the bottom of the vast Nasser Reservoir.[113] Therefore, with the construction of the dam, silt is now deposited at the entrance to lake Nasser/Nubia where a new delta has formed.

This had two major consequences. First, the silt which contributes to the fertile soil of the agricultural lands of the Nile valley was no longer deposited on the soil, instead it has now settled in the reservoir. Instead of the Nile silt which was once used to enrich the soil, farmers in the Nile delta must now use expensive fertilizers-estimated to cost more

[112] Kliot(1994),p.45.
[113] McCully(1996),p.35.

than £ E20 million per year.[114] This cost of commercial fertilizers is used as a measure of the effect of the loss of sediment .

Also, the loss of sediment is particularly significant and evident in the delta which in turn constitutes two- thirds of Egypt's cropland. Usually, deltas are formed by the deposits of tens of thousands of river sediments. Other dams built on the Nile throughout the twentieth century further reduced the sediment reaching the delta , but it was only with the building of the High Dam that the Nile all but ceased to wash sediments into the Mediterranean.[115] Today the Nile no longer has a true delta.[116]This bad impact on the delta can be assigned an existence value due to the dam.; as long as the dam exists its impact on the delta is inevitable and this impact has nothing to do with current or optional use of the dam.

This sediment has built the delta and Egypt over the thousands of years. Of the average 110 million tons moved by the river annually, 40% is silt , 30% fine sand , and 30% clay.[117]The effect of this loss of the various chemical nutrients and minerals downstream has been underestimated . The official view from the beginning has been that the silt was of minor nutritive value and could easily be replaced by chemical fertilizers.[118]Moreover, because of the silt's low nitrogen content, Egypt had relied heavily on chemical fertilizers even before the High dam was built (consumption of nitrogenous fertilizers rose from 648,000 tons in 1952-53 to 1.2 million tons in 1064-65; phosphate fertilizer consumption rose from 92,000 to 322,000 tons over the same

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114 Kliot(1994),p.45.
115 McCully (1996), p.35.
116 Ibid.
117 Waterbury (1979), p.129.
118 Ibid., p.130.

period).[119] It was also noted that about 80 percent of the annual silt load was flushed out to sea while only 13 million tons actually reached Egypt's fields, the major beneficiary being the 800,000 feddans under basin irrigation in Upper Egypt , which received about 7 million tons of sediment annually.[120] However, these initial estimates underestimated the importance of other trace elements such as iron, zinc, and magnesium whose absence are strongly being felt.

Also, the silt was an important component in the production of bricks which was compensated with productive soil for materials in the brick production . Brick makers in Egypt have always been dependent on silt in their production .To assess the effect of the lost silt in the brick industry we use the change in productivity technique to compare the change in the production of bricks due to the construction of the dam. Total production was over one billion bricks a year in 1964 but, by 1967, fell off by more than a third.[121] Silt, as a result of the construction of the Aswan High Dam , has become a scarce commodity. The predictable result was that brick makers began to buy topsoil from peasants, and in certain areas the price of one feddan of topsoil up to a meter in depth reached £E 800 (ca.$1,600).[122] For a peasant who stands to make only £ E100 net from his crops , the economic incentives for running down his plot are irresistible.[123] Also, this loss of silt affected the fishing population in the Mediterranean.

Section 4.3.2: Erosion and Degradation

[119] Ibid.
[120] Ibid.
[121] Ibid.,p.131.
[122] Ibid.
[123] Ibid.

The second consequence of the loss of silt occurs as a result of the operating policy of the Aswan High dam and relates to the second environmental concern raised by the construction of the dam. What is released from the reservoir is silt-free water leaving behind the deposited silt. This causes degradation as the silt –free water erodes the riverbed. This in turn lowers the riverbed, increasing the stress on the barrages. If a barrage collapsed from such scouring damages, it would be very difficult, if not impossible, to irrigate the area it served.[124]

This phenomenon of degradation or scouring, as it is known, was also found before the construction of the Aswan High Dam. The annual flood would erode sections of the river's banks jeopardizing the barrages built. However, in the past this erosion was localized and most importantly temporary owing to the fact that the silt deposit of the same flood or subsequent one would fill in the gaps. This compensatory mechanism kept the degradation effect to minimal and insignificant. However, with the construction of the Aswan High Dam, this compensatory mechanism was lost as silt free waters traverse the river banks and deepen even more the scour holes. Instead of temporary riverbed erosion, silt-free scouring sets in motion a secular trend of degradation that can be halted only when some new and indeterminate equilibrium is achieved.[125]This in turn entails the probability of the collapse of downstream sides of the major barrages, bridges and embankments that would subsequently entail prohibitive costs in the form of major required engineering works.

The downstream sides of the major barrages are now so deeply eroded that the Ministry of Irrigation has been building barriers behind the Aswan, Esna and Neg-

[124] Whittington and Guarise (1983),.p.88.
[125] Waterbury (1979), p.126.

Hammadi barrages over the last decade to reinforce them.[126] For 1963-72 the average riverbed level dropped downstream from the Aswan dam by 17cm, downstream from the Esna barrage by 31cm, downstream from the Nag Hammadi Barrage by 24cm, and downstream from the Assiut barrage by 9cm.[127] As a result, by 1992 the riverbed had deepened by approximately 60-70 cm below Aswan and by 75 cm downstream from Nag Hammadi.[128]

To assess the effect of erosion and degradation we use the actual defensive or preventive expenditure technique. In this technique we assess the various defensive expenditures that the Egyptian government undertook to reduce the unwanted environmental effects of erosion and degradation. The cost of designing and constructing networks of reinforcements at these barrages to reduce these effects is a measure that erosion and degradation had on the environment.

Section 4.3.3: Evaporation and Seepage

Seepage and evaporation has received the most attention and rated as one of the greatest controversies surrounding the construction of the Aswan High Dam. According to the 1959 Niles Water agreement between Egypt and the Sudan, 10 billion m^3 of the annual discharge was allocated to evaporation . However, the variable that determines evaporation is the reservoir level. Table 7 displays this fact. At 160 meters above sea level , the reservoir surface is 3,084 km^2, and at 180 meters it is 6,200 km^2 ; that is the exposed surface is almost doubled.[129] In short, if the reservoir is kept at optimal levels

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[126] Kliot (1994), p.46.
[127] Ibid.
[128] Ibid.
[129] Waterbury(1979), p.123.

of 170-175 meters, evaporation will be well in excess of initial estimates.[130] More than half of Egypt 's planned increment from the Aswan is thus lost because of evaporation (12-15 billion m^3) and seepage (0.6-2.0 billion m^3) which is between 12 and 21.4 percent of the annual discharge of the Nile.[131] The reasons behind evaporation is the dam's immense size , its location in a desert environment and the arid climate in which Egypt is situated in. Six dams and eight barrages, all constructed to regulate flow and storage of the Nile contribute significantly to a decrease in available water, as there is leakage and loss at each water stop.[132]To best assess the impact of evaporation and seepage, we would use the change in productivity technique to trace the effect of different levels of water supply on production. However such information is very hard to obtain.

Section 4.3.4: Water Quality

Since Egypt lies in an arid desert region the Nile compromises the only source of water. Because of this critical need to assure an adequate water supply , quantity has traditionally been the parameter most heavily focused upon in water-related national planning.[133]This assurance of a continuous supply of water was the driving force behind large-scale national development water projects that gave rise to vertical and horizontal expansion of agricultural land, and industrial growth. However , another aspect of water has taken center stage recently. The issue of water quality is gaining more importance and recognition. Water quality is seen now as an obstruction to the implementation of development plans aspired by the availability of water.

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[130] Ibid.
[131] Kliot (1994), p.46.
[132] Fahim (1981), p.145
[133] Ibid., p.143.

