Chapter 17
Impacts of the High Aswan Dam

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17.1 Introduction

Without any doubt, the High Aswan Dam in Egypt has been the most well-known dam in the world in the past five decades. From Argentina to Australia and from Tokyo to Timbuktu, professionals in water management and development are often familiar with the High Aswan Dam, even though they may not be aware of the names and locations of major dams in their own countries. The logical question that arises is why are numerous people aware of a dam in a distant part of the world, which they have never visited, when they often lack even elementary knowledge of important dams in their own regions? What is so special about the High Aswan Dam that has made it one of the world's most well-known, if not *the* most well-known, and most discussed water infrastructures in the world?

There is also a fundamental issue that needs to be discussed. The vast majority of Egyptians have been fully aware that without the High Aswan Dam, their country would have faced serious socio-economic and political crises during the last 50 years. They are not only proud of the dam, but also strongly believe that the structure has significantly contributed to the nation's prosperity as well as economic and social stability. In sharp contrast, the prevailing international view outside Egypt has consistently been that the dam is an unmitigated disaster for the country in

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social, economic and environmental terms. Myths relating to the dam's adverse impacts—many of which are propagated by so-called 'experts' who have never visited the dam and its environment, let alone spent any time seriously studying its impacts, both positive and negative—circulate around the world. In fact, if the average environmentalist outside Egypt is asked to identify the worst dam in the world, chances are very high that the person will name the High Aswan Dam for this dubious distinction. Even the World Commission on Dams vilified the dam and failed miserably to consider its overall impacts in an objective fashion. All these perceptions abound, despite the fact that any unbiased and objective person would be hard pressed to identify a dam anywhere in the world whose overall social and economic benefits to the country concerned have been so overwhelming positive.

In order to answer the fundamental question as to why the perception of the world is totally different from the reality on the ground, the Third World Centre for Water Management undertook a study of the dam, with the support of the Arab Fund for Economic and Social Development in Kuwait. The present chapter is a small part of this overall study (Biswas and Tortajada 2012).

17.2 Methodological Considerations

Some facts and methodological issues of the study should be noted. Prior to the completion of this assessment, a detailed, comprehensive and objective impact analysis, covering both positive and negative aspects, of the High Aswan Dam was not available. It should, however, be pointed out that the absence of an objective impact analysis for this particular dam is not an exception. In fact, the number of large dams anywhere in the world for which economic, social and environmental impacts have been scientifically and objectively monitored on a regular basis after 10–20 years of operation and then evaluated, can be counted on the fingers of one hand, and still leave some fingers over! (Biswas and Tortajada 2001)

At present, thousands of studies on Environmental Impact Assessments (EIAs) of large dams are available, some of which are quite good; but many others are not even worth the paper they are printed on. It should also be noted that all EIAs are invariably predictions and until dams become operational, their impacts (types, magnitudes, spatial and temporal distributions, facts about who receives the benefits and who pays the costs, etc.) are not certain, and thus remain in the realm of hypotheses. Even the best pre-project impact assessments conducted anywhere in the world can reliably forecast only about 70–75% of the actual impacts in terms of time, space, magnitude and the nature of beneficiaries. The EIAs that were conducted in the past for an average dam did not properly identify or assess nearly 40–50% of impacts (Biswas 2004).

The High Aswan Dam was planned, designed and constructed during an era when the world was significantly less environmentally conscious than it is at present. During the late 1950s and throughout the 1960s, no country in the world had an environmental ministry, nor was an EIA required for any type of development project anywhere in the world. In fact, methodologies for conducting EIAs were not even available when the High Aswan Dam was formally opened in 1970. The National Environmental Policy Act of the United States (or NEPA) became operational only in 1971. This pioneering legislation made EIAs mandatory in the United States which, in turn, contributed to the accelerated development of EIA methodologies, and also to the collection of data on which EIA depends. Other countries came to require EIAs later.

However, for a dam that was conceived, planned and constructed before the era of EIAs, the High Aswan Dam received considerable environmental and social attention from its planners and designers, which was somewhat unusual for its time, especially in a developing country. This means that the experts who planned and designed this structure were aware of, and sensitive to, environmental and social issues. More than 45 years after its completion, it is extremely difficult to identify a large dam anywhere in the developing world whose resettlement was carried out (in contrast to the planning phase alone) as sensitively and properly as was the case with the High Aswan Dam. Similarly, issues such as erosion and sedimentation were carefully analysed and considered by the designers. Thus, in many ways, the planners and designers of this dam were well ahead of their time.

Two other issues should also be mentioned. First, the EIAs, as conducted in the past and at present, mostly consider only negative ones—positive impacts are often ignored. In both conceptual and real terms, the impact analysis of a large dam is significantly more than consideration of the negative environmental developments alone. It should also consider all types of impacts due to improvements in the availability of water supply, transportation, hydropower generation, agricultural production, industrial development, control of floods and droughts, as well as all their social, cultural, economic, political and environmental impacts. These assessments are seldom carried out.

