Chapter 3
Physical Environment

It is essential to understand the abiotic environment in Lake Nasser and its relation with biological processes. Physical factors affect, directly and indirectly, the various organisms inhabiting the Lake. Fish migration may be controlled by water temperature and currents. Primary production is also affected by transparency. Increase or decline of tilapia production, forming more than 90% of the total Lake fish production, due to changes in the area of spawning grounds, is related to changes in water level, shoreline length and other factors. Physical processes such as lateral and vertical movements of water masses, diffusion from water surface or bottom sediments, inflowing of a highly turbid water mass, and stratification of the water column cause changes in the distribution and concentration of many kinds of chemical substances. The changes in chemical aspects caused by these physical processes may affect the biological processes in the Lake. Therefore, the physical and chemical aspects are closely related with the biological activities in the Lake ecosystem.

Since the completion of the High Dam, many investigators (Entz & Ramzy 1971, Entz 1972, 1974b, 1976, Entz & Latif 1973, 1974, El-Shahawy 1975, Elewa 1976, 1980, Latif & Elewa 1977, 1980, Fead 1980, Latif 1984a, Ahmad 1988, Ahmad *et al.* 1989, Abdel-Monem 1995, Abdel-Mageed 1995, Fishar 1995, SECSF 1996, Mohamed 1998 etc.) studied the various parameters of the Lake environment. Nevertheless, it is unknown up to the present whether the various aspects of the Lake ecosystem have reached a steady state or not. Hence, a clear situation and trend of long-term changes of abiological environment and its relation with biological activities in the Lake is greatly needed at present and continuous monitoring of the various parameters is of utmost importance.

Investigating physical and chemical characteristics of Lake Nasser, provide data which can be used for the following purposes:

1. To know the effect of the abiological environment on the biological processes of aquatic fauna and flora and total ecosystem in the Lake.
2. To clarify the relation between abiological environmental changes and aquatic resources especially fish.

3. To achieve the stabilization of fish resources for the permanent maintenance, proper management and development of fisheries, using scientific knowledge on the Lake environment (sustainable development).
4. To use the obtained scientific knowledge for improving the fishermen's welfare and prosperity.

Needless to mention that with the formation of Lake Nasser, the impounded water changed from riverine to lacustrine conditions. The main factors affecting the physico-chemical properties in the Lake are temperature and flood.

TEMPERATURE

Water Temperature. The average values of air temperatures recorded in Lake Nasser are 33.1, 40.4, 36.0, and 25.7 °C compared with 25.8, 28.6, 25.7 and 16.7 °C for surface water in April, July, October and January respectively (Fig. 23). It is worth mentioning that the difference between surface and bottom temperatures in riverine environments, is found to be slight, while the difference increases with impoundment, becoming more pronounced in summer.

In Lake Nasser, because of the low relative humidity (the Lake is surrounded entirely by desert), especially in summer when humidity falls below 20 or 30% evaporation must be very great. This phenomenon may explain why the mean water temperature at the surface of the Lake in the summer is about 5 - 7 °C much lower than the mean air temperature. In general, there seems to be a close correlation among air temperature, humidity, mean strength and duration of wind, and surface water temperature.

Comparing Lake Nasser with Lake Volta, air and water temperatures in the latter were almost the same all around the year, but water temperatures were normally a little higher than air temperatures, because of the high humidity and low rate of evaporation.

Surface Water Temperature and Regional Variations. Studies during 1983 on monthly variations of water temperature in the main channel of the Lake show that the monthly average values range from 18.5 °C in February to 26.6 °C in September (Table 14). A relatively high value (i.e. 25.3 °C) is recorded in July, being affected by the high air temperature during this month. The mean annual water temperature recorded at different stations show slight regional variations, with a difference of 1.7 °C between the minimum of 20.2°C at stn. 1 (El Ramla) and the maximum of 21.9 °C at stn. 3 (Allaqi) (Table 14). The mean annual value at six stations in the Lake is 21.2 °C. It is worth mentioning that during warm and cold seasons surface water temperatures are not far from those of the air. Records of 1996 (SECSF, 1996) of the surface water temperatures show that the minimum temperature is recorded at the High Dam site in winter (16.28 °C) and the maximum (34 °C) at Tushka (Table 15) in summer. In 1993/1994 the average water temperature at all stations along the main channel varies from a minimum of 20.21

and 20.51 in spring and winter to a maximum of 29.2 °C in summer (Abdel-Mageed 1995).

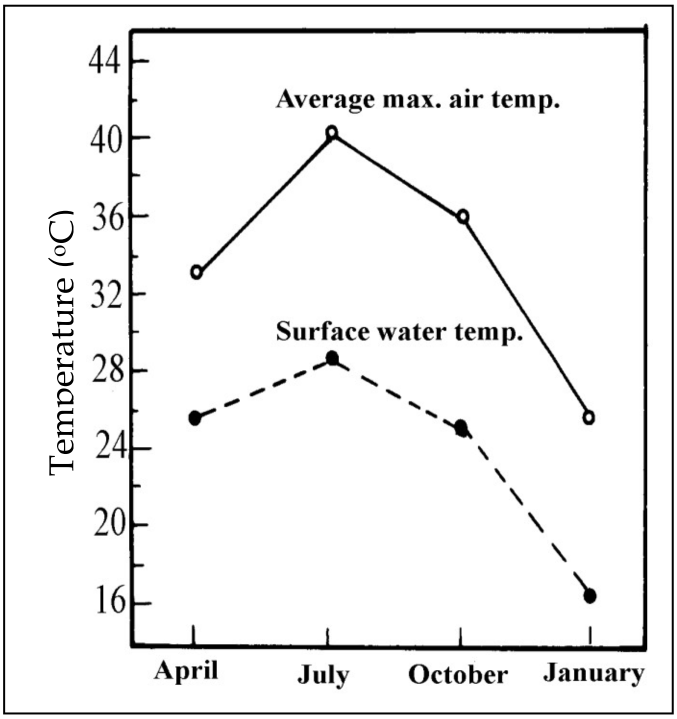

Fig. 23 **Relation between surface water temperature and average maximum air temperature in different seasons (Latif 1984a).**