Therefore, just recently has water quality moved to the forefront of policy design. Salinity and water-logging have become increasingly more severe, however, in recent years because of over-watering and inadequate drainage.[134] About 33% or 0.8 million ha are affected by salinity and poor drainage and yields have dropped by 30% in the affected areas .[135] These processes have been accelerated since the operation of the Aswan dam. [136] This was a result of inadequate drainage and over-watering. As the Aswan High Dam made water more available, especially during the summer peasants have a tendency to over -use water. In quantitative terms, it is believed that 10 billion m^3, or nearly 20% of Egypt's agricultural water needs, represent over-irrigation and a further stimulus to a rising water table.[137] In 1975, only about 2.7 million feddans (2 million in the delta and 700,000 in Upper Egypt) had drainage of any kind. [138] It was reckoned that adequate drainage could raise crop yields by 20-30 percent at far less expense than by land reclamation [139].

Drainage was not seen as a problem and therefore steps taken to install better drainage were not taken . Again in , 1975, of the 800,000 feddans so converted , only 393,000 had any drainage at all while a scant 61,000 had covered field drains.[140]

To assess the impact of salinity and water-logging we would use the preventive expenditure technique where we would calculate the cost of implementing better drainage systems. The cost of these drainage projects would provide us with a measure of the effect of salinity and water-logging. Drainage programs were undertaken by the

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134 Kliot (1994), p.46.
135 Ibid., p.47.
136 Ibid.
137 Waterbury (1979), p.132.
138 Ibid.
139 Ibid.
140 Ibid., p.133.

Ministry of Agriculture with the financial aid from various international organizations. In cooperation with the World Bank, four major projects have been launched since 1970 to tackle the drainage problem in the Delta and Upper Egypt. In all, over one billion dollars- of which 80 percent is from Egypt- are being devoted to installation of underground drains and remodeling of surface drains. [141] This cost reflects the preventive expenditure that the government had to undertake to reduce the effects of the environmental damage caused by salinity and water-logging.

The quality of water was also affected by the use of forms of pesticides, and other chemicals in an attempt to increase agricultural production. The increased clarity of the Nile due to the virtual elimination of its silt by the High Aswan Dam has caused a proliferation of algae and phytoplankton in the river.[142]This has fouled the water supply of Cairo and other riverine cities and necessitated an increased use of chlorination, which has in turn led to an increased presence in drinking water of the carcinogenic chemicals formed when chlorine reacts with organic matter.[143] Diseases such as bilharzia, are spreading as a result of changes in water quality. An assessment of the impact of the Aswan High Dam on public health in Egypt has to account for schistosomiasis, which is a major endemic disease.[144]The extension of irrigation and drainage networks and the change from basin to perennial irrigation in Upper Egypt is believed to increase the occurrence of the aquatic snail vectors of schistosomiasis.[145]

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141 Sands (1979), p.135.
142 McCully (1996), p.150.
143 Ibid.
144 Abu-Zeid (1979), p.283.
145 Ibid.

To asses this impact of water quality on health we would use either the loss of earnings technique or the replacement cost technique . In the loss of earnings approach, the monetary value of these health impacts can be determined by the willingness to pay of the Egyptian people for improved health. Otherwise, in the replacement cost replacement technique these health impacts can be assessed by calculating medical expenditures that individuals or the government has to undertake. In either case, each method would provide an assessment of the impact of the Aswan High Dam on public health .

Soil salinity and water-logging, ranked as the severest environmental consequence of the Aswan High Dam, reducing the availability of productive lands with every passing year. Silting, bank deterioration and erosion, have added to the negative impacts of Lake Nasser and to the economic cost of maintaining the irrigation system and land fertility.[146]

Conclusion:

All but a tiny proportion of Egypt's agriculture is now dependent on the regulation of the Nile achieved through the construction of the Aswan High Dam. Government sources claimed in 1993 that 690,000 hectares had been 'reclaimed' from the desert since the High Dam was built.[147]Yet according to FAO statistics, the actual area of irrigated land in Egypt in 1989 (2.6 million hectares) was virtually unchanged from the area irrigated in 1961, when construction started on the dam.[148]

There are several reasons for this statistical discrepancy. The first is the tendency on the part of the Egyptian government to be vague with every aspect of the Aswan High Dam. Other reasons are the mining of well over 100,000 hectares of fertile topsoil by the makers of mud bricks (the loss of the annual deposit of flood-borne silt resulted in brick factories along the Nile buying up farmland to quarry) and the urbanization of more than 125,000 hectares of previously irrigated land. [149]The degradation of formerly cultivated land due to water-logging and the related side-effects of perennial irrigation (land which had previously withstood several millennia of traditional flood irrigation) and the appalling record of the schemes to bring water to previously uncultivated desert lands also explains Egypt's failure to expand its irrigated area.[150]

Because of increasing populations around the world, there are continuous calls for increases in land areas, water resources, fertilizers, pesticides and energy. The lesson learned from the Aswan project is that dams may be built with missionary zeal but little

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[146] Kliot (1994), p. 49.
[147] McCully (1996) , p.167.
[148] Ibid.
[149] Ibid.
[150] Ibid.

careful planning and monitoring of side effects.[151] The Aswan High dam did achieve its primary project goals ;flood and river flow control , expansion of irrigated cropping, water storage and increased hydroelectric power generation. It was obvious that environmental concerns were not taken seriously nor even considered.

In the case of the Aswan High Dam, for example, an Environmental Impact Assessment (EIA) might have introduced into the project a number of components such as : works on coastal protection against sea waves erosion, procurement of fertilizers to compensate for the Nile silt, supplementary measures for public health protection against water-borne diseases, increased drainage on the newly irrigated areas and finally more careful approach to the resettlement operation, compensation for fisherman, etc…[152]

The main result of this research indicates that the Aswan High Dam did not provide Egypt with either water or, more importantly, food security. There is little indication that food self- sufficiency, Egypt's most ambitious goal, will ever be achieved.

With Egypt's increasing population, maximizing production entails that land and water be intensively used. However , since these resources are fixed or declining, the need arises for their efficient use , and in an environmentally sound fashion so that sustainability can be realized. Future agricultural growth will have to be preceded by an increase in the efficient use of water and land, technological improvements , investment in human and physical capital and finally environmental protection.

