ENVIRONMENTAL EVALUATION FOR HIGH ASWAN DAM SINCE ITS CONSTRUCTION UNTIL PRESENT

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ABSTRACT

In 1956 it was decided by the Egyptian government to build one of the highest dam in the world with the biggest man made reservoir in the world. Several studies had been conducted to study the impact of High Aswan Dam (HAD) on the surrounding environment. However, these studies were usually conducted on scattered matter, i.e. there was no integration of all of the different impacts the analysis of this study is to produce auditing for the HAD project. It also aims the reviewing the positive and the negative impacts of the project that affect the environment. A general evaluation for the HAD project has been drown out.

INTRODUCTION

Nile River floods ranges from 43 to 150 billion cubic meters per year. Due to the great yearly variation and the month to month flood variation it was very important to build a major structure to secure water resources during low periods and protect Egypt from high floods. This structure was build in 1960 s and called High Aswan Dam (HAD)

HAD has many advantages which can be listed as follows:

1) Expansion of cultivation.
2) Transfer one million feddans from seasonal to perennial irrigation.
3) Protection from high floods.
4) Hydropower generation.
5) Improvement of navigation.

On the other hand, it has some disadvantages which can be listed as follows:

1) Fertility problem of the cultivation lands due to the storage of the sediment U.S. the HAD
2) Shore protection problem due to the erosion of the shores by the sea.
3) Some other physical social biological and cultural problems

BACKGROUND

Project description

The High Aswan Dam is a rockfill dam, constructed across the Nile at a distance of 7 km south of the city of Aswan. The Spillway is located on the western side. The total length of the dam is 3600 m, of which 520-m is located between the two banks of the river, and the rest extend along both sides. The height of the dam is 111 m above the riverbed. Its width is 980 m at the bottom and l0 m at the top The body of the dam consists of granite and sand, in the middle of which there is a core of Aswan puddle clay to minimize water Seepage. At the front, it is connected with a horizontal impervious curtain. Since the dam bed consists of alluvial materials, it has a vertical Cut-off curtain extending below the core. With the same depth as the sedimentary layer, the reservoir storage capacity is 162 Billion Cubic Meters (BCM) distributed as follows:

90 BCM: lives storage capacity between levels 147 m and 175 m.
31 BCM: dead storage for sediment deposition
41 BCM: storage available for high flood waters between Levels of 175 m and 182 m

The hydroelectric power station is situated at the outlets of the tunnels and consists of 12 units with a capacity of 175,000 kW each, i.e. with a total capacity of 2.1 million kW, producing 10x 10^9 kWh of power annually. Each generating unit consists of a Francis-type hydraulic turbine. Work was started on the first stage of the project in 1960 and ended in May 1964. This stage included the excavation of the diversion channel, the construction of the main tunnels, the construction of the body of the dam up to the level of 132.50-m (17.5-m above riverbed), and the diversion of the Nile's course to enable the completion of the dam

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ANALYSIS

The concept of (EIA)

EIA is understood as an integrated part of the planning process devoted to the identification, quantification and qualification of environmental impacts due to the development of a project as well as the definition of policies and strategies required to monitor and control such impacts.

METHODOLOGY

Several studies have been conducted to study the impact of HAD on the surrounding environment. However, these studies are usually conducted on scattered matter, i.e. there were no integration of all of the different impacts .

The present study aims at introducing the integration of all impacts

So to be able to perform the study, different factors were considered as follows:

1- Physical factors (degradation, deposition, flood protection, drainage and groundwater, navigation)
2- Biological factors (hydropower, agriculture, fertilizers, health, employment, tourism, earthquake, brick industry)
3- Socio-economic factors (meteorological, fish and wetlands)
4- Culture factors

Analysis of study

After the construction of the HAD, the river Nile in Egypt has become more stable. The following types of scour and degradation are noticed along the river:

1- Long term degradation along the reaches downstream hydraulic structures.

2- Contraction scour due to bridges.

3- Local scour downstream hydraulic structures.

A major effect of the HAD construction is the change of the suspended sediment concentration from about 2800 PPM at El-Gafra gauging station to 50 PPM. In addition to the change of the average monthly flow pattern after the construction of HAD, as shown in Figure (1). These changes cause water to erode bed and banks of the river.

Analysis of cross section

1- The irregularity in the cross sections were considered as well as the changes in the orientation of the sections with respect to the main reservoir longitudinal axis.

2- The present study identifies locations of scour and deposition across each section in the transverse direction.

3- A contour map of bed profile can be produced for any year to define the change of the river bed morphology.

4- The calculated cross sections show good agreement with the field measurements along the whole sedimentation zone.