Some have erroneously claimed that the World Commission on Dams prepared numerous comprehensive assessments of large dams in different parts of the world. Regrettably, the vast majority of these assessments are somewhat superficial and often skewed to prove the dogmatic and one-sided views of the authors who prepared them. It is most unfortunate that mainly anti-dam analysts were selected by the Commission to carry out such analyses of selected dams from different parts of the world. Many scholars, professionals and governments have seriously questioned the objectivity and reliability of these studies. No serious peer reviews of these studies were ever carried out and, as a result, if there was some 'wheat' among what is mostly 'chaff', it has remained very well hidden. Thus, not surprisingly, these studies have been largely ignored by the world.

One important methodological issue should also be considered whenever ex post impacts of large development projects are to be analysed, which relates to the period over which such assessments are to be conducted. There is now general agreement among experts that in the initial years after a dam's construction, its direct and indirect impacts can be identified, and their cause-and-effect relationships can also be established with a reasonable degree of confidence. However, as time passes, it is difficult to say with any degree of reliability what percentage of the impacts can be attributed to the dam and what to other development factors, some of which may have been unleashed by the dam. Generally speaking, as the years pass, the attributable impacts of dams become hazier and hazier, because of changes brought about in other development sectors. Furthermore, after a certain period, most of the impacts of a new dam stabilise and they come into some form of equilibrium. As a general rule, most of the impacts of any large dam stabilise from 2 to 15 years after it becomes operational. Thereafter, the changes are often not significant, and their attributions to the dam become less and less relevant.

Because of these reasons, this study of the High Aswan Dam considered developments for some 35 years after the construction of the dam, even though the later impacts that could be attributable to the dam, especially during the third decade, are not definitive. As time progressed, especially during the third decade and after, the impacts of the dam were progressively overshadowed by other external development factors.

Any large infrastructure like the High Aswan Dam invariably has many impacts, some of which are positive while others are adverse, and some are very significant while others are minor. It is simply not possible that for any major project there will be only benefits and no costs, and only beneficiaries with no one having to bear costs. There is always a mixture of costs and benefits, and there will always be beneficiaries and people who will have to pay the costs. Ideally, determined attempts should be made to transform those who are likely to pay the costs to become beneficiaries of the project.

The impacts of large infrastructure projects like the High Aswan Dam are not easy to determine on a very reliable basis for many reasons. First, whereas many impacts can be estimated with a considerable degree of confidence, several others cannot be reliably estimated since our knowledge base at present, let alone at the time the dam was planned, leaves much to be desired. Second, the world of development is very complex—often cause-and-effect relationships cannot be established with any degree of dependability. This is because there could be several interacting forces that contribute to a net impact, the dam being only one among many factors. It is often very difficult to estimate which specific forces contributed to what percentage of impacts. Third, while many impacts can be estimated in quantifiable terms, others are intangible and so cannot be measured. Estimates of intangible benefits and costs depend on the experience, knowledge and bias of the analysts. Thus, they could vary, often very significantly, from one analyst to another.

Fourth, the world is not static. Accordingly, the boundary conditions of a project invariably change considerably within the period of the impact estimation, which may have no relation to the project, or only indirect relation. For example, in the case of the High Aswan Dam, land-use changes in Egypt may have been at most an indirect result caused by the dam's construction. This is because the population of Egypt has steadily increased since the dam was built, and industrial, agricultural and urban development have also progressed. The Egyptian population would have grown with or without the dam, and the land-use patterns would have changed because of substantial increases in human population and their activities. Of course, there is no question that the dam contributed to the improvement of the economy very significantly, especially during the early years of its operation when its impacts on the country and its people were the highest.

Fifth, there is also a time dimension to the change. Some impacts may be visible immediately after construction of the dam, like changes in erosion and sedimentation. These changes often stabilise with time, since after a certain period, the new forces unleashed reach an equilibrium with their environment. In contrast, some impacts take time to develop, for example, increase in groundwater or salinity levels due to over-irrigation and lack of adequate drainage facilities. When such impacts become visible and are considered significant, appropriate remedial measures are generally introduced, which unleash new and different forces. These forces again come to an equilibrium with the passage of time.

Finally, in all countries, including Egypt, many developments take place concurrently, along with the dam, which affect the final impacts. For example, the increasing incidence of schistosomiasis immediately after the dam and canal systems were constructed can be directly linked to the absence of sewage treatment works, education level of the population and level of health services available at that time. Each of these and other associated factors could explain the increasing incidence of schistosomiasis in the country. It is difficult to estimate what may be the relative contributions of each of these factors, and what percentage of these impacts could be attributed to the dam directly and exclusively.

Making realistic and accurate estimates of all the impacts pose serious methodological challenges, including data availability and reliability. However, a serious attempt was made in this study to estimate them as accurately as possible with the current state of knowledge.