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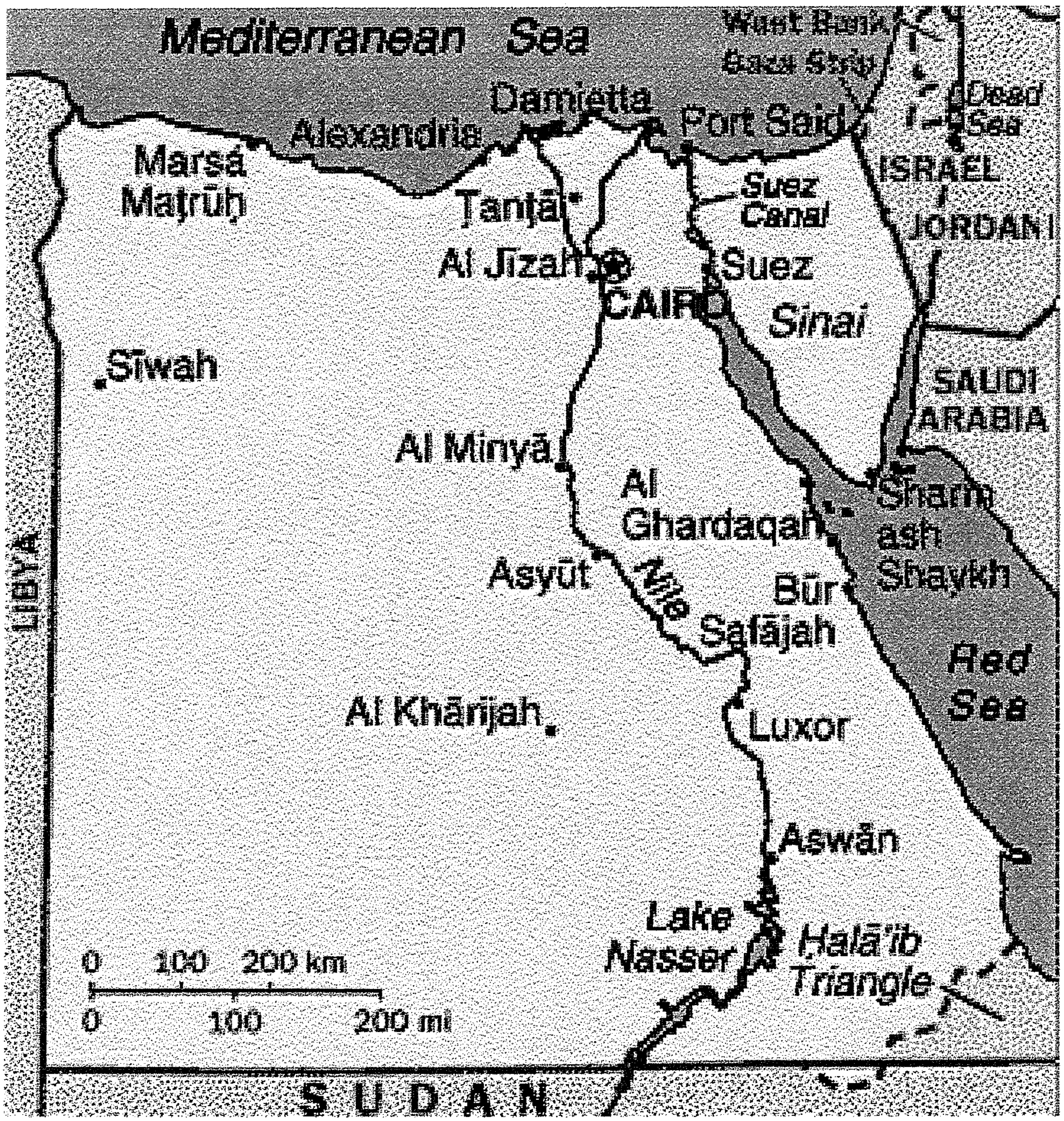
[151] Kliot (1994), p.48.
[152] Razvan (1996), p. 434.

Therefore, in conclusion, what is required is an integrated set of economic and environmental sound policies (i.e. family planning, efficient management and allocation of natural resources etc) targeted all at once for the formulation of national policies regarding food self-sufficiency.

Map of Egypt
Source: http://www.theodora.com/wfb/egypt/egypt_maps.html



ap of Egypt
urce: http://city.net/countries/egypt/maps

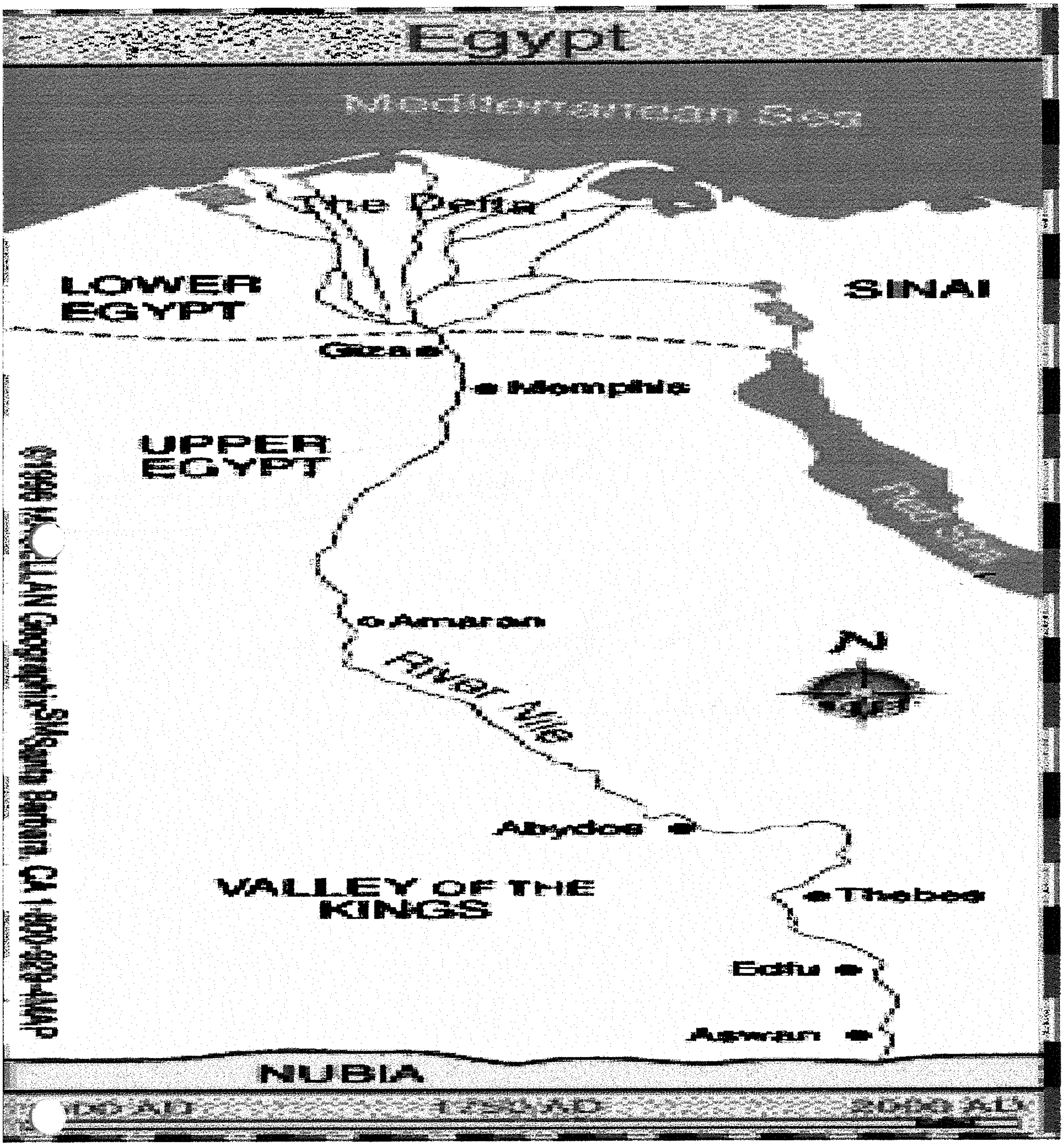
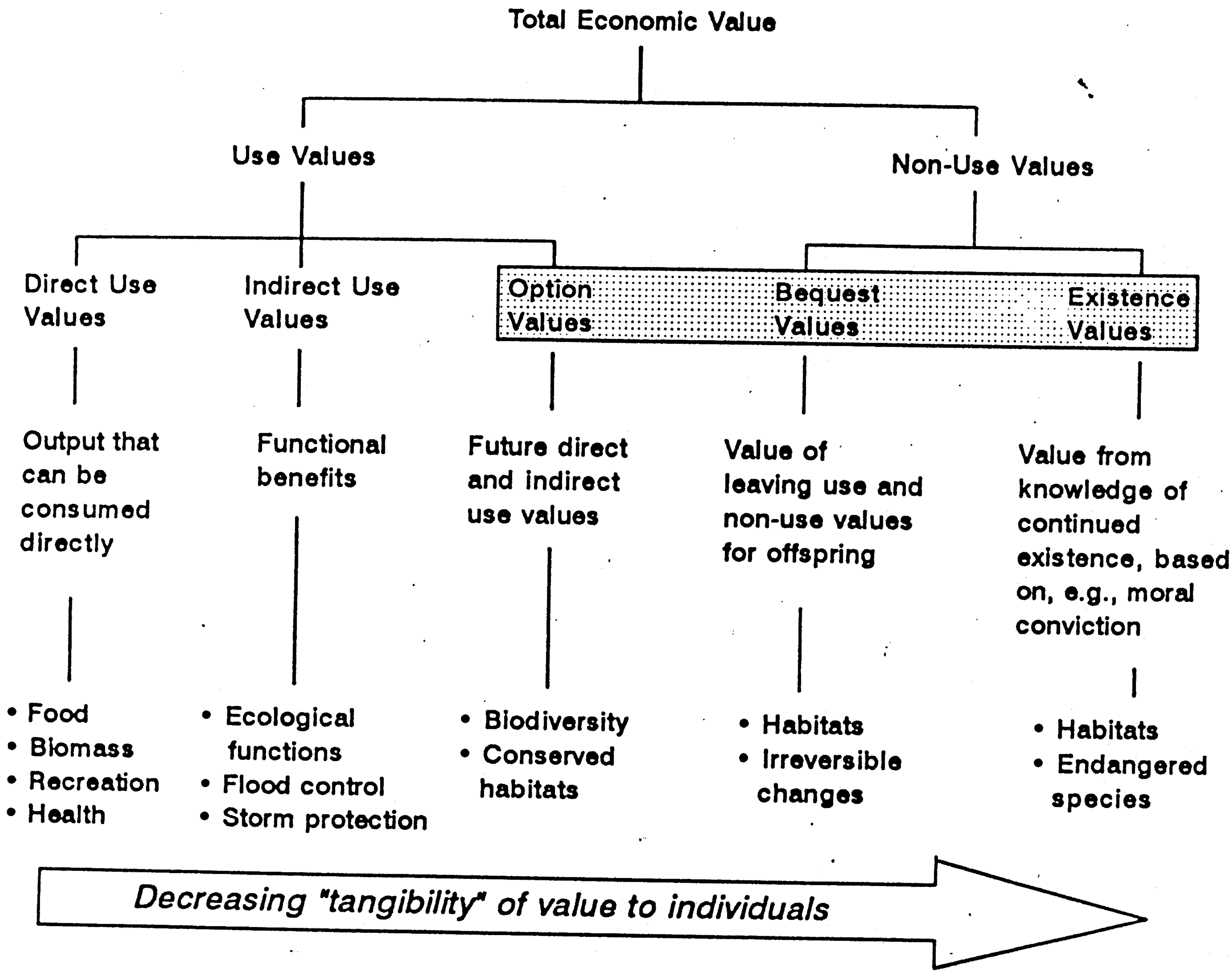