5- The sediment deposition will continue until year 2000 in the first 140 km and the bed level will rise 1.5 m in the average to reach level 160 m. This deposition will be followed by an erosion period until year 2010 and the bed level will reach level 150 m. the eroded sediment will move to the next 60 km in the dam direction.

Figure (2) shows what happened for cross section seven on the River Nile at Km 74,73 during construction of HAD and Figure (3) shows what happen for cross section seven on the River Nile at Km 74,73 after construction of HAD.

Prediction of High Aswan Dam Reservoir life time

The measured cross sections in 1964 and the calculated ones in 1995 were compared to calculate the deposited area at each cross section and to calculate the deposited volume along the reservoir. Table (1) indicates the calculated deposited volume during the period from 1964 to 1995. The variables shown in the table are defined as follows:

Length (km): is the length of the reach represented by the given cross section.

Area-64 (m^2): is the area of the measured cross section in 1964.

Area-95 (m^2): is the area of the calculated cross section in 1995 except sections 26, 25, 22, and 20 are measured.

Dep.area (m^2): is the calculated deposited area at each cross section during the period from 1964 to 1995) = (Area-95) - (Area-64)

Dep.vol (1000 m^3): is the volume of the deposited sediment at each reach where

Dep.vol (1000 m^3) = Dep.area (m^2) * length (km)

Table (1) Volume of the deposited sediment from 1964 to 1995

C. Sec.	Dist. km u/s AHD	Length Km	Area-64 M^2	Area-95 m^2	Dep. Area m^2	Dep. Vol. $1000m^3$
23	487.5	23.5	6803	3510	3293	77386
19	466.0	19.8	10375	5248	5127	101264
16	448.0	17.5	14550	6602	7948	139097
13	431.0	16.3	21425	9405	12020	195320
10	415.5	13.8	26433	9027	17406	239336
8	403.5	10.8	25350	10709	14641	157386
6	394.0	12.8	30250	11925	18325	233647
3	378.0	11.0	37008	14244	22764	250401
D	372.0	5.0	42275	15340	26935	134675
28	368.0	4.0	55795	19916	35879	143518
27	364.0	5.5	118109	38571	79537	437455
26	357.0	6.0	155100	84257	70843	425057
25	352.0	13.0	203103	180645	22458	290826
22	331.1	13.5	218289	192380	25908	348469
20	325.1	3.0	252672	224624	28049	84146
					Sum =	**3,257,982**

The life time of dead zone is about 311 years and the life time of live zone is about 1202 years. This is comparable to other investigators results.

6- the lifetime of the dead zone of High Aswan Dam Reservoir (HADR) is expected to be 311 years and for the live zone is expected to be 1202 years, (Abdl Aziz, 1997)

Other studies show that the life time could reach 500 years, (Abo El Atta, 1978).

Analysis of study

In 1946, before the construction of HAD the flood damaged about 70,000 feddan while in 1964, during its construction it protected Egypt from damage of about 100,000 feddan which were estimated by a value of 10 million L.E.

HAD also has protected us from damage of high floods in (1975, 1988) and it saved Egypt.

Also saved us from drought in (1972/73, 79/80, 87/88), (Afifi, 1993).

Hydropower Analysis:

Before the High Dam Hydro Electric Power Station (HEPS) construction, the upstream level of the Aswan dam HEPS fluctuated within 101-121 meters. Owing to this fact, the head of the Aswan HEPS fluctuated from 7.5 m (minimum) to 32 m (maximum).

(1) Total hydropower generation in the period 1967-1991 =193050 M.K.W.H.

(2) Total energy generated from thermal power station (P.S.) 1967-1991 = 314427 M.K.W.H .

(3) Saved fuel due to hydro in period 1967-1991 = 61796 (1000 ton Maz. Eq).

(4) Consumed fuel for U.P.S. 1967-1991 = 92991 (1000 ton Maz. Equ).

After the high dam HEPS was put into operation, an average yearly power generation increased due to the stability of average values of head of Aswan HEPS.

Average energy generated/year for Aswan dam through the period 1960-1966 = 1273 M.K.Wh./year.

Average energy generated/year for Aswan dam through the period 1967-1984 = 1732.5 M.K.wh./year.

Energy increased = 460 M.K.Wh./year.

Note: The two power plants were constructed, put into operation in year 1985.

1- Total energy generated from H.D. in the period 1967-1991 = 143430 MKWH.
2- Total energy generated from thermal P.S. period 1967-1991 = 314427 MKWH.
3- Fuel save due to high dam energy generated in periods 1967-1991 = 45956 (1000 ton maz eq).
4- Fuel consumption for U.P.S. in periods 1967-1991 = 92992 (1000 ton maz equ), (El-safty, M.T., and H.A. Younes, 1993)

Figure (4) show the percentage of hydropower generation to all electricity generation in Egypt.