Thermal Stratification. The changing conditions of Lake Nasser result in the occurrence of thermal stratification in summer. This phenomenon could be followed from the early data during the period 1973 - 1979 (Elewa 1980). The latter author summarized the seasonal features of the water column in the following:

a. No thermal stratification was observed during winter, as the water temperature shows no or slight difference with depth (Table 16 and Fig. 24).

b. A decrease in water temperature with depth becomes clear in spring. In May the water temperature difference was wider than in April (Fig. 25).

c. During summer, Lake Nasser is stratified and the surface water temperature reaches its maximum. Generally, the temperature difference between surface and bottom waters shows a wide range in summer (Table 17 and Fig. 26).

d. In autumn, the picture is different in the northern region of the Lake than at the southern one (Table 16 and Fig. 27).

Elewa (1987a) shows that the thermal stratification becomes more prominent during summer time, with wide difference in temperature between the surface and bottom. He adds that the destruction of stratification takes place in autumn and winter due to the lowering of air temperature and intrusion of flood water in the southern part of the Lake.

Latif (1984a) mentioned that during 1970, 1974, 1975 and 1976, the maximum surface water temperature was 31.4 °C in September 1975 at Allaqi, and the minimum 15 °C prevailed at Adindan in January 1975. The minimal bottom temperature of 15 °C was also recorded in January 1975 and the highest bottom temperature of 24 °C in November 1974.

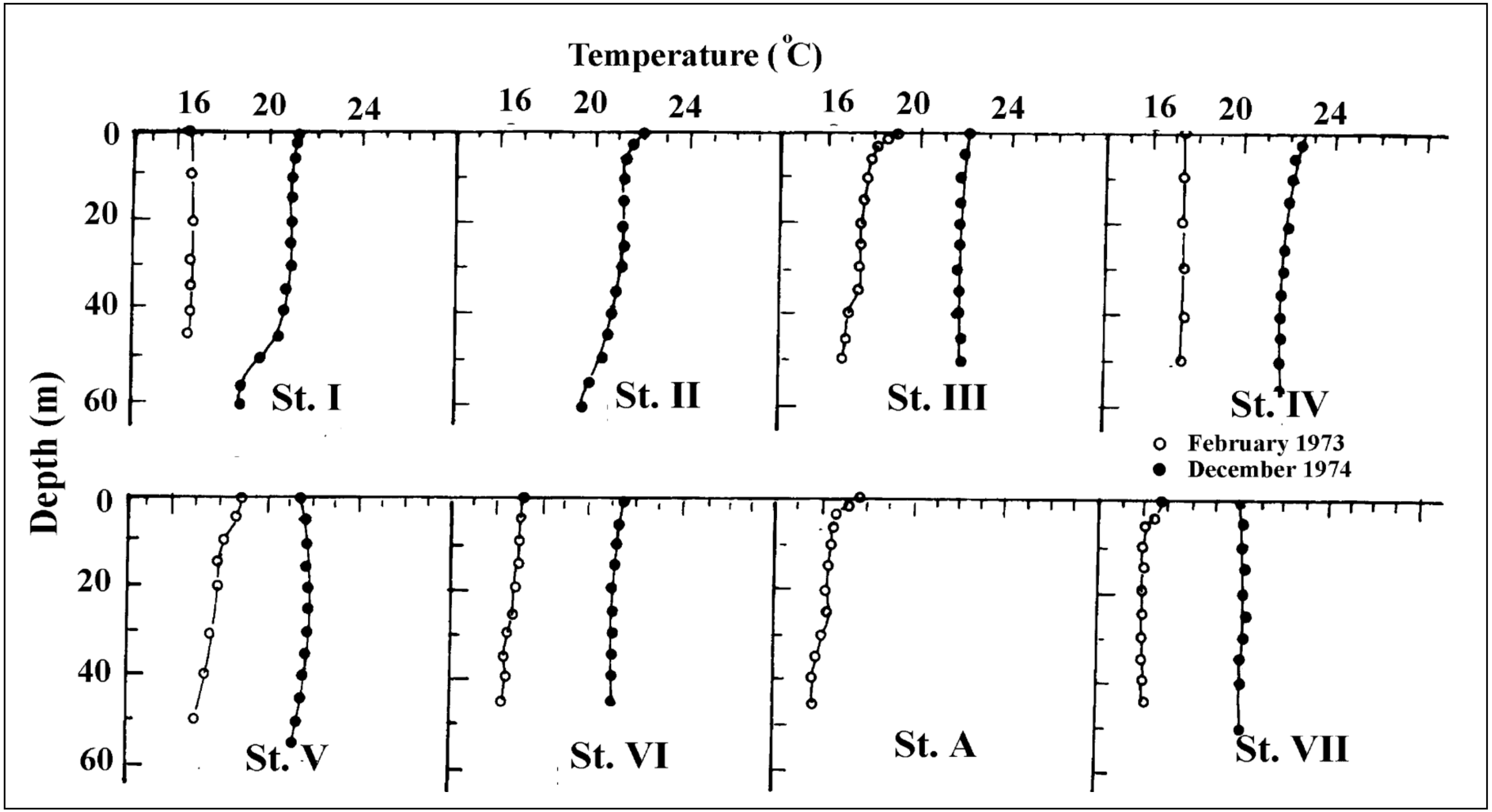

Fig. 24 **Temperature profiles of lake Nasser in different stations during winter 1973/ 1974, (Elewa 1980) [**For stations refer to Table 18, main channel**].**