Chart A



Total Economic Value
Use Values
Non-Use Values
Direct Use Values
Indirect Use Values
Option Values
Bequest Values
Existence Values
Output that can be consumed directly
Functional benefits
Future direct and indirect use values
Value of leaving use and non-use values for offspring
Value from knowledge of continued existence, based on, e.g., moral conviction
• Food
• Biomass
• Recreation
• Health
• Ecological functions
• Flood control
• Storm protection
• Biodiversity
• Conserved habitats
• Habitats
• Irreversible changes
• Habitats
• Endangered species
Decreasing "tangibility" of value to individuals

Chart 2

Cropping Pattern,1986-1994

Crop	1986	1990	1994	1986	1990	1994	Delta
	'000 feddans			%			
Beans	307	345	374	2.7	2.8	2.9	0.1
Rice	1009	1037	1379	9.0	8.4	10.5	1.5
Wheat	1206	1955	2111	10.7	15.9	16.1	5.4
Cotton	1055	993	729	9.4	8.1	5.6	-3.8
Maize	1483	1975	2057	13.2	16.1	15.7	2.5
Sugarcane	262	274	278	2.3	2.2	2.1	-0.2
Berseem	2736	2620	2686	24.4	21.3	20.5	-3.9
Potatoes	174	70	58	1.5	0.6	0.4	-1.1
Tomatoes	394	371	339	3.5	3.0	2.6	-0.9
Other vegetables	648	568	661	5.8	4.6	5.0	-0.7
Oranges	197	237	243	1.8	1.9	1.9	0.1
Other crops	1755	1860	2201	15.6	15.1	16.8	1.1
Total cropped area	11226	12305	13116	100.0	100.0	100.0	0.0

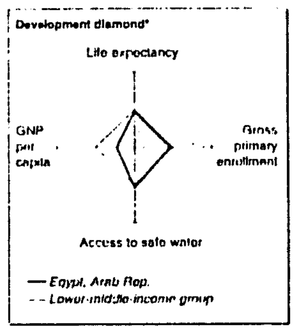
Note:
Delta = Crop share for 1994 minus crop share for 1986

Source:Serageldin and Steeds(1997),p.284.

Chart 3

Arab Republic of Egypt at a glance

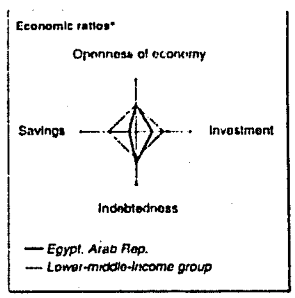
POVERTY and SOCIAL	Egypt	M. East & North Africa	Lower-middle-income
Population mid-1995 *(millions)*	57.7	273	1,154
GNP per capita 1995 *(US$)*	790	1,780	1,700
GNP 1995 *(billions US$)*	45.5	486	1,952
Average annual growth, 1990-95			
Population *(%)*	1.9	2.7	1.4
Labor force *(%)*	2.9	3.3	1.8
Most recent estimate *(latest year available since 1989)*			
Poverty: headcount index *(% of population)*		..	
Urban population *(% of total population)*	45	58	56
Life expectancy at birth *(years)*	63	66	67
Infant mortality *(per 1,000 live births)*	50	49	36
Child malnutrition *(% of children under 5)*	9	..	..
Access to safe water *(% of population)*	84	82	78
Illiteracy *(% of population age 15+)*	49	39	..
Gross primary enrollment *(% of school-age population)*	97	97	104
Male	105	104	105
Female	89	90	101



KEY ECONOMIC RATIOS and LONG-TERM TRENDS

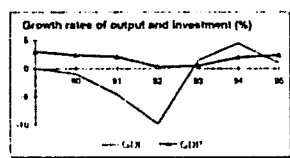
	1975	1985	1994	1995
GDP *(billions US$)*	11.4	34.7	42.9	46.4
Gross domestic investment/GDP	33.4	26.7	17.5	16.9
Exports of goods and non-factor services/GDP	20.2	19.9	21.7	21.3
Gross domestic savings/GDP	12.3	14.5	5.9	6.0
Gross national savings/GDP	14.1	12.5	16.3	42.7
Current account balance/GDP	-21.2	-9.3	-1.2	-2.1
Interest payments/GDP	0.7	2.6	2.7	2.9
Total debt/GDP	42.3	104.1	77.7	71.7
Total debt service/exports	10.3	25.8	14.6	17.0
Present value of debt/GDP	..	..	51.0	..
Present value of debt/exports	..	..	140.6	..