Agricultural Analysis:

HAD had achieved all the planed sector in agriculture (horizontal expansion)in added to the second step or let us say the long term benefit in agricultural sector due to HAD construction which is (vertical expansion) as shown in Figure (5).

Climatic Change Analysis:

Comparison between the estimated and calculated evaporation losses in HAD reservoir.

Comparison between air temperature in Aswan City before and after HAD.

Comparison between relative humidity in Aswan City before and after HAD.

Relationship between water level and evaporation losses in HAD reservoir.

The estimated amount of evaporation from HAD reservoir (Lake Nasser) is 10 BCM Before construction and the actually evaporation calculated is 9.6 BCM although the method of measure is difference (Beth method in 1960) and (aero dynamic method now) so we can say that this estimation is exactly due to the difference in accurately of the two methods .

From Figure (6) the air temperature in Aswan City became lower after the construction of HAD.

From Figure (7) the relative humidity in Aswan City became higher after the construction of HAD.

Wet Land and Lakes

Table (2) shows different species comparison (%) in Lake Manzala over 6 periods from 1920 to 1993. While Table (3) summarizes the change in the lake size along with other production features. Table (4) is used for comparison purpose in regard to the change in lake size, the acreage's of the lake. Table (5) shows that the change in Burullus Lake size over time, the acreage of the lake. While Table (6) shows that the change in Edco lake size over time, the acreage of the lake and Table (7) shows that the change in Maryout lake size over time, the acreage of the lake. (El-Gamal, 1999)

Table (2) Species comparison (%) in Lake Manzala over 6 periods from 1920 to 1993

Period	Mullet	Constructions	Other marine species	Tilapia	Eels	Freshwater species
1929-1920	55.8	17.7	3.3	19.9	3.1	0.06
1958-1957	21.9	5.9	7.2	59.7	1.1	4.4
1966-1962	13.4	9.7	6.4	64	0.7	5.7
1976-1972	9.2	1.9	1.4	82	0.9	4.6
1980-1979	2.2	6	0.7	85.4	0.8	4.9
1993-1989	9.2	2.5	2.3	69.5	0.5	9.8

Table (3) Euroconnsult (1992) summarized the change in the lake size along with other production features

Years	1929-1920	1966-1962	1980-1979
Lake area (fed)	407000	300000	255000
	-	-	-
Fish yields (kg/f) Marine species	22	15	10
High value crustaceans	7	7	1
Tilapia and other freshwater species	9	48	233
Low value crustaceans	-	-	10
Total fish yield (kg/fed)	38	70	254

Table (4) Comparison of the change in lake size, the acreage's of the lake

Year	Area (fed)	Comments
1953	303390	Based on topographical maps
1973	232770	Based on landsat satellite imagery
1981	215440	Based on landsat satellite imagery

Table (5) Change in Burullus lake size over time, the acreage of the lake

Year	Area (fed)	Comments
1953	136190	Topographical maps
1973	124830	Landsat satellite image
1981	114520	Landsat satellite image

Table (6) Change in Edco lake size over time, the acreage of the lake

Year	Area (fed)	Comments
1953	35770	Topographical maps
1973	28480	Landsat satellite image
1981	27470	Landsat satellite image

Table (7) Change in Maryout lake size over time, the acreage of the lake

Year	Area (fed)	Comments
1950	32160	-
1953	31370	Topographical maps
1973	16280	Landsat satellite image

CONCLUSION

This study performs an environmental evaluation for HAD since its construction until present from different perspectives (physical, socio economic, biological and culture parts).

It was found that there is a big advantage in many sectors either in short or long terms due to HAD construction such as agriculture, hydropower, protection from floods and droughts, tourism, employment, migration, meteorological and long run in brick industry. There were also some negative impact on fertilizers, sediment (deposition) and brick industry. There was no impact on health, earthquake occurrences, degradation and culture. It was found that there is a need for more studies on fish and wet lands, groundwater and drainage, and navigation.

Finally, we may conclude that HAD has many benefits which affect positively the environmental and economic conditions in Egypt. The negative impacts are still to be monitored and studied to minimize their effects.