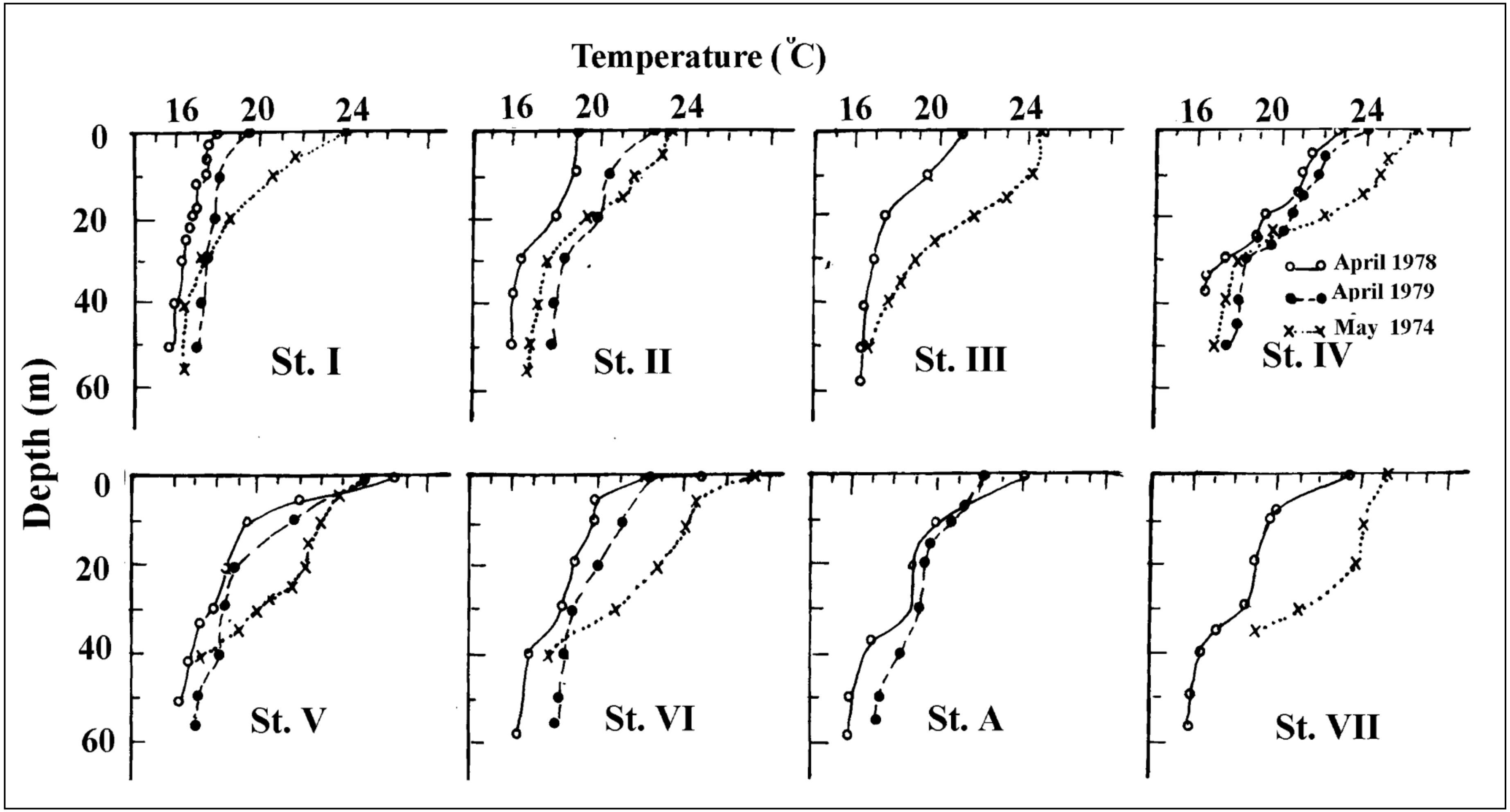

Fig. 25 **Temperature profiles of lake Nasser in different stations during May 1974, April 1978 and April 1979 (Elewa 1980)**

[For stations refer to Table 18, main channel].