	1975-84	1985-95	1994	1995
(average annual growth)				
GDP	8.6	2.1	2.0	2.4
GNP per capita	5.6	1.2	0.7	0.5
Exports of goods and non-factor services	3.9	5.6	-7.6	4.2

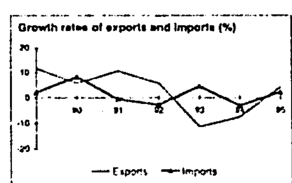


STRUCTURE of the ECONOMY

	1975	1985	1994	1995
(% of GDP)				
Agriculture	29.0	20.0	16.5	16.2
Industry	26.9	28.6	33.7	33.8
Manufacturing	17.4	13.5	16.7	17.2
Services	44.1	51.5	49.7	49.9
Private consumption	62.9	68.2	80.5	80.6
General government consumption	24.9	17.2	13.5	13.4
Imports of goods and non-factor services	41.3	32.0	33.3	32.3



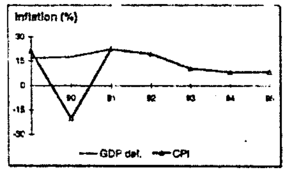
	1975-84	1985-95	1994	1995
(average annual growth)				
Agriculture	2.8	1.0	2.9	3.0
Industry	10.2	-0.7	-0.3	3.0
Manufacturing	..	1.6	-0.6	3.5
Services	13.2	4.3	3.1	1.5
Private consumption	8.5	1.5	2.0	2.3
General government consumption	4.0	0.7	3.3	1.3
Gross domestic investment	7.7	-0.7	4.5	1.0
Imports of goods and non-factor services	3.9	0.5	-3.2	2.2
Gross national product	8.2	3.4	2.5	2.3



Source:The World Bank(1996),p.157.

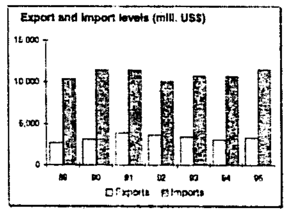
PRICES and GOVERNMENT FINANCE

	1975	1985	1994	1995
Domestic prices				
(% change)				
Consumer prices	9.7	12.1	8.2	6.3
Implicit GDP deflator	9.2	9.0	8.2	8.3
Government finance				
(% of GDP)				
Current revenue	.	22.2	33.8	33.2
Current budget balance	.	-13.7	2.6	3.5
Overall surplus/deficit	.	-21.6	-2.5	-1.6



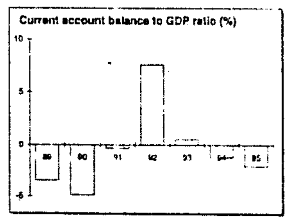
TRADE

	1975	1985	1994	1995
(millions US$)				
Total exports (fob)	.	3,928	3,065	3,316
Petroleum		2,634	1,499	1,559
Cotton	.	414	45	50
Manufactures		446	832	922
Total imports (cif)	.	10,516	10,716	11,514
Food	.	2,711	2,351	2,561
Fuel and energy		459	623	685
Capital goods		2,398	2,804	3,031
Export price index *(1987=100)*		127	97	100
Import price index *(1987=100)*		145	103	107
Terms of trade *(1987=100)*		87	94	93



BALANCE of PAYMENTS

	1975	1985	1994	1995
(millions US$)				
Exports of goods and non-factor services	2,503	6,866	9,319	10,083
Imports of goods and non-factor services	5,141	12,606	14,303	15,275
Resource balance	-2,636	-5,740	-4,985	-5,192
Net factor income	-244	-991	-625	-824
Net current transfers	456	3,522	5,073	5,060
Current account balance, before official transfers	-2,425	-3,209	-536	-956
Financing items (net)	2,000	3,599	2,508	2,132
Changes in net reserves	426	-390	-1,972	-1,175
Memo:				
Reserves including gold *(mill. US$)*	535	1,587	25,577	26,752
Conversion rate *(local/US$)*	0.5	1.0	3.4	3.4



EXTERNAL DEBT and RESOURCE FLOWS

	1975	1985	1994	1995
(millions US$)				
Total debt outstanding and disbursed	4,835	36,102	33,358	33,293
IBRD	14	1,048	1,411	1,320
IDA	84	802	961	1,036
Total debt service	305	2,817	2,280	2,791
IBRD	1	147	307	313
IDA	1	8	19	21
Composition of net resource flows				
Official grants	1,123	734	1,192	1,000
Official creditors	2,159	1,634	426	237
Private creditors	49	560	-260	-263
Foreign direct investment	8	1,178	1,256	525
Portfolio equity	0	0	10	4
World Bank program				
Commitments	132	59	644	80
Disbursements	62	269	199	134
Principal repayments	0	70	203	212
Net flows	62	198	-4	-78
Interest payments	1	64	123	122
Net transfers	61	114	-127	-200

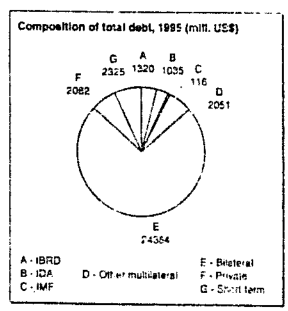
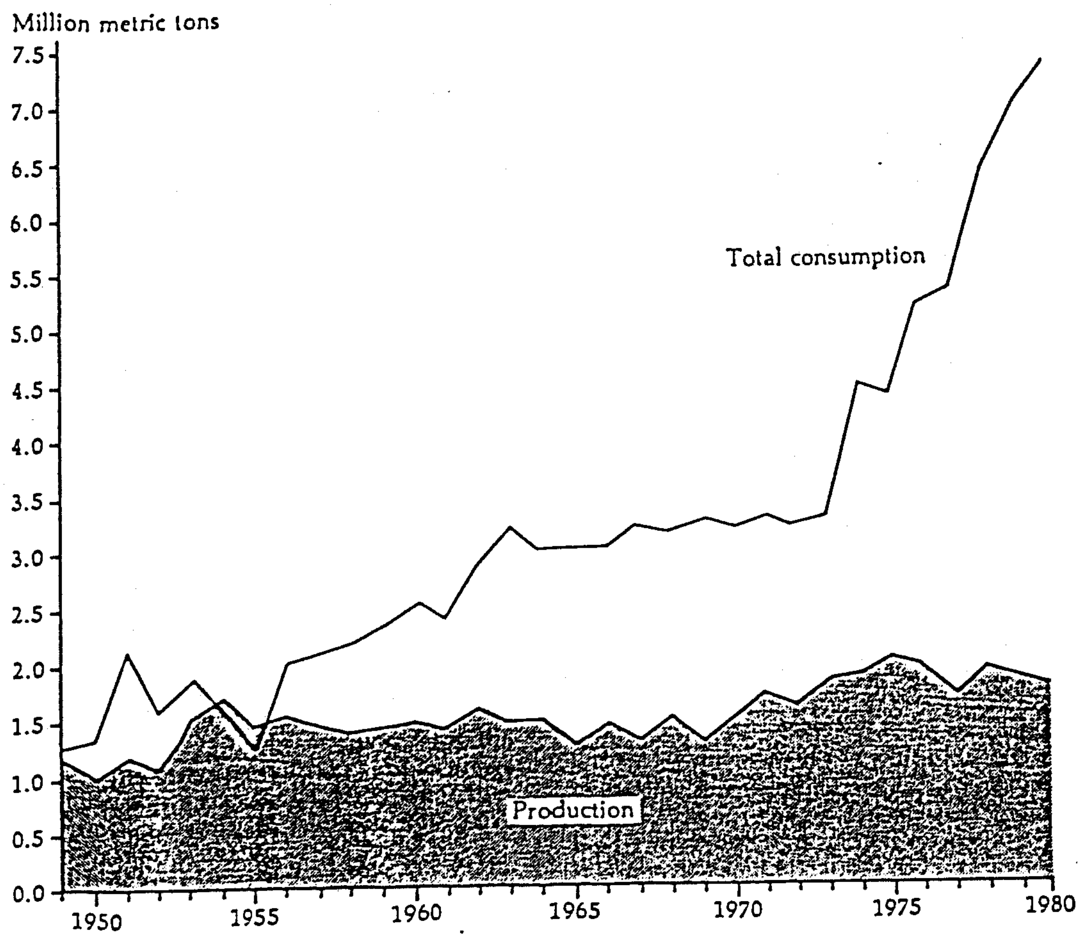