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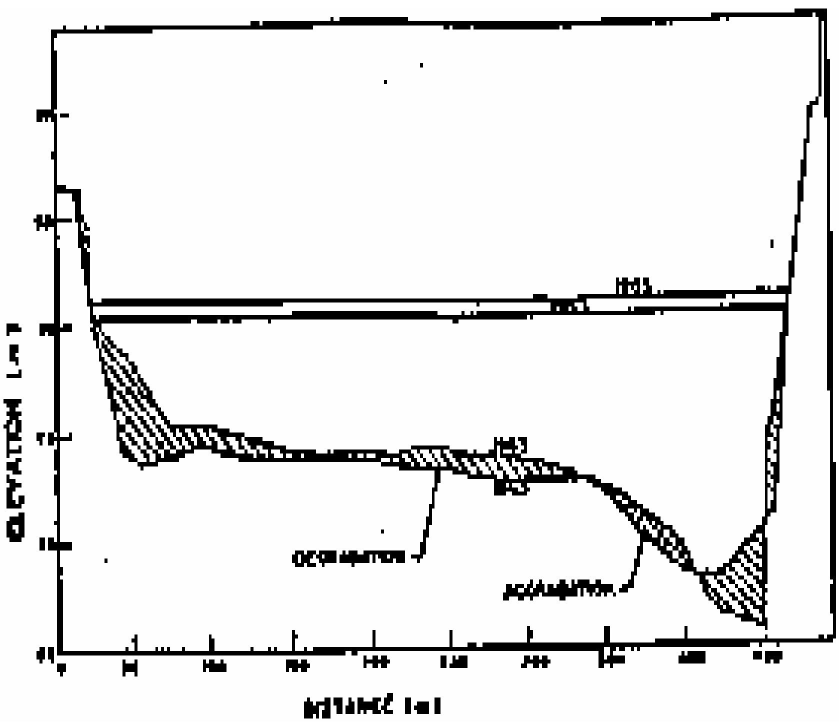
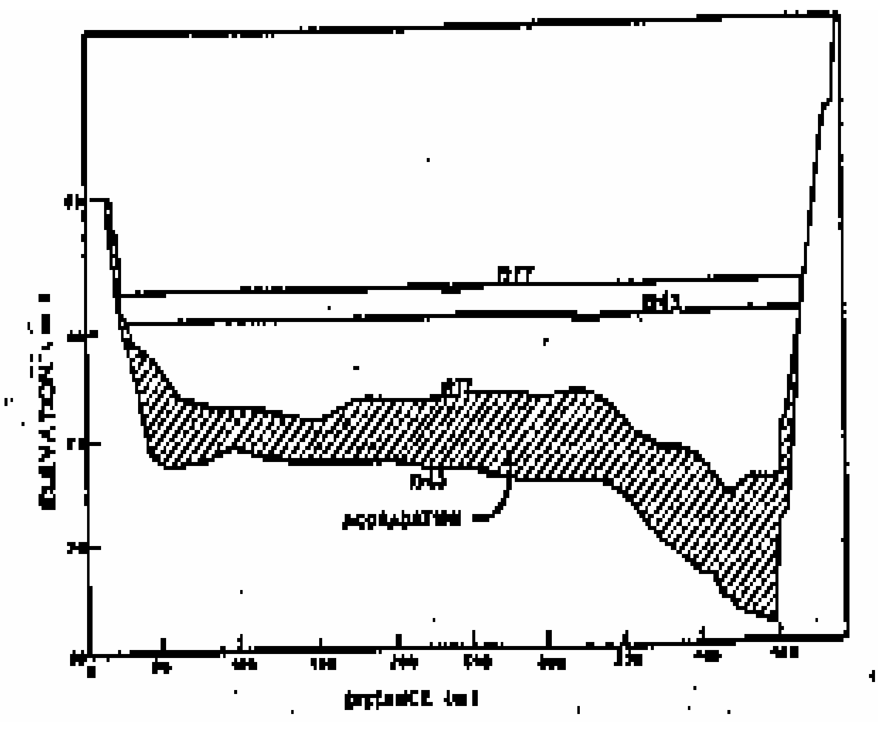


A



B

Figure 1. Cross section at Km. 74.73 a) during HAD Construction
b) after HAD Construction