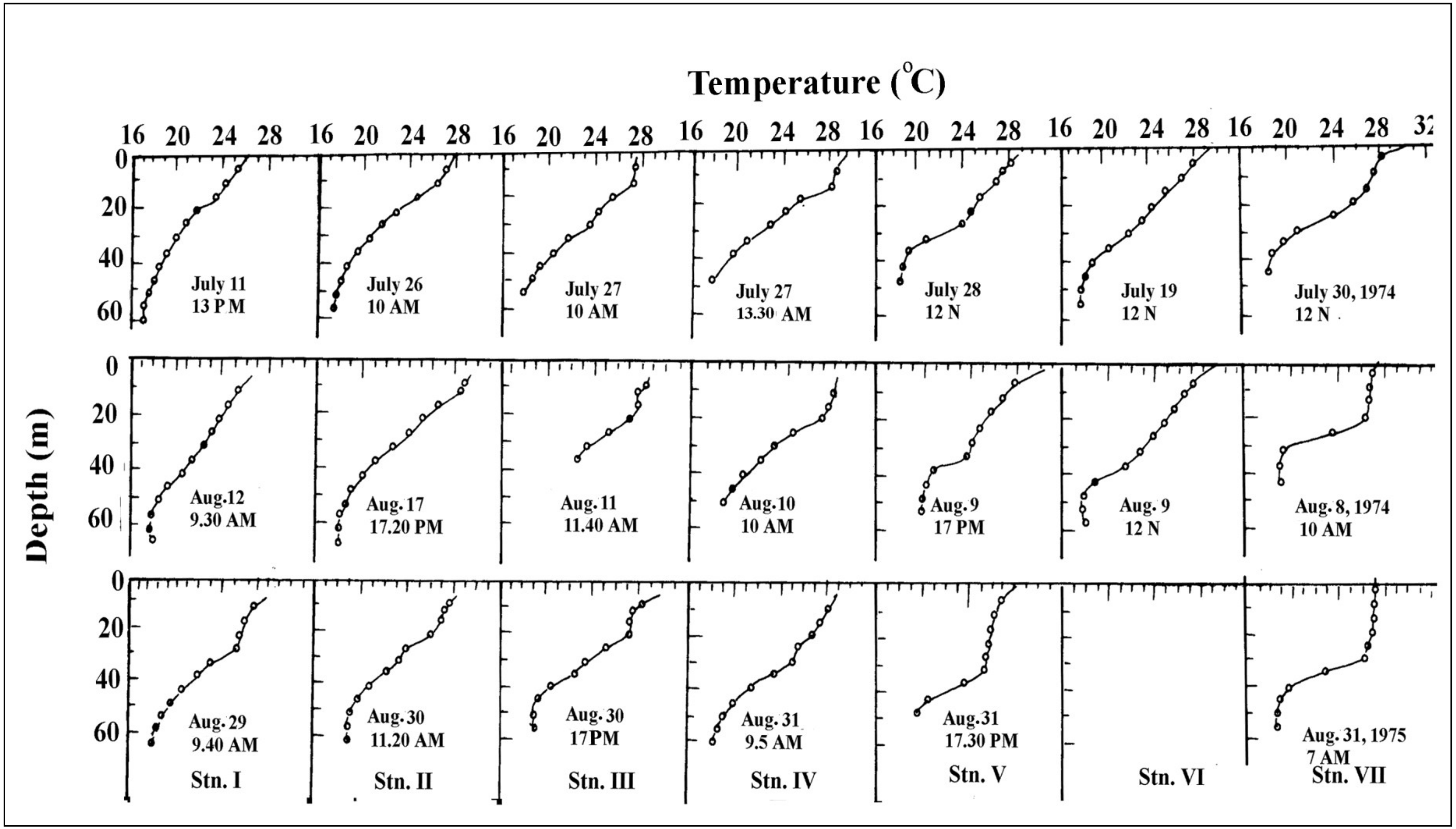

Fig. 26 **Temperature profiles of lake Nasser in different stations during July/August 1974 and August 1975 (Elewa 1980)**