17.3 Impacts of the Dam

The overall impacts of the construction of the High Aswan Dam can be classified into four broad categories: physical, biological, economic and social. This classification is somewhat arbitrary since many of the impacts are often interrelated, and some of them may spawn effects of other types.

Among the main physical impacts of the dam were the following:

- Changes in the level, velocity and discharge of the flow in the Nile River both upstream and downstream of the dam
- Increase in groundwater levels due to the introduction of year-long irrigation
- Changes in soil salinity and water logging
- Erosion of the river banks, beds and delta
- Sedimentation in the river and Lake Nasser
- Possible earthquakes
- Reclamation of desert for human habitat and agriculture

There were several major biological impacts, which included:

- Incidence of schistosomiasis
- Implications for fish production
- Changes in flora and fauna

Among the economic impacts were:

- Generation of hydropower
- Increase in industrial activities and industrial diversification, because of the availability of electricity
- Increase in agricultural land, as well as crop intensification and diversification
- Impacts on brick-making industry

There were several social impacts, which included:

- Peace and stability of the country due to increased economic activities and higher standard of living
- Eliminating the ravages of floods and droughts downstream of the dam
- Resettlement issues

It is impossible to cover this range of impacts in any meaningful fashion because of space limitations. The detailed analyses of all these impacts can be found in Biswas and Tortajada (2012). In this chapter, only one key issue each from the physical, biological and economic sectors has been selected for discussion.

17.4 Erosion and Sedimentation

It has been widely acknowledged for centuries that whenever there is human intervention in river flows, because of the construction of hydraulic structures such as dams, barrages or weirs, the hydrological and morphological characteristics of the watercourses are invariably changed. The High Aswan Dam is no exception to this rule. The dam irreversibly changed many of the prevailing characteristics of the Nile River. Among the major physical changes was the transformation of the river upstream of the dam from having a riverine to lacustrine nature, and the flow was very strictly controlled and regulated downstream of the structure.

The dam created a major lake at Aswan (Lake Nasser), which is nearly 500 km long and 10 km wide. The entire flow of the Nile was stored in the 3,830 m long dam from 1967. The storage of this enormous quantity of water in the reservoir ensured that as the river flow approached the reservoir, its velocity began to decline. When the flow entered the reservoir, its velocity fell to zero. As the flow velocity declined, so did its carrying capacity of suspended sediments. Consequently, suspended sediments began to precipitate as the water approached the reservoir. For all practical purposes, the river lost nearly all the sediments it carried as the flow approached and entered the reservoir. This meant that when water was discharged downstream of the dam, it was clear and free from sediments. Even during flood seasons when the sediment loads in the river were at their maximum, virtually all the sediments were captured upstream of the dam. In other words, the sediment-trap efficiency of the dam has been almost 100%. Since the water discharged downstream of the dam was sediment free, in the initial years of the dam's operation it contributed to erosion of the river bed and banks. The flow thus steadily picked up sediment as it progressed downstream. These changes were observed all the way to the Nile delta.

Historically, some 90% of the annual sediment flow in the river occurred during the flood season. The average suspended sediment load passing Aswan before the dam was constructed was estimated at 134 million tons (Abu-Zeid and El-Shibini 1997). A very significant percentage of this load is now deposited in the approach to the High Dam Lake. The rest is then deposited in the lake itself. During the planning of the dam, it was estimated that the annual sedimentation in the lake would average at about 60 million m^3. Consequently, the reservoir was designed for a dead storage capacity of 31.6 km^3, and the levels between 85 m and 147 m were reserved for dead storage. The reservoir has a live storage capacity of 90.7 km^3, up to level 175 m, and then a provision for flood storage of 39.7 km^3 up to level 182 m. Monitoring of the actual sedimentation in the reservoir indicates an annual deposit of 60–70 million m^3, which is well within its design considerations. Studies have also indicated that the sedimentation is mostly occurring within 250 km upstream of the dam.

Predictions of erosion and sedimentation downstream of the dam, especially in the mid-1950s when the available knowledge and analytical capability were not as advanced as at present, were very difficult and complex. The problem was further compounded by the lack of reliable data and absence of a consensus among the erosion and sedimentation experts of the world on which method for estimating rates would best suit the Aswan case. Since different methods, with different assumptions, were used by different experts for these predictions and knowledge of the geological aspects of the river bed was grossly inadequate, these predictions, not surprisingly, varied widely. The predictions of drop in water levels and overall degradations downstream of each barrage ranged from 2 to 10 m.

During the late 1980s and the early 1990s, the National Water Research Centre of Egypt undertook detailed studies on water level to determine erosion and sedimentation changes following the dam's construction. Monitoring was undertaken at El Gaafra, Isna Barrage (downstream), Naga Hammadi Barrage (downstream) and Assiut Barrage (upstream and downstream). These studies (Abdelbary et al. 1990; Abdelbary 1996) showed some important changes before and after the construction of the dam. First, the suspended sediment content of the Nile waters decreased remarkably after the dam was constructed. For example, the mean annual suspended load declined at El Gaafra from 129 m/year in pre-dam conditions to 26.3 m/year in 1964, 4.20 m/year during 1965–1967, and has stabilised at around 2.27 m/year during the post-1967 period. If the peak annual sedimentation concentrations are considered, the changes are even more stark. This declined from about 3,000 ppm during the pre-construction period to about only 50 ppm later, representing a reduction of nearly 98.5%.