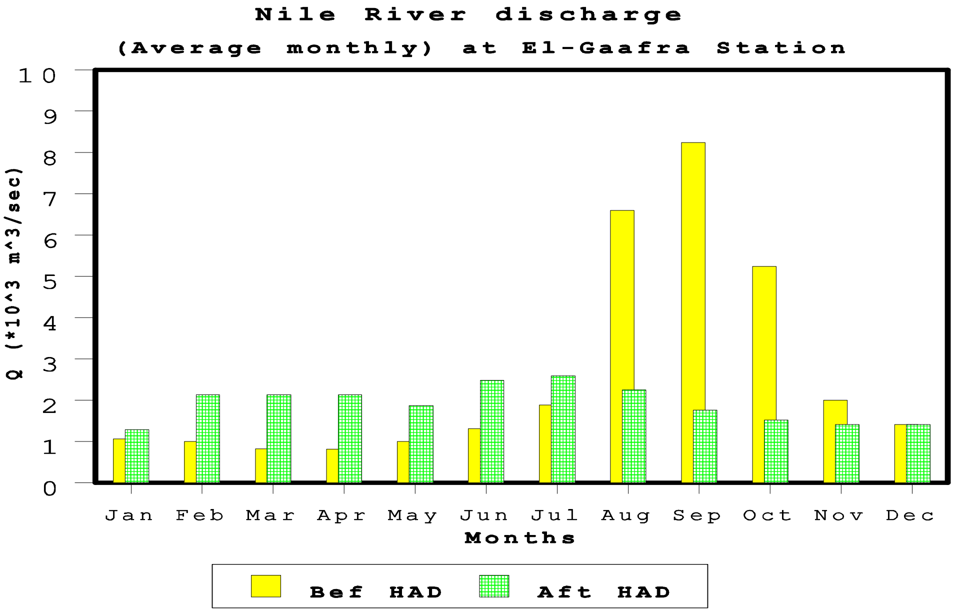


Figure 2. Average monthly flow at El-Gaffra Station

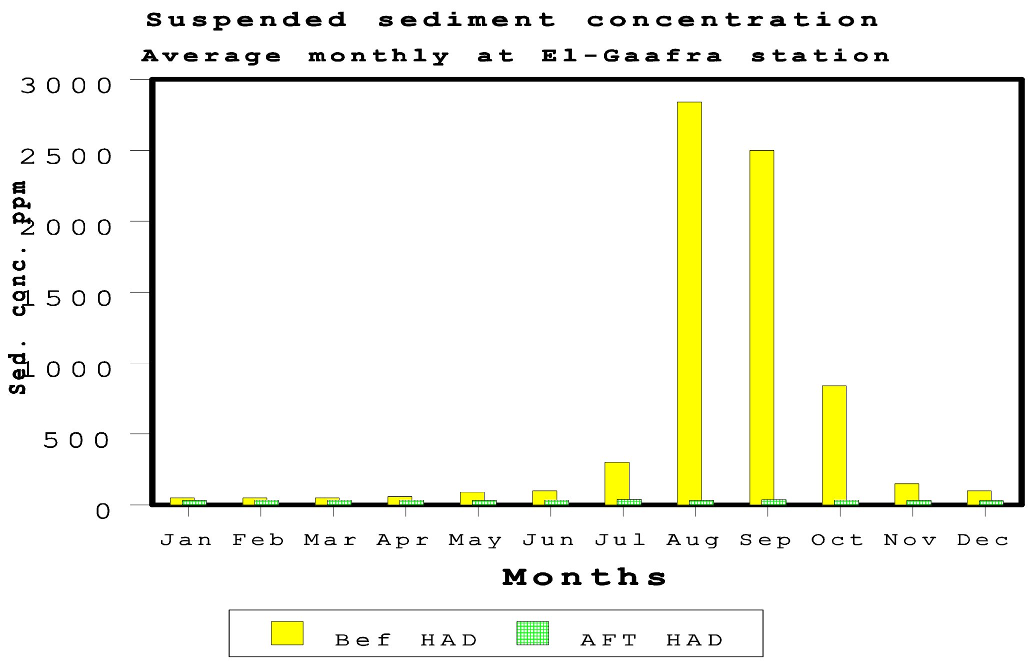


Figure 3. Average monthly