[For stations refer to Table 18, main channel

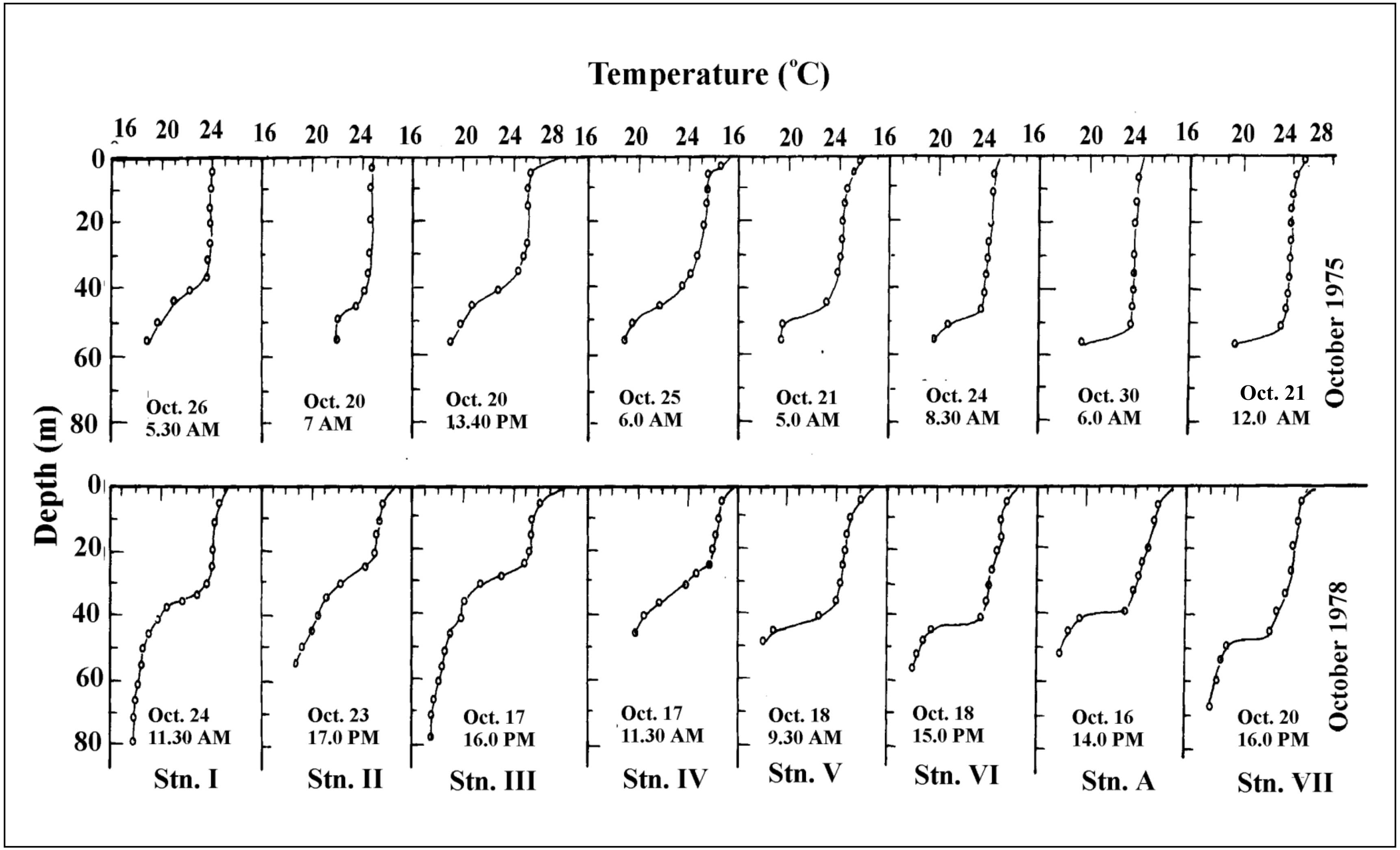

Fig. 27 **Temperature profiles of lake Nasser in different stations during October 1975 and 1978 (Elewa 1980)** [For stations refer to Table 18, main channel].

Table 14 **Monthly and mean annual variations of average values of surface water temperature (°C) in 1983.**

Month	Station						Monthly average
	1	2	3	4	5	6	
Jan.	16.2	16.1	16.6	17.3	16.4	15.9	16.4
Feb.	15.2	15.8	14.4	16.1	15.4	15.7	15.8*
Mar.	15.7	15.8	16.2	16.3	16.0	16.2	16.0
Apr.	17.1	18.8	18.6	18.2	19.0	16.6	18.1
May	21.3	20.4	21.7	20.5	22.4	20.6	21.1
June	20.3	24.1	24.8	23.2	27.1	25.0	24.0
July	23.4	25.0	27.1	22.9	26.9	26.8	25.3
Aug.	22.7	21.9	25.8	23.8	23.0	24.1	23.5
Sep.	25.9	27.1	27.6	25.3	26.7	27.1	26.6**
Oct.	23.2	24.6	25.0	23.4	25.1	24.6	24.3
Nov.	21.8	22.2	22.6	22.2	22.5	22.4	22.3
Dec.	19.6	20.1	20.7	21.3	21.1	21.2	20.7
Mean annual	20.2*	21.0	21.9**	20.9	21.8	21.3	21.2

*and ** designate minimum and maximum values, respectively.
Refer to Fig. 4 for stations (Abdel-Rahman & Goma, 1992b).

Table 15 **Average air and surface water temperatures (°C) at different localities in the main channel during 1996 (SECSF 1996).**

Site	Temperature							
	Winter		Spring		Summer		Autumn	
	Air	Water	Air	Water	Air	Water	Air	Water
High Dam	14.2	16.28	25.6	22.67	32	26.7	20.6	18.94
El Ramla	20.8	20.14	26.6	24.99	32	24.9	20.2	20.35
Kalabsha	15.0	17.69	32.2	26.79	35	28.0	18.8	20.93
Allaqi	22.0	19.73	29.2	28.21	33	31.6	21.7	--
El-Madiq	18.3	18.73	33.0	25.56	32	30.0	204	21.35
Korosko	25.9	20.23	33.0	28.11	35	31.7	17.0	22.46
Amada	21.6	22.50	35.8	29.10	30	29.0	26.4	23.39
Tushka	22.8	18.80	30.0	23.44	37	34.0	18.20	22.08
Abu Simbel	18.0	18.56	24.8	27.82	35	36.1	22	21.98

In 1983, the vertical distribution of water temperature showed that the mean annual values were about 23.1 °C at Kalabsha and 22.7 °C at Allaqi, showing slight decrease to 10 m depth (less than about 1 °C) (Goma & Abdel-Rahman 1992a - Figs. 28 and 29). Furthermore, the monthly variation of the Lake water temperature was about 12 °C, with the highest (i.e. 28 - 30 °C) recorded in June-September and the lowest (i.e. 16 °C) in January-March. The minimum water temperatures of 16.1 - 16.2 °C were recorded in March through the water column at Kalabsha (Fig. 28). At Allaqi, the minimum value of 15.8 -15.9 °C was observed from February to March (Goma & Abdel-Rahman 1992a- Fig. 29). This low temperature may be due to wind cooling and to the weakening of the solar radiation. The maximum water temperature of 27.8 - 30.1 °C was recorded in July-September (summer season) at both stations (Goma & Abdel- Rahman 1992a- Figs. 28 and 29). This high temperature value may be due to the effect of air temperature and the flood which starts in August and the thermocline becomes deeper.