Second, as the Nile flowed downstream of Aswan in the pre-dam era, its sediment load declined steadily as it reached the delta that drains into the Mediterranean Sea. This pattern was completely reversed after the dam was constructed. This is not surprising, and was in line with the planners' forecast. Prior to the operation of the dam, the sediment content of the river flow fell as it progressed downstream because some

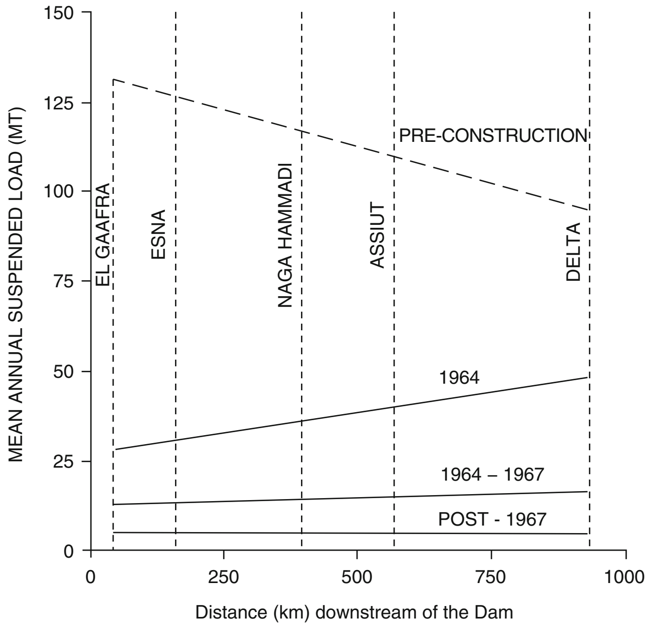

Fig. 17.1 Suspended sediment loads in the Nile downstream of Aswan (*Source*: Abdelbary 1996)

of the sediments precipitated upstream. Thus, the sediment content of the flow was the lowest when it reached the delta. Once the dam became operational, the relatively sediment-free water travelled downstream of the dam and steadily picked up sediments. At present, the sediment content of the water increases as it reaches the delta. The pre- and post-dam sediment contents of the flow are shown in Fig. 17.1.

It should be noted that the gradual increase during the post-dam period in the sediment load of the river, as it travelled downstream, might not be solely attributable to the construction of the structure. It is likely that the sediment load also increased because of other natural factors, such as sediment inflows from the wadis (in certain Arabic-speaking countries, a valley, ravine, or channel that is dry except in the rainy season), wind-blown sand and inflows to the river from the drainage system. Without a detailed analysis of the sediment balance from various sources, it is not possible to determine what percentage of the sediment can be attributed to erosion that occurred because of the dam. Detailed sediment balance of the river after construction of High Aswan Dam is not available.

Another impact caused by erosion and sedimentation is a reduction in the total bank length of the river after the High Aswan Dam, which is calculated by estimating the river length multiplied by two, and adding the bank lengths of the islands. The islands that are considered are those which have permanent vegetation. These do not include sand bars. Based on data available (Abdelbary 1996), the total bank length before the construction of the dam was estimated at 2,409 km. By 1978, the total bank length had fallen to 2,047 km, and by 1988, it marginally declined further

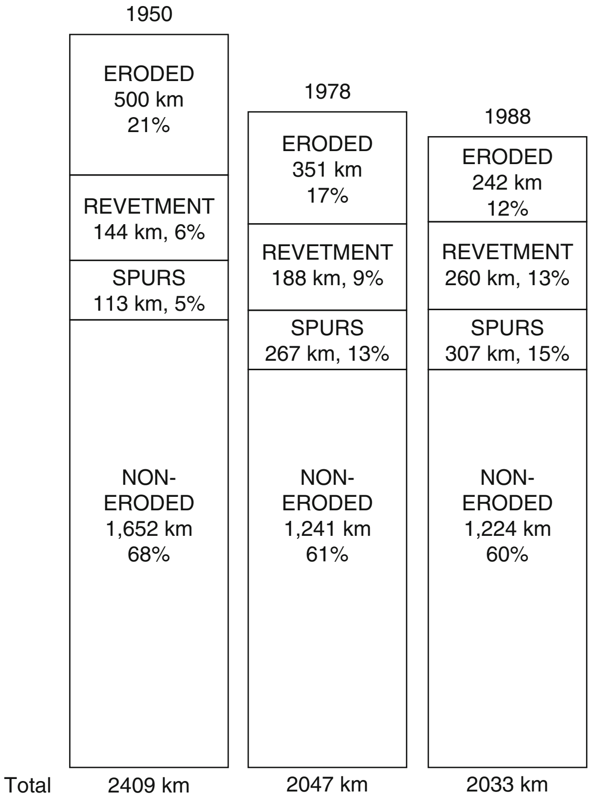

Fig. 17.2 Status of Nile River banks in 1950, 1978 and 1988. *Note*: Eroded bank length for 1950 is an estimate. 1978 and 1988 lengths are based on actual observations (*Source*: Abdelbary 1996)

to 2,033 km. This also indicates that the erosion and sedimentation activities have now basically reached an equilibrium. This is shown in Fig. 17.2.