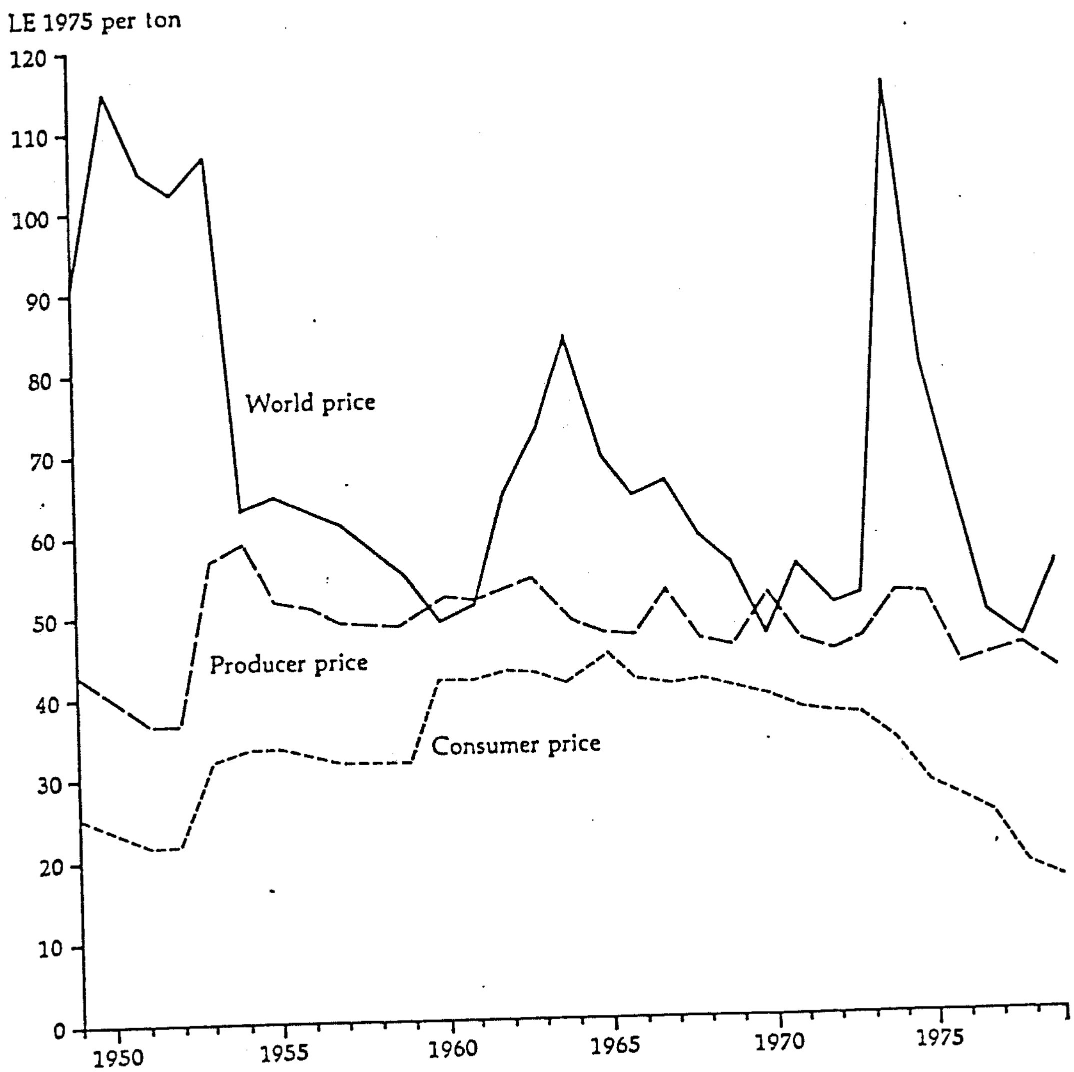
Figure 1
Production and Consumption of wheat 1949-80



Source: Scobie(1981), p.24.

Figure 2

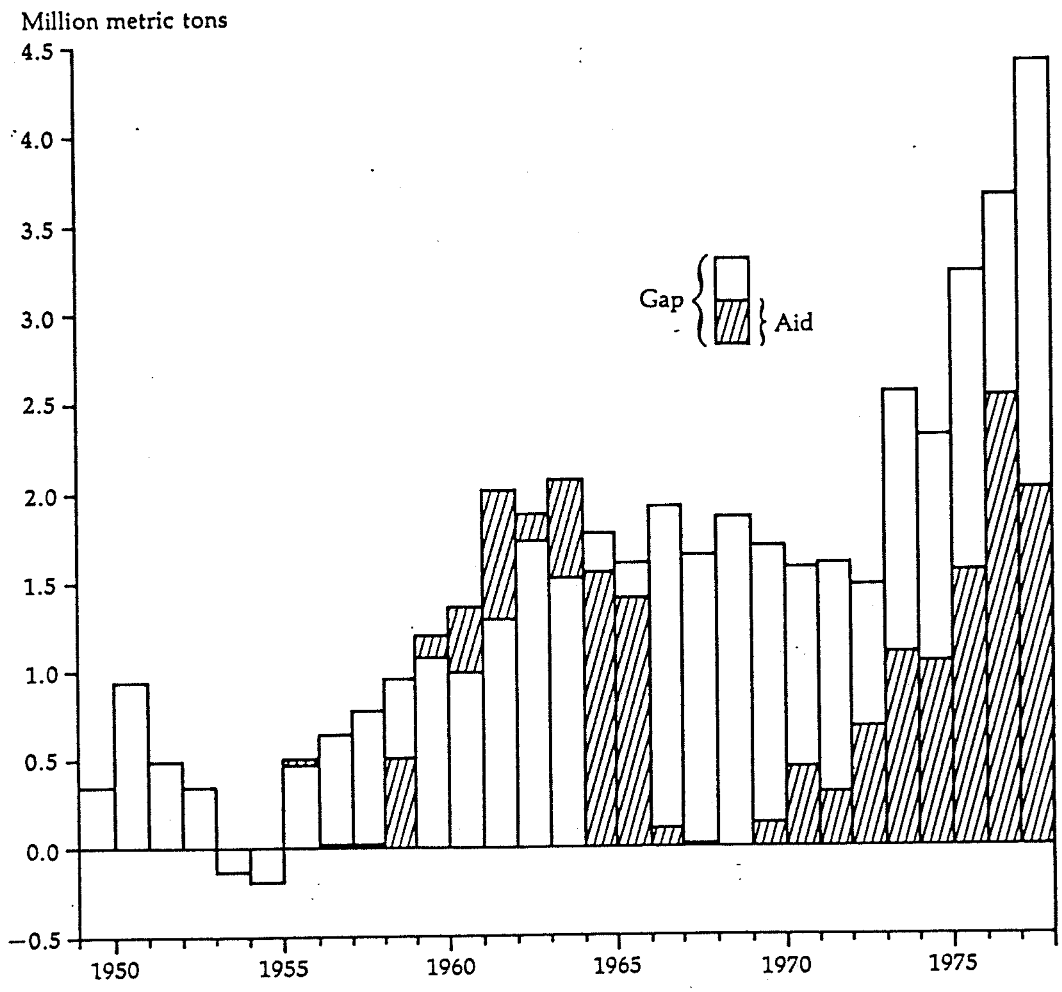
Real Wheat Prices
1949-79



Source: Scobie(1981), p.27.