suspended sediments concentration at El-Gaffra Station

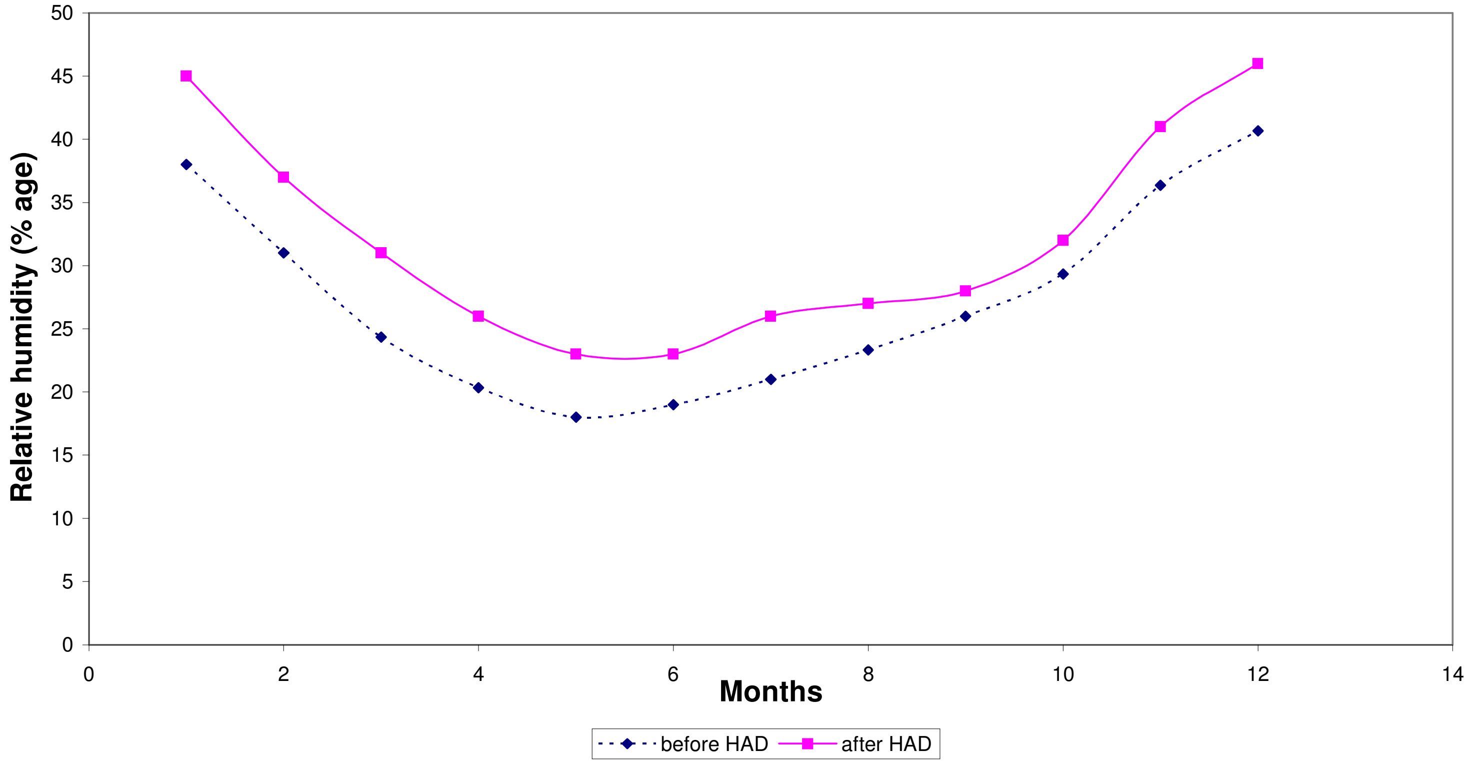


Figure (7) Comparison between relative humidity before and after HAD