Table 16 **Ranges of water temperature at different stations of Lake Nasser (1973 - 79) Elewa 1980.**

Month/year	High Dam	Kalabsha	Allaqi	El-Madiq	Amada	Tushka	Abu Simbel	Adindan
				Winter				
Feb. 1973	16.6-16.5	---	19.0-16.7	17.3-17.2	20.6-16.3	17.2-16.4	17.6-15.7	16.7-16.1
Dec. 1974	21.0-18.7	22.0-19.6	22.0-21.7	22.2-21.5	21.3-21.0	21.2-21.0	---	20.0-20.2
				Spring				
May 1974	23.0-16.5	23.5-16.7	25.8-20.5	26.5-16.5	25.5-17.5	27.5-18.0	---	25.0-19.5
April 1978	18.0-15.8	19.0-16.0	21.0-16.5	22.5-16.5	26.5-16.5	25.0-16.5	24.0-16.0	23.5-15.9
April 1979	19.5-17.0	22.5-17.8	---	24.0-17.4	26.5-17.0	22.5-18.0	23.0-17.5	---
				Summer				
July 1973	---	28.4-18.4	---	29.4-18.0	27.6-19.4	28.0-19.8	---	---
Aug. 1974	26.0-18.0	29.25-18.0	28.2-22.5	23.5-19.0	30.75-20.2	30.0-18.0	---	27.5-19.2
June 1975	25.7-17.0	---	26.5-17.7	27.7-17.0	28.0-18.0	27.5-17.0	---	19.0-17.7
July 1975	27.5-17.7	30.1-17.7	28.0-17.5	28.2-17.0	---	31.8-17.5	---	16.7-18.0
Aug. 1975	27.4-18.2	28.4-19.0	31.4-19.2	28.7-18.2	28.5-19.5	---	---	27.6-18.7
July 1979	---	28.0-18.8	28.0-19.0	---	28.5-18.8	28.2-19.0	28.7-18.7	---
				Autumn				
Oct. 1975	24.2-18.7	24.7-22.0	28.7-19.0	26.7-19.0	25.7-19.7	26.2-22.6	24.0-19.5	24.9-19.5
Oct. 1978	25.0-17.1	26.5-19.0	28.5-17.7	26.7-19.9	25.7-18.5	26.0-18.2	27.4-18.0	25.2-18.2

The monthly fluctuations of water temperature at 0 and 20 m depth in the Lake during 1984, and the vertical distribution of mean water temperature of the Lake in February, March, August and November 1984 showed that in January and February, the water temperature was almost constant in the water column at all stations, while in June, July and August the surface temperature was higher than that in deeper layers and the water column was well stratified (Figs. 30 and 31).

The vertical and seasonal variations of water temperature at six stations in Lake Nasser were studied during 1985 (Abdel-Rahman & Goma 1992c) and the results indicated that the lowest temperature was recorded in January and March respectively (Fig. 32). It ranged from 17.9 to 19.4 °C in January, from 17.0 to 20.8 °C in February, and from 16.5 to 21.4 °C in March (Fig. 32). The highest temperature was recorded from June to August. Thus, it ranged from 17.6 to 30.6 °C in June, from 17.9 to 32.0 °C in July and from 18.0 to 30.7 °C in August.

The average difference in water temperature between the near bottom and surface water was 13.3°C during the warm season, while it was 3.4 °C during the cold season. The water temperature was the same in the water column at all stations in January and February because of convection. However, the water column was well stratified from June to August (Kihara 1989).

It is worth mentioning that at six stations (Fig. 4) along the main channel of Lake Nasser in different years, during summer a remarkable thermocline is observed (Fig. 33). The surface temperature reached a maximum for the whole year (Fig. 34), and the extreme surface temperature recorded was 29.8 °C. Generally, the temperature difference between surface and bottom waters shows a wide range in summer (Fig. 34). The temperature difference was high (i.e. 9.3, 9.3, 10.4, 9.5 and 8.8 °C) during the years 1973, 1974, 1975, 1979 and 1983 respectively (Fig. 34). A less temperature difference (i.e. 3.8 - 5.5 °C) was recorded during the years 1984, 1986, 1987, 1988 and 1989 (Fig. 34).

Table 17 **Surface and bottom water temperatures (°C) in the main channel of Lake Nasser during the period of June to August 1973-1979 (Elewa 1980).**

Month	Year	Surface temperatures		Bottom temperatures	
		Lowest	Highest	Lowest	Highest
July	**1973**	27.6	29.4	18.0	20.3
July	**1974**	26.0	30.5	17.0	18.6
Aug.	**1974**	26.0	30.75	18.0	22.5
June	**1975**	25.7	29.0	19.0	18.0
July	**1975**	26.7	31.8	17.0	18.0
Aug.	**1975**	27.4	31.4	18.2	19.5
July	**1979**	28.0	28.7	18.8	19.0

Table 18 **List of main stations in the main channel, and their distance from the High Dam.**

Station number	Site	Distance (km from HD) (upstream)
I	High Dam (H.D)	3
II	Kalabsha	50
III	Allaqi	100
IV	El-Madiq	140
V	Amada	200
VI	Tushka	250
A	Abu Simbel	275
VII	Adindan	290