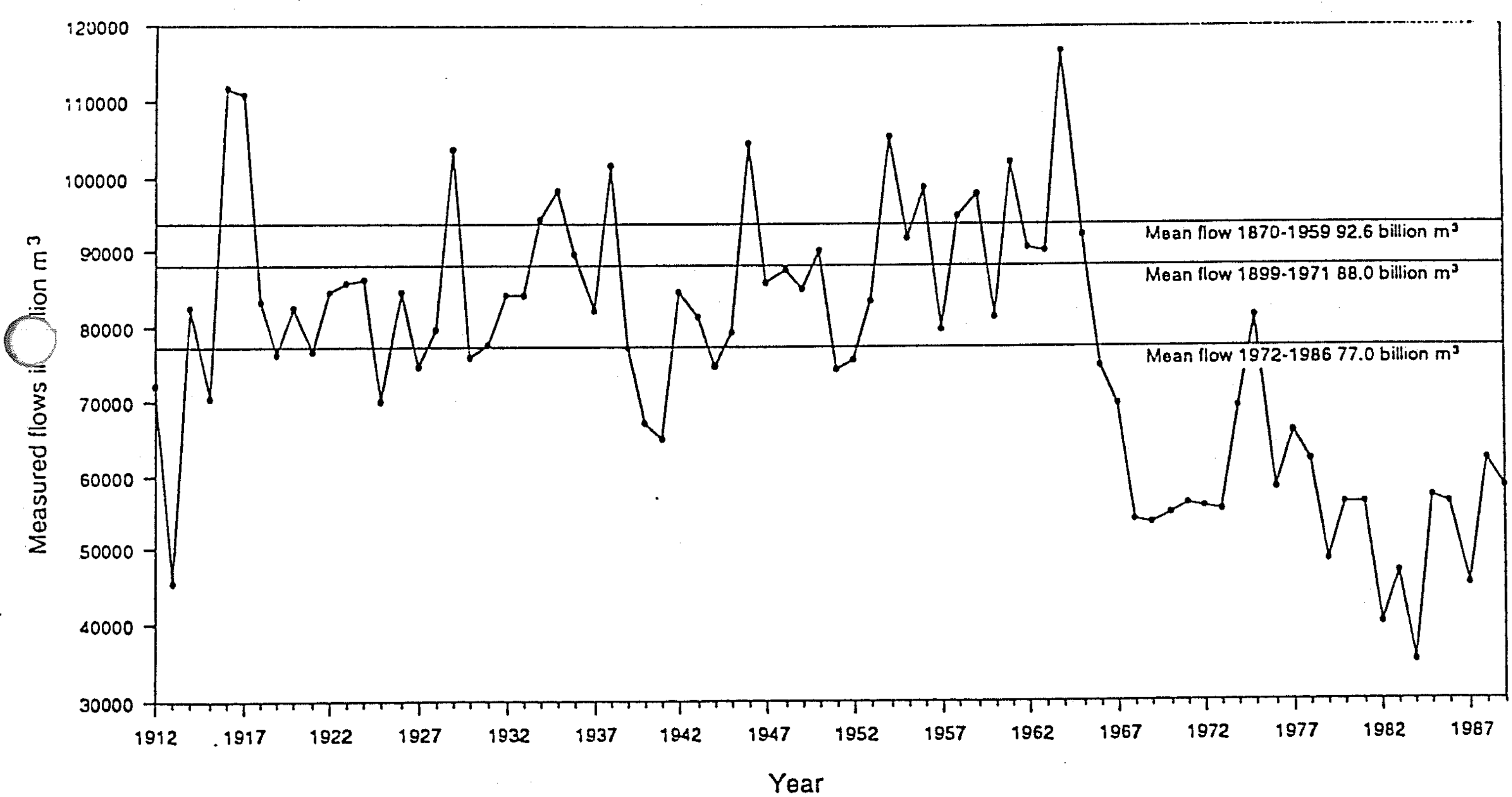
Figure 3

Aid and the gap between production and consumption of wheat, 1949-78



Source: Scobie (1981), p. 25

Figure 4
The Nile mean average flows 1912-87 (in million cubic metres)



<u>Source:</u> Kliot(1994), p. 24

Table 1

Production and trade of Wheat and Wheat Flour 1949-79

Year	Production (QC) (1,000 metric tons)	Area(AC) (1,000 hectares)	Yield(YC) (tons/hectares)	Wheat imports (MC)	Aid Shipments Flour(MF) (1000 metric tons)	Aid Shipments Wheat(AIDC)	Flour (AIDF)
1949	1,167	595	1.96	283	6	0	0
1950	1,018	576	1.77	443	89	0	0
1951	1,209	629	1.92	1028	89	0	0
1952	1,089	589	1.85	710	144	0	0
1953	1,547	752	2.06	467	67	0	0
1954	1,729	754	2.29	10	50	0	0
1955	1,451	640	2.27	0	10	3	0
1956	1,547	660	2.34	610	53	481	12
1957	1,467	636	2.31	710	95	9	1
1958	1,412	599	2.36	774	286	8	2
1959	1,443	620	2.33	731	467	200	220
1960	1,499	612	2.45	631	473	523	482
1961	1,436	581	2.47	661	431	431	659
1962	1,593	611	2.61	860	510	810	877
1963	1,493	565	2.64	972	815	725	831
1964	1,500	544	2.76	810	776	926	828
1965	1,272	481	2.64	1230	610	857	496
1966	1,465	542	2.7	1428	610	804	430
1967	1,299	530	2.45	1783	651	14	62
1968	1,526	602	2.53	1507	560	0	1
1969	1,277	531	2.4	1200	228	142	142
1970	1,519	551	2.76	851	275	133	133
1971	1,732	570	3.04	1931	345	439	439
1972	1,618	523	3.09	1386	216	299	299
1973	1,838	525	3.5	1490	227	671	1
1974	1,884	576	3.27	2850	258	963	89
1975	2,033	586	3.47	2970	521	1021	10
1976	1,962	586	3.35	2930	690	1205	253
1977	1,699	504	3.37	3346	719	1814	523
1978	1,933	580	3.33	3759	980	1509	360
1979	1,856	585	3.17	3609	934	1639	427

Source: Scobie, (1981) p. 68.

Table 2

Drain of food imports on Hard Currency Revenues
1981-87
Million of U.S. Dollars

Item:	**1981-82**	**1982-83**	**1983-84**	**1984-85**	**1985-86**	**1986-87**
Hard currecy receipts						
Petroleum	4,669	4,164	4,532	4,781	3,995	2,679
Cotton	380	314	452	414	356	343
Suez Canal tarrifs	909	957	974	897	1,028	1,148
Total gov. receipts	***5,958***	***5,435***	***5,958***	***6,092***	***5,379***	***4,170***
Worker's remittances	1,935	3,165	3,931	3,496	2,973	2,845
Tourism	611	304	288	410	321	376
Total hard currency recepits	***8,504***	***8,904***	***10,177***	***9,998***	***8,673***	***7,391***
Cost of agricultural Imports						
Wheat & Flour	1,130	834	1,056	1,013	983	
Other commodities	1,550	1,559	1,877	1,698	1,583	
Total	***2,680***	***2,393***	***2,933***	***2,711***	***2,566***	
Cost of agricultural imports as a share of government receipts (percent)	***45***	***44***	***49***	***45***	***48***	***48***
Cost of agricultural imports as a share of hard currency receipts (percent)	***32***	***27***	***29***	***27***	***30***	***27***

Source: Sadowski (1991), p. 19.

Table 3

Population Growth in Egypt, 1960-1990.

Item	1960	1970	1980	1985	1988	1990
Population (Millions)	26	33	39.8	48.5	53.3	54.7
GNP per capita (Dollars)	N.A	N.A	580	610	760	650
Density (Number of person per habitable square kilometer)	686	869	1047	1276	1403	1458
Crude birth rate (births per thousand persons)	43.1	35.1	37	36	38	38
Crude death rate (deaths per thousand persons)	16.9	15.1	12	10	9	9
Rate of natural increase	2.6	2	2.5	2.6	2.9	2.8

Source: Sadowski (1991), p. 16.