The post-dam Nile has created a problem in terms of coastal erosion. Before the dam was constructed, the Nile carried a high sediment load during the flood period, which was deposited in the delta. During the winter months, the sediments were removed by wave action. Over the centuries, an equilibrium was established between the amount of sediment that was deposited during the flood season, and its removal by wave action during the winter season. This contributed to a reasonably steady shore line.

However, as soon as the first hydraulic structure was built on the Nile over a century ago, the sediment equilibrium was disturbed. Those built prior to the construction of the High Aswan Dam were not major, and thus the disturbance to the sedimentation–erosion equilibrium in the delta was not high. The dam had a serious impact on this equilibrium, as a result of which significant erosion was witnessed along the Mediterranean coast after it became operational. Considerable research and monitoring (Smith and Abdel-Kader 1988) were conducted to determine the extent of erosion of the coast over time, and to identify preventive steps. Appropriate remedial measures have now been taken.

17.5 Impacts on Fisheries

Impacts of large dams on fisheries, especially over the long term, are hard to predict. They are also difficult to estimate after the dams are constructed and become operational. This is because, as with any large infrastructure project, dams unleash a series of interacting forces of all types, over both space and time, which are difficult to forecast and to quantify.

17.5.1 Fish Catches Prior to the Dam

The data currently available on fish catch for the 1950s and 1960s in the Nile River and its delta can be used at best as an indicative estimate. For example, the Yearbook of Coast Guards and Fisheries of the Ministry of Defence (1960–1967), collated by the institution that was responsible for collecting fisheries data when the dam was being constructed, records a total fish catch from the Nile in 1955 as 850 metric tons. However, another available estimate of the fish catch for the same year was 6,700 metric tons. Even though the Ministry of Defence (specifically its Coast Guard) was the official governmental custodian of the fisheries data of Egypt during the 1950s, their estimates of the annual Nile fish catches appear to be consistently low. This underestimation can be appreciated by the fact that two sets of official data for the total Nile fish catch are available for the period between 1963 and 1967—one from the Ministry of Defence (MOD) (Saleh 2004), and the other from the then newly established civilian authority, General Enterprise for Aquatic Resources (GEAR). They are simply not comparable. For example, the GEAR estimate for 1963 is nearly 38 times that of the MOD. Similar divergences can be observed for other years.

Statistics for annual Nile fish catches are available from 1985 onwards from the statistical yearbooks of the General Authority for Fish Resources Development (GAFRD), another civilian institution. It is difficult to draw authoritative conclusions on the reliability of the GEAR or GAFRD data. For example, for the 1966–1975 period, GEAR consistently provided an annual fish catch at the same neat, round number of 20,000 metric tons, which is highly unlikely to be accurate.

Construction of a dam creates a barrier which reduces nutrient flows in the river downstream of the structure, and also to the estuary. This, in turn, reduces primary production, of organisms like phytoplankton and zooplankton, on which fish life depends. Accordingly, the construction of dams generally reduces fish production downstream of the structure, at least in the initial years. However, large hydraulic structures invariably trigger different forces that are often difficult to predict in terms of time, space and magnitude. For example, electricity generation and availability of water from the new dam often contribute to employment creation, which may further accentuate urbanisation. In the entire developing world, where wastewater treatment left much to be desired during the 1960s and 1970s, increasing urbanisation often contributed to higher nutrient loads to the rivers because of discharges of untreated, or partially treated, human waste. While the level of waste treatment in Egypt has improved somewhat since 2000, it is still inadequate, and the nutrient discharges to the Nile and its delta continue to remain high.

In addition, with reliable availability of irrigation water from the newly created reservoir, two to three crops can be grown each year instead of only one using floodwaters, as was the case under the pre-dam conditions. Increased cropping intensity has in turn significantly increased the total fertiliser use. Also, much more land has been converted to irrigation than before the dam, which again has contributed to additional input of fertilisers. Because of these developments, more and more phosphates are leached into the river downstream and on to the delta. This nutrient enrichment, over time, has generally increased primary production. The increase in primary production is followed by increased fish production, and thus fish catch.