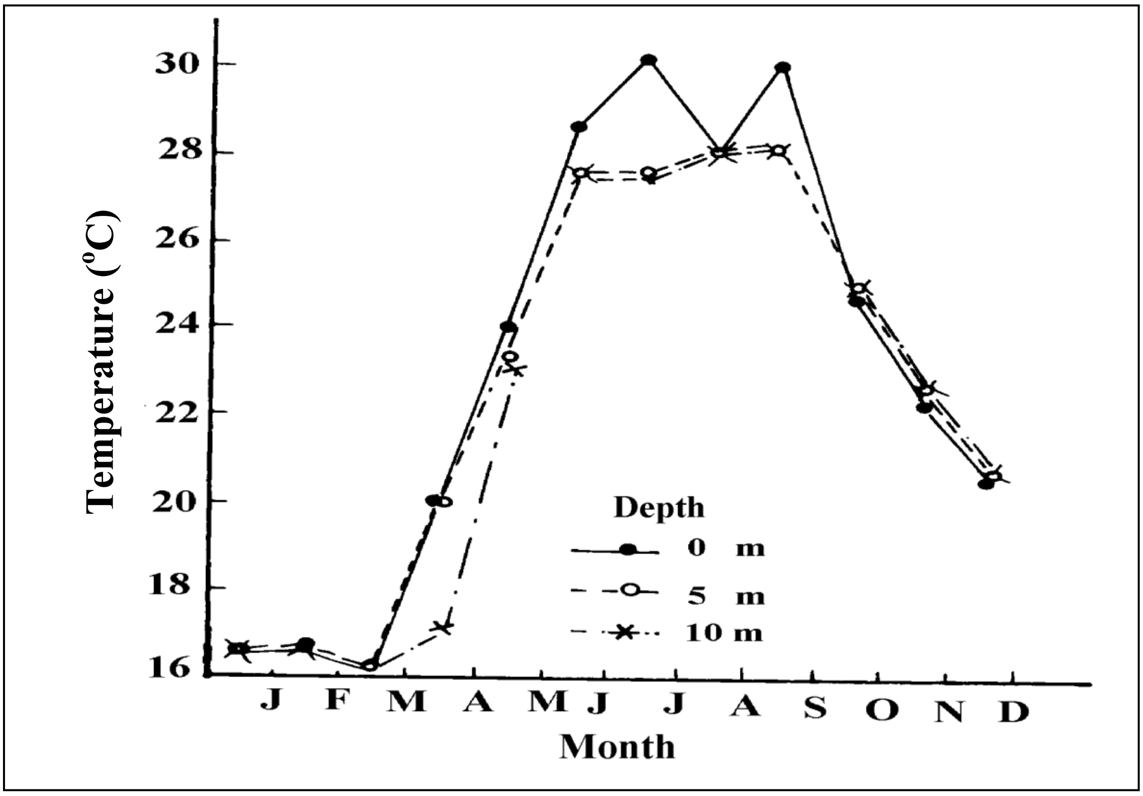

Fig. 28 **Monthly variations of water temperature at station 2 (Kalabsha) in 1983 (Goma & Abdel-Rahman 1992a).**

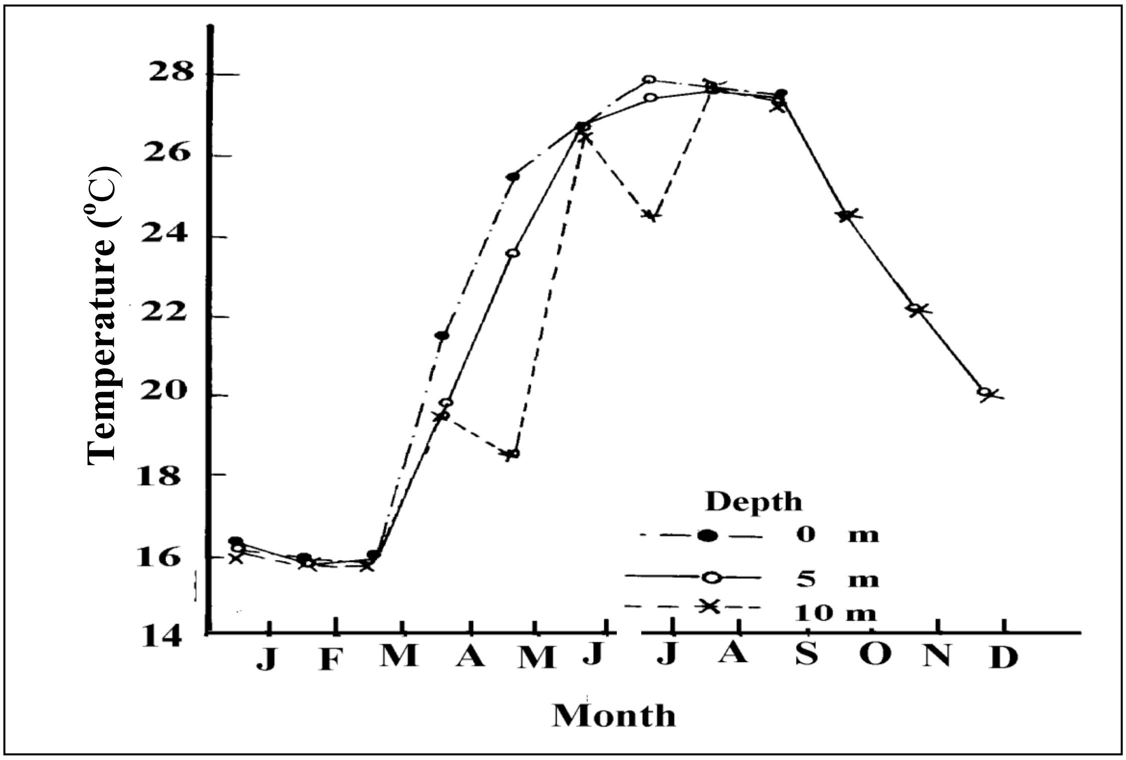

Fig. 29 **Monthly variations of water temperature at station 3 (Allaqi) in 1983 (Goma & Abdel-Rahman 1992a).**