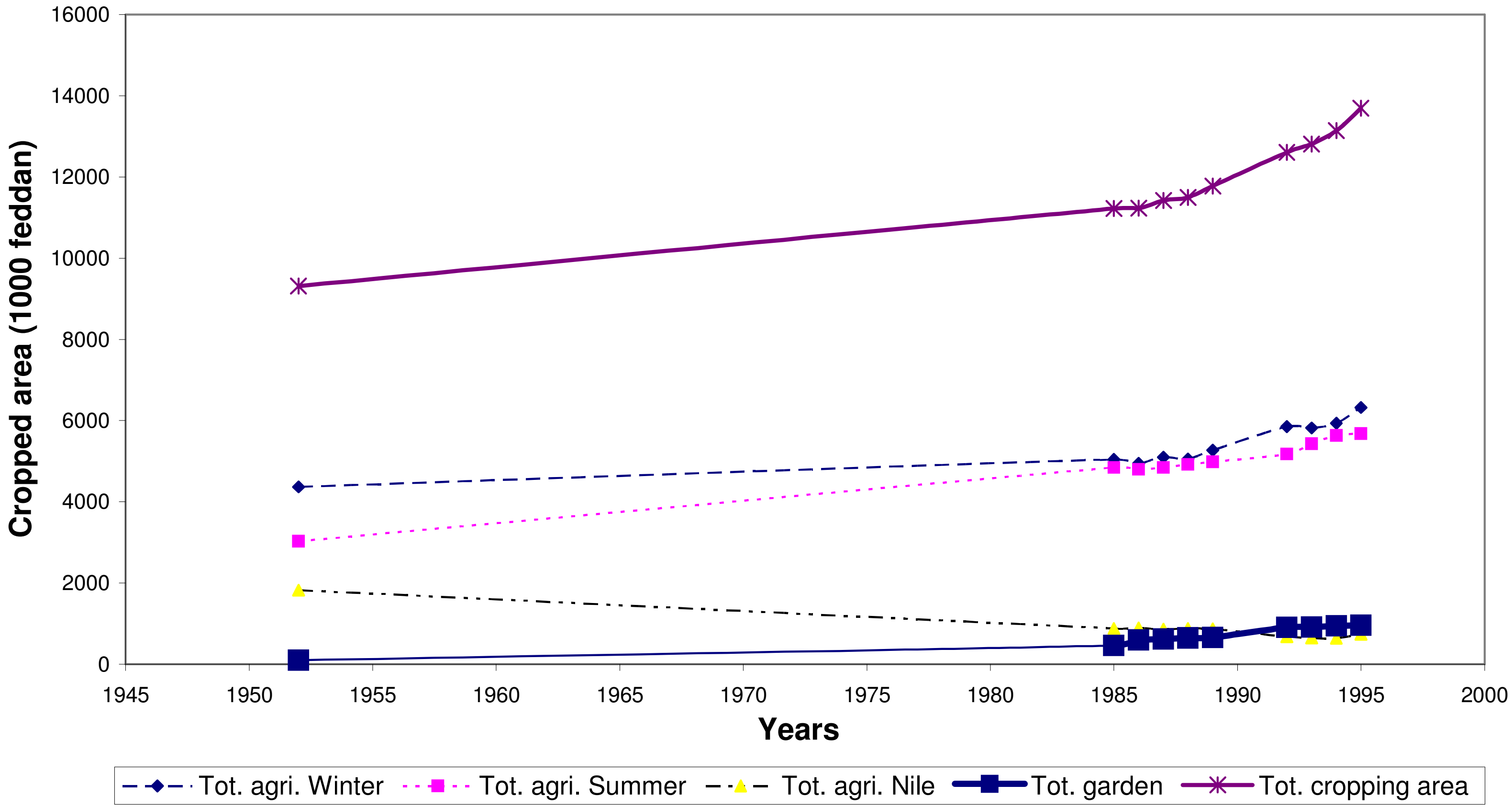


Figure (5) Developing of agriculture from 1952 to 1995

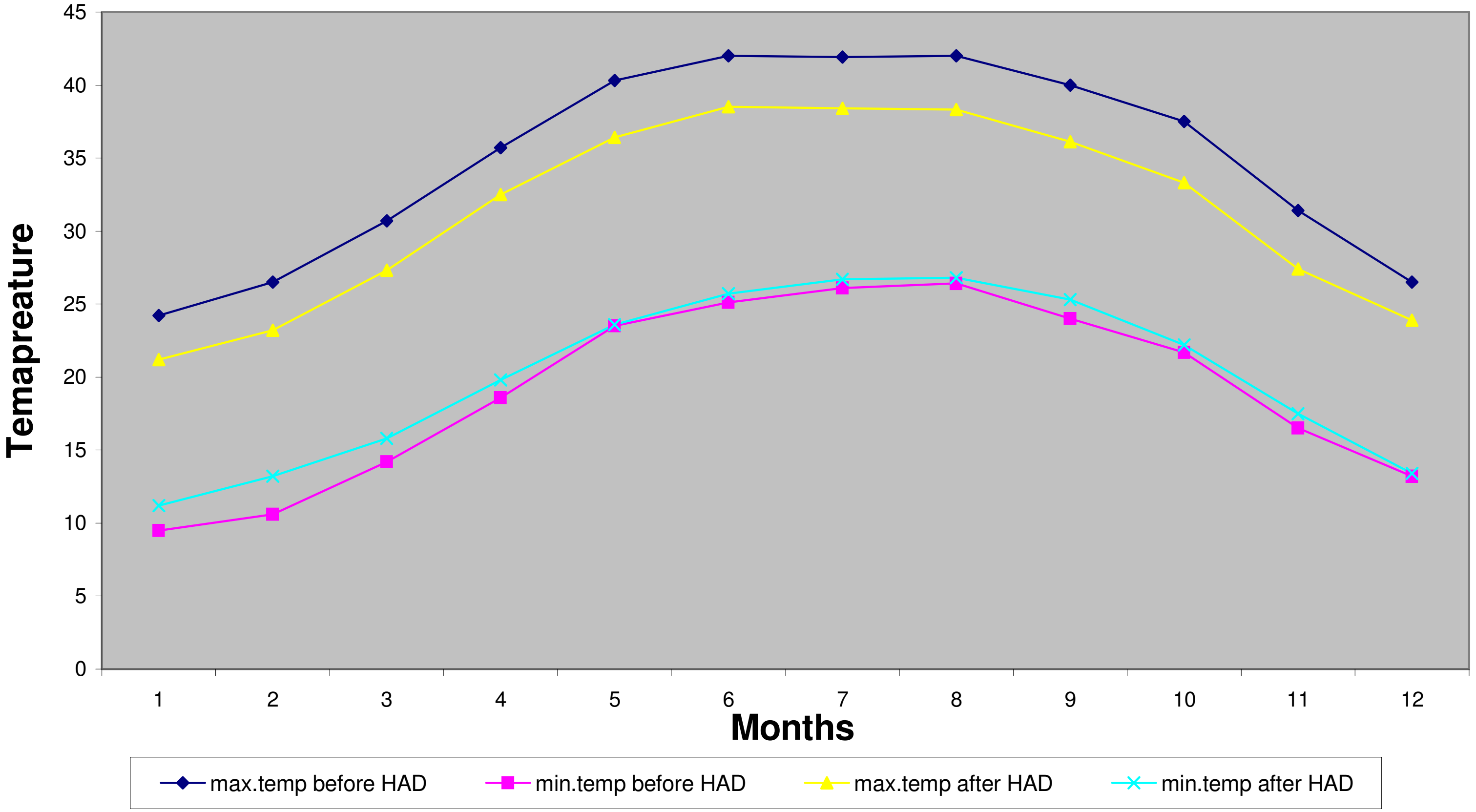


Figure (6) Comaparison between