Official data on fish catches are also somewhat unreliable because the price of fish is controlled, and also because the imposed fixed price is lower than the prevailing free market price. The price differential has resulted in extensive fish smuggling that does not get recorded in official statistics. As a general rule, the higher the differential between official and free market prices, the higher the level of smuggling. This factor, for example, may be the reason for the apparent decline in annual fish catches from Lake Nasser in the early 2000s, when the official fixed fish prices were a fair bit lower than the free market price.

The complexity of the fish catch statistics is further enhanced by other factors. For example, after the Egypt–Israel Peace Treaty was signed in 1979, security considerations in the Mediterranean changed significantly. Large areas of fishing ground that were off-limits to the fishing vessels for over a decade suddenly became available. These areas had considerably more fish since they had not been exploited during the previous decade. In addition, the eastern zone of the Mediterranean (east of Port Suez) was also opened up for fishing from 1980 onwards. Thus, the area over which fishing was possible expanded remarkably within a short period of time. The expansion of the fishing ground further changed the economics of fishing. This resulted in new investments in terms of adopting better fishing technology which had not been economically attractive earlier.

Reductions in fish catch from about mid-1967 and increases from 1978 onwards were partly caused by military considerations. Therefore, part of the decrease in fish catch during the earlier phase and the increase thereafter had nothing to do with the construction of the High Aswan Dam, but to reasons linked with national security. It is difficult to estimate what percentage of these changes in the fish catch from the Mediterranean during the 1967–1980 period can be attributed to military reasons. These factors should, however, be carefully noted in any comparison of pre- and post-dam fish catches. Many authors (e.g. Ibrahim and Ibrahim 2003) have claimed that fisheries in the area collapsed completely immediately after the construction of the High Aswan Dam (Thomas and Wadie 1989; Caddy 1993). While there is no question that fish catches declined following construction of the dam, the most important question is what was the extent of the decline that can be attributed directly to the dam?

The pre and post-dam fish catches from the Mediterranean are shown in Fig. 17.3. The available data show that fish catches increased rapidly from 1958 to 1960, with a

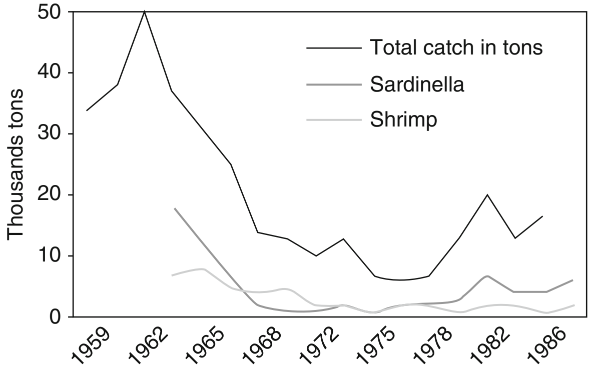

Fig. 17.3 Total catch, 1958–1986; sardinella and shrimp catch, 1962–1986 (*Source*: Fishery Statistics, Institute of Oceanography and Fisheries, Alexandria)

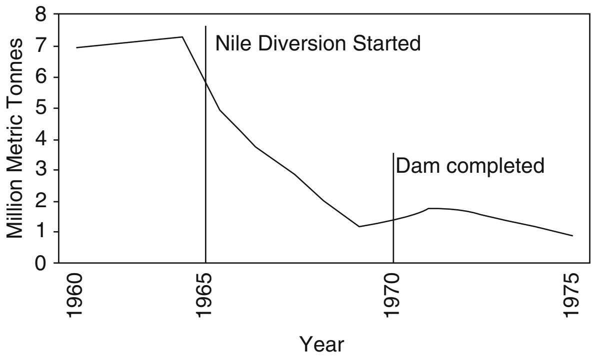

Fig. 17.4 Annual Mediterranean shrimp catch (*Source*: FAO 2005)

very pronounced peak in 1960. Unfortunately, data are not available for 1961, and thus it is not easy to say if a sharp decline began from 1960 or 1961, well before the Nile diversion was put into place in 1964. By 1965, the total catch had declined by nearly 70%. Much of this decline, going by current evidence, cannot be attributed to the dam.

This rise and then the sharp decline in fish catches can be directly linked, from 1958 to at least 1964, to government policies on fishing that were implemented in the late 1950s. The policies aimed at increasing fish catch, and included supporting fisheries cooperatives and subsidising the mechanisation of fishing vessels and gear. Because of these policy interventions, between 1958 and 1961 the number of motorised fishing boats increased by nearly 50%, from 428 to 622 (El-Zarka and Koura 1965). The policy ensured high fish catches during 1958–1961, which in turn contributed to overfishing and a resulting rapid decline in fish catch from 1962 onwards. Therefore, well before the dam was constructed, the fish catch from the Mediterranean had begun to decline very significantly. This is one aspect that nearly all the environmental impact analyses of post-dam developments have failed to consider.