Table 4

Growth of Egyptian Population and Cultivated and Cropped Land: (1821-1975)

Year	Population	Cultivated area (1000 Feddans)	Per Capita cultivated area	Cropped Area (1000 Feddans)	Per Capita Cropped area
1821	4,230,000	3053	0.73	3,053	0.73
1846	5,290,000	3764	0.71		
1882	7,930,000	4758	0.6	5,754	0.72
1897	9,717,000	4943	0.53	6,725	0.71
1907	11,190,000	5374	0.48	7,595	0.67
1917	12,718,000	5309	0.41	7,729	0.6
1927	14,178,000	5544	0.39	8,522	0.61
1937	15,921,000	5312	0.33	8,302	0.53
1947	18,967,000	5761	0.31	9,133	0.48
1960	26,085,000	5900	0.23	10,200	0.39
1966	30,075,000	6000	0.2	10,400	0.34
1970	33,200.000	5900	0.18	10,900	0.33
1975	37,000,000	5700	0.15	10,700	0.29

Source: Waterbury (1979), p. 36.

Table 5
Agricultural Performance in Egypt and 17 other countries (1965-87)

Arab Countries	**Population** *1987 (millions)*	**GNP** *1987 (U.S. Dollars)*	**Annual average growth in agriculture** *(percent)* *1965-80*	*1980-87*	**Average Index of food production per capita** *1985-87 (1979-81=100)*
Kuwait	1.9	14,610	N.A	23.6	N.A
United Arab Emirates	1.5	15,830	N.A	11.6	N.A
Saudi Arabia	12.6	6,200	4.1	10.3	209
Oman	1.3	5,810	N.A	9.4	N.A
Algeria	23.1	2,680	5.6	6	103
Tunisia	7.6	1,180	5.5	4.2	114
Jordan	3.8	1,560	N.A	4.1	108
Morocco	23.3	610	2.2	3.6	109
Egypt	50.1	680	2.7	2.7	106
Yemen Arab Republic	8.5	590	N.A	2.3	115
Mauritania	1.9	440	-2	1.5	90
Sudan	23.1	330	2.9	0.8	100
Syria	11.2	1,640	4.8	-1.1	96
Non-Arab Countries					
China	1,068.50	290	3	7.4	124
United States	243.8	18,530	1	3.5	97
Indonesia	171.4	450	4.3	3	117
Mexico	81.9	1,830	3.2	1.4	97
India	797.5	300	2.8	0.8	109

Source: Sadowski (1991), p.16.

Table 6

Water Storage Facilities on the Nile

Facility	Completed	Area Km^2	Capacity (billion m^3)	Location
Old Aswan (3rd Rasing)	1933		5.3	Aswan , Egypt, Main Nile
Sennar	1925	160	0.9	The Sudan, Blue Nile
Jebel Auliya	1937	600	3.5	The Sudan, White Nile
Khashm al-Girba	1966	150	1.2	The Sudan, Atbara
Roseires	1966	290	3	The Sudan, Blue Nile
Aswan High Dam	1971	4000	164	Aswan, Egypt, Main Nile

Source: Waterbury (1979), p. 88.

Table 7

Rate of Reservoir Fill and Estimated Evaporation Losses

Year Level was reached	Reservoir Height (meters)	Reservoir surface (km^2)	Reservoir volume (billion m^3)	Estimated evaporation losses (billion m^3)
1964-65	127.6	550	9.8	1.4
1967-68	151.2	2,200	41.1	5.9
1970-71	164.8	3,500	78.5	9.4
Oct.1975	175	5,168	115	13.9
Never attained	182	6,200	157.4	15.3-16.7

Source: Waterbury (1979), p. 124.

REFERENCES

1.Abbasi,S.(1991) *Environmental Impact of Water Resources Projects*. Discovery Publishing House.

2.Abu-Zeid, M.(1979) "Short and Long Term Impacts of the River Nile Projects."*Water Supply and Management* , v 3. Pergamon Press.

3.Biswas ,A;Samaha ,M.;Amer ,M ;Abu Zeid ,M ;(1978) *Water Management For Arid Lands in Developing Countries* .Pergamon Press.

4.Bojo; Maler; Unemo(1992) *Environment and Development :An Economic Approach.* London: Kluwer Academic Publishers.

5.Costa-Pierce,B.(1997) *From Farmers to Fisheries; Developing Reservoir Aquaculture for People Displaced by Dams.*Washington , D.C.: The World Bank.

6. Daily G.C; Ehrlich P.R (1992) "Population, Sustainability, and Earth's Carrying Capacity." *BioScience,* Vol.42, No.10, p.761-771.

7.Dixon ; Talbot; Le Moigne(1989) *Dams and the Environment: Considerations in World Bank Projects.* Washington ,D.C.: The World Bank.

8.Dixon ,J.A ; Sherman ,P.B.(1990) *Economics of Protected Areas: A New Look At Benefits and Costs*.London: Earthscan Publications Ltd.

9.Fahim,H.(1981) *Dams, People and Development: The Aswan High Dam Case.* Pergamon Press.

10.Fahim, H.(1983) *Egyptian Nubians : Ressetlements and Years of Coping.* Salt Lake City :University of Utah Press.

11.Kliot,N.(1994)*Water Resources and Conflict in the Middle East* .New York: Routledge.

12.LeMoigne,Guy *et al.* (1990) *Dam Safety and the Environment* .Washington ,D.C.: The World Bank.

13. *Materials for Final Engineering Report on the Aswan High Dam* (1970) Project Bulletin 10, Organization of Construction ,Aswan.

14.McCully,P.(1996) *Silenced Rivers: The Ecology and Politics of Large Dams* .Zed Books.

15. Munasinghe ,M.(1993) *Environmental Economics and Natural Resource Management in Developing Countries*. Washington ,D.C.: The World Bank.

16.Pearce ,D ; Barde , J.(1992) *Valuing the Environment : Six Case Studies.* London: Earthscan Publications Ltd.

17.Pearce,D. ; Turner K (1990) *Economics of Natural Resources and the Environment.* New York: Harvester Wheatsheaf.

18.Paranjpye ,V.(1988) *Evaluating the Tehri Dam :An Extended Cost Benefit Appraisal.* Indian National Trust for Art and Cultural Heritage

19. Razvan, E. (1996) " Importance of the High Aswan Dam for Hydraulic Engineering". *Management and Development of Major Rivers.*

20.Saab ,G.(1967)*The Egyptian Agrarian Reform 1952-1962* .New York :Oxford University Press.

21.Sadowski,Y.(1991) *Political Vegetables :Businessman and Bureaucrat in the Development of Egyptian Agriculture* .Washington ,D.C.: The Brookings Institution.

22.Sands W.(1979) " The High Dam and the Transformation of the Nile ." *The Middle East Journal* ,v. XXXIII, p. 179.

23.Scobie, G.(1981) *Government Policy and Food Imports :The Case of Wheat in Egypt.* International Food Policy Research Institute , Research Report #29.

24.Serageldin ,I.; Steeds,D.(1997) *Rural Well Being ;From Vision to Action.*Washington,D.C.:The World Bank.

25.Stephenson,D. ; Peterson,M. (1991)*Water Resources Development in Developing Countries* .New York :Elsevier.

26.The Economist (Oct. 25, 1997)"A Revolution to end the Revolution."

27.Waterbury ,J.(1979) *Hydropolitics of the Nile Valley.* New York :Syracuse University Press.

28.Whittington D. ; Guariso G.(1983) *Water Management Models in Practice :A Case Study of the Aswan High Dam.* New York:Elsevier.

29.---(1993) *Arab Republic of Egypt :An Agricultural Strategy for the1990s*. Washington, D.C.: The World Bank.

30.---(1996) *Trends in Developing Countries* . Washington, D.C.:The World Bank.

31.Department of Economic and Social Affairs :Statistics Division , Monthly Bulletin of Statistics, Vol.LII, No.3, United Nations ,New York ,1998.