max and min tempreature before and after HAD

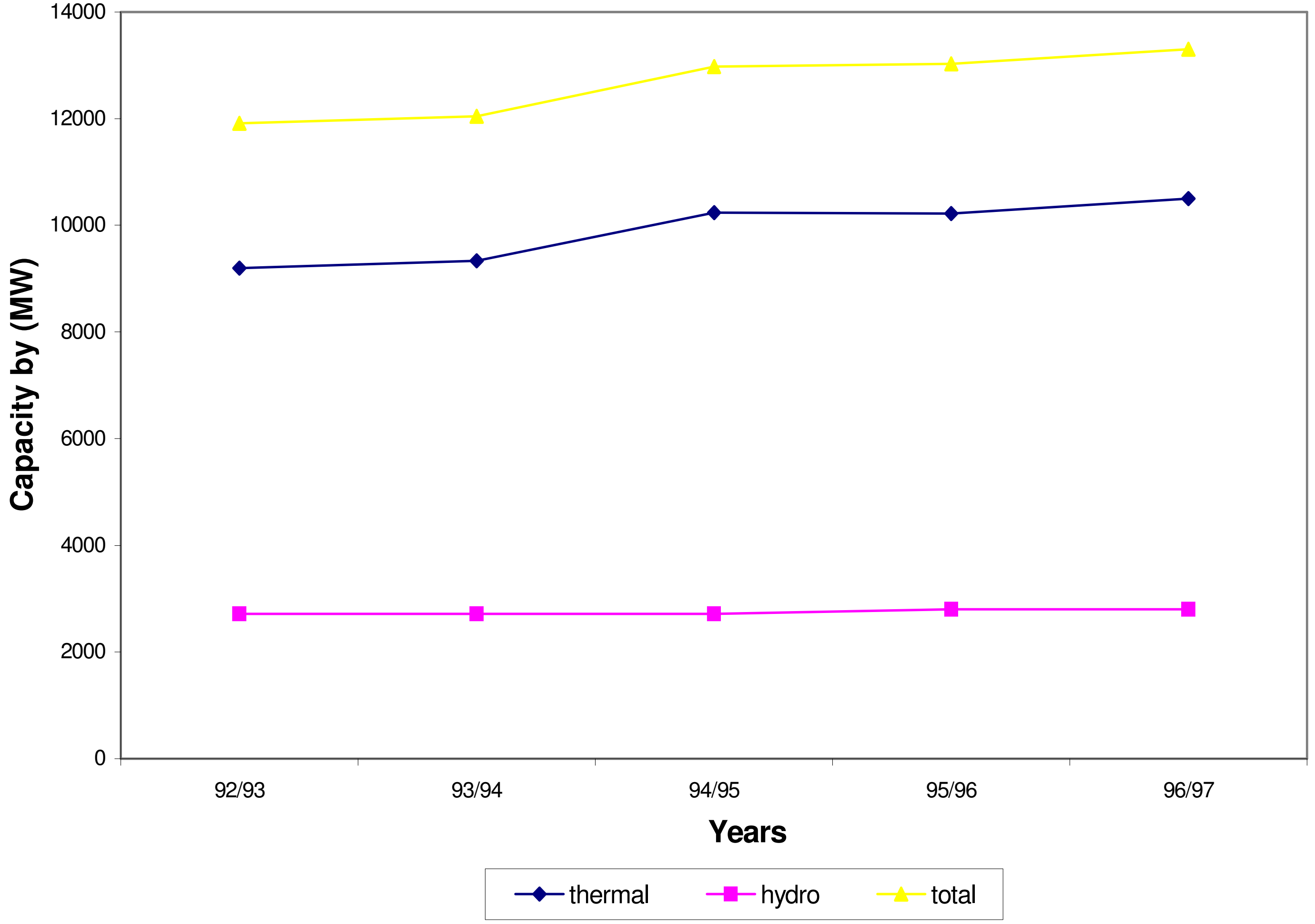


Figure (4) Comparison between hydro and thermal to the total power generation