Figure 17.4 shows detailed information on the changing nature of the annual shrimp catch from the Mediterranean for the period 1960–1975. It illustrates that

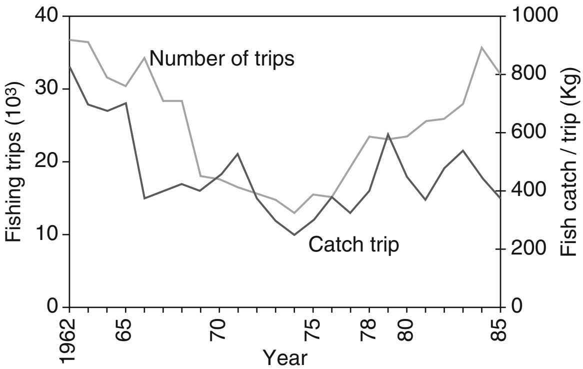

Fig. 17.5 Number of trips and average annual catch per trip (*Source*: Saleh 2004)

the rapid decline in the shrimp catch could be observed well before the Nile diversion was built in 1964, and then continued for another 4 years before reaching some sort of an equilibrium for a while.

17.5.2 Fish Catches After the Dam

This discussion will separately consider fish catches from the Mediterranean and those from Lake Nasser.

17.5.2.1 Mediterranean Catches

The reduction in fish catches after 1965 from the Mediterranean can thus be attributed to several reasons, among which were the decrease in primary productivity of the coastal areas, the reduction in fishing area after 1967 due to military considerations and earlier government policies which contributed to overfishing. The catch declined from 680 to 380 kg/trip, a 44% fall, within a 1-year period of 1965–1966 (Fig. 17.5). By 1973–1975, the catch had declined even further, to about 250 kg/trip, a level that was only 37% of the 1965 value and about 31% of the 1961 value (Saleh 2004).

These figures are not directly comparable since the number of fishing trips declined rapidly, from about 37,000 in 1962 to about 9,000 at the lowest points of 1973–1975, when the fish catches became some of the lowest (Fig. 17.5). As yield per fishing trip started to increase during the post-1977 period, so did the number of trips, because of the higher catch and thus the improved economics of fishing.

What is evident, however, is that the fish catch from the Mediterranean started to increase dramatically from about 1977. The most likely hypothesis could be the increasing nutrient loads that began to reach the Mediterranean (Nixon 2004; Oczkowski et al. 2009) because of increasing urbanisation (and the resulting discharge of untreated or partially treated domestic wastewater to the coast), and also due to higher levels of fertiliser leaching into the Mediterranean as more and more land was

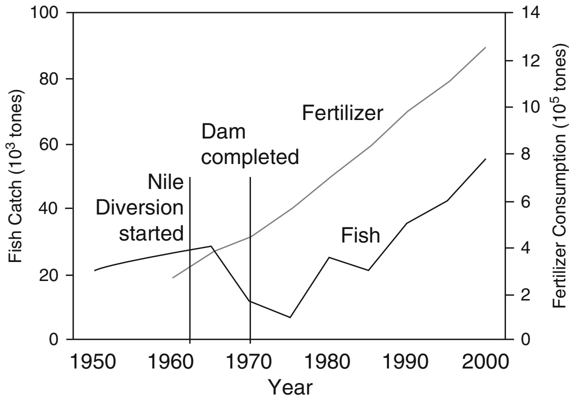

Fig. 17.6 Fish catch from the Mediterranean and fertiliser use in Egypt (*Source*: FAO 2005)

brought under irrigation as well as increasing fertiliser use per unit area to obtain higher yields (Fig. 17.6). While the discharges of this higher nutrient load have been beneficial thus far, especially in terms of increased fish catch, care needs to be taken to ensure that this load does not continue to increase progressively in the future. Otherwise, at some stage, such increased nutrient loads will over-fertilise the coastal waters, which in turn will adversely impact the total fish catch from the Mediterranean. It is worth noting that even though the Nile diversion was started in 1964, its dynamic implications are still being observed some 45 years later.

Thus, if total fish catches before and after the High Aswan Dam are compared, there is no question that after the dam was built, Egypt had more fish available from the Nile (including Lake Nasser) and the delta, compared to the pre-construction period.

17.5.2.2 Catches from Lake Nasser

The total annual fish catch from Lake Nasser in 1968, as expected during its initial years, was quite low at about 2,662 metric tons. The catch steadily increased from that time and reached a maximum of 34,206 metric tons by 1981. Records indicate that 1980–1983 were the most productive years, when the annual fish catch varied between 28,667 and 34,205 metric tons. Thereafter, the catch began to decline. The total annual catch fluctuated around 20,000 metric tons between 1993 and 1998 (Saleh 2004).

17.6 Hydropower Generation

A very major economic benefit of the High Aswan Dam is the electricity it generated when the country needed it the most. Thanks to this generated renewable energy, it was possible to provide electricity to much of the country's rural area. This simple factor of development changed the social and environmental conditions

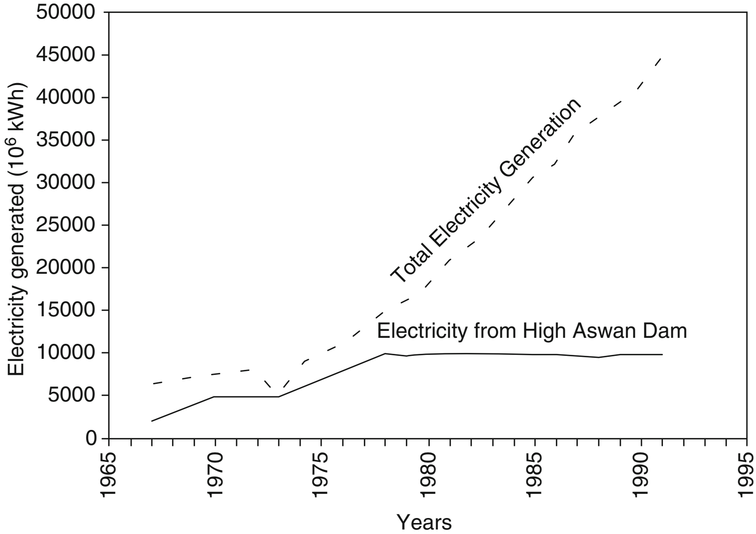

Fig. 17.7 Contribution of the High Aswan Dam to Egypt's electricity generation

of much of Egypt, and also substantially improved the quality of life of a very significant number of its people.

The 12 generating units of the Aswan are capable of producing 10 billion kWh of electricity per year. Before the dam became operational, Egypt had to import fossil fuel. The electricity generated by the dam reduced in a most significant way the potential energy import bill of the country. Figure 17.7 shows the contribution the dam has made to the generation of electricity in the country. Up until 1979, the dam contributed to nearly half of the electricity generated in the country. In some years, its share was significantly more than 50%. As time progressed, and especially after 1980, the dam's share began to decline because of increasing contributions from newly constructed thermal power plants which met the burgeoning electricity requirements of the country.

If one looks solely at the electricity generated by the dam since its beginning, the accrued benefits from this sector alone paid for the entire construction cost of the structure quite some time ago.

17.7 Overall Benefits and Costs of the Dam

According to the detailed benefit-cost analysis carried out by the Egyptian Ministry of Irrigation, at the time of the dam's construction its total cost, including subsidiary projects and the extension of electrical power lines, amounted to Egyptian £450 million (Abul-Atta 1978). These costs seem to be realistic since they are somewhat similar to World Bank estimates. The then Irrigation Minister, Abdul Azim Abul-Atta, estimated that this cost was recovered within only 2 years, since the dam's annual return to national income was estimated at E£255 million, consisting of E£140 million from agricultural production, E£100 million from hydropower generation, E£10 million from flood protection and E£5 million from improved navigation. Detailed estimates of these costs were prepared by the Egyptian government, and since no one has challenged them, they can be assumed to be reliable. Thus, our focus has been to assess appropriate impacts, especially environmental and social, about which there has been considerable global controversy ever since the construction of the dam was initiated.

The importance of the dam to Egypt's economic survival was clearly demonstrated, at least qualitatively, during the 1980s. It is not too difficult to hypothesise what would have happened to the Egyptian economy and socio-political conditions if the dam had not been there to protect the country from, first, the potentially catastrophic impacts of a prolonged drought from 1979 to 1986, and immediately thereafter the abnormally high summer flood of 1988, which had devastating effects on Egypt's upstream neighbour on the Nile Basin, Sudan. Even with the Aswan High Dam in place, Egypt had come perilously close to experiencing the catastrophic impacts of the drought by early 1988, due to a dangerously low water level in Lake Nasser.

17.8 Conclusions

The analysis of selected impacts, both positive and negative, made in this chapter, should provide a clear indication of the complexities and difficulties of assessing impacts of any large hydraulic structure. There are several levels of complexities, the most important of which is the fact that it is difficult to assign accurately the benefits and the costs that can be attributed to any specific impact.

The problem is further compounded by the fact that the development of any country is never static. There are continuous changes, government policies are often dynamic, and the ranges, extents and magnitudes of human activities are constantly changing. It is thus very difficult to isolate and attribute benefits and costs to one specific activity—they are often impacted by many other factors. This challenge is made more complicated by the fact that the necessary data are often not available, or reliable, in developing countries, and many of the impacts are not quantifiable. This makes authoritative impact predictions for any dam or large structure a very difficult task under the best of circumstances.

The three important impacts of the High Aswan Dam analysed in this chapter indicate the complexities of the issues, as well as the danger of drawing simplistic conclusions because they often prove to be wrong. The case of the High Aswan Dam is an excellent example of how numerous people from all over the world have failed to understand and appreciate the difficulties associated with such simplistic analyses and linear thinking, which have led to totally erroneous conclusions. Based on the study carried out by the Third World Centre for Water Management, it is evident that the High Aswan Dam is one of the most successful hydraulic structures of the world, and not one of the worst as is often presently contended at the international level.

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