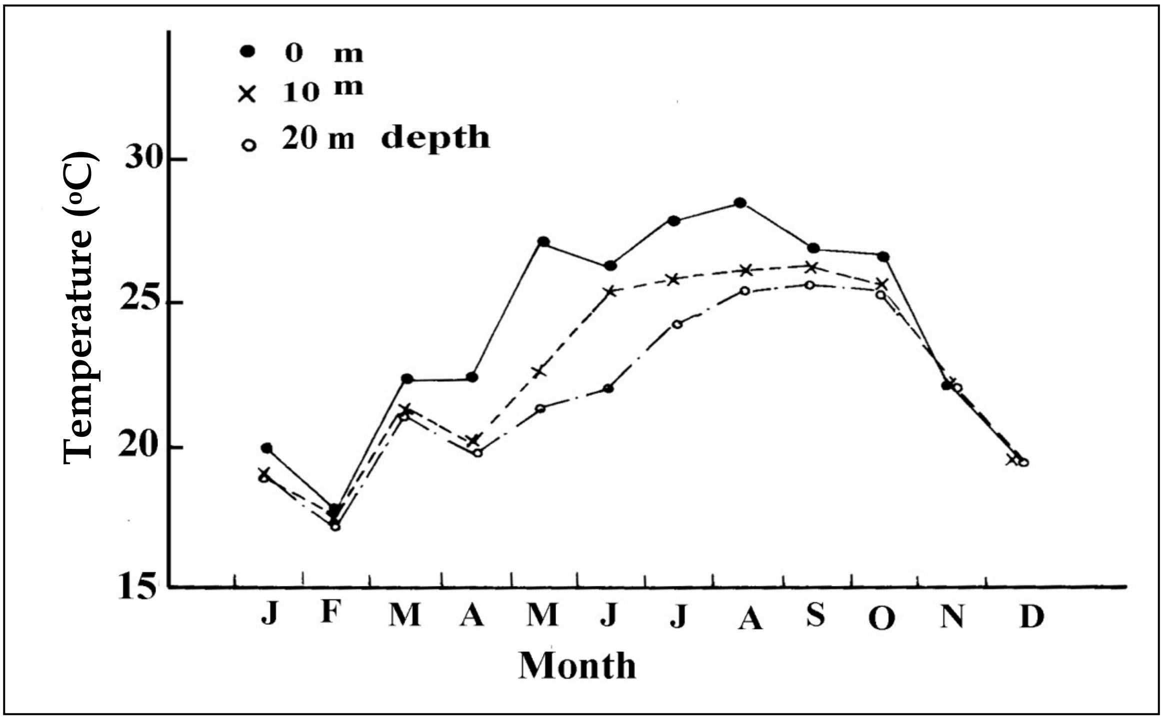

Fig. 30 **Monthly fluctuation of water temperature (°C) at 0, 10, 20 m depth in Lake Nasser in 1984 [mean value of six stations] (Goma & Abdel-Rahman 1992b).**

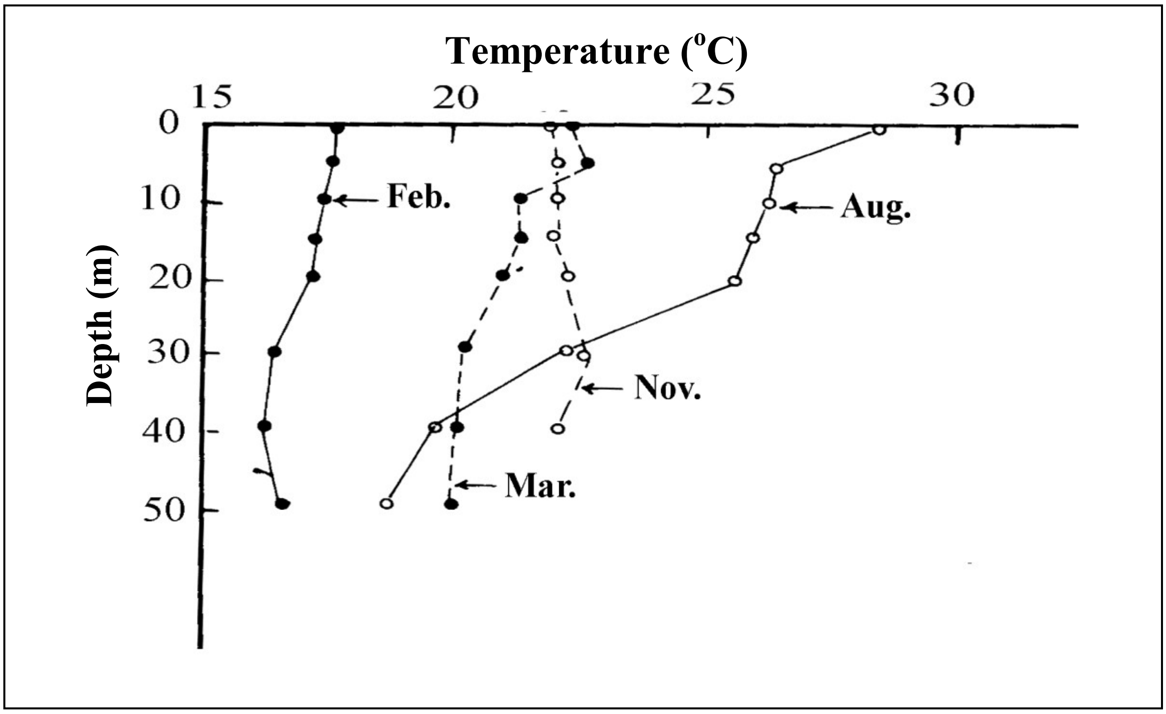

Fig. 31 **Vertical distribution of mean water temperature of Lake Nasser in February, March., August. and November 1984 [mean value of six stations] (Goma & Abdel-Rahman 1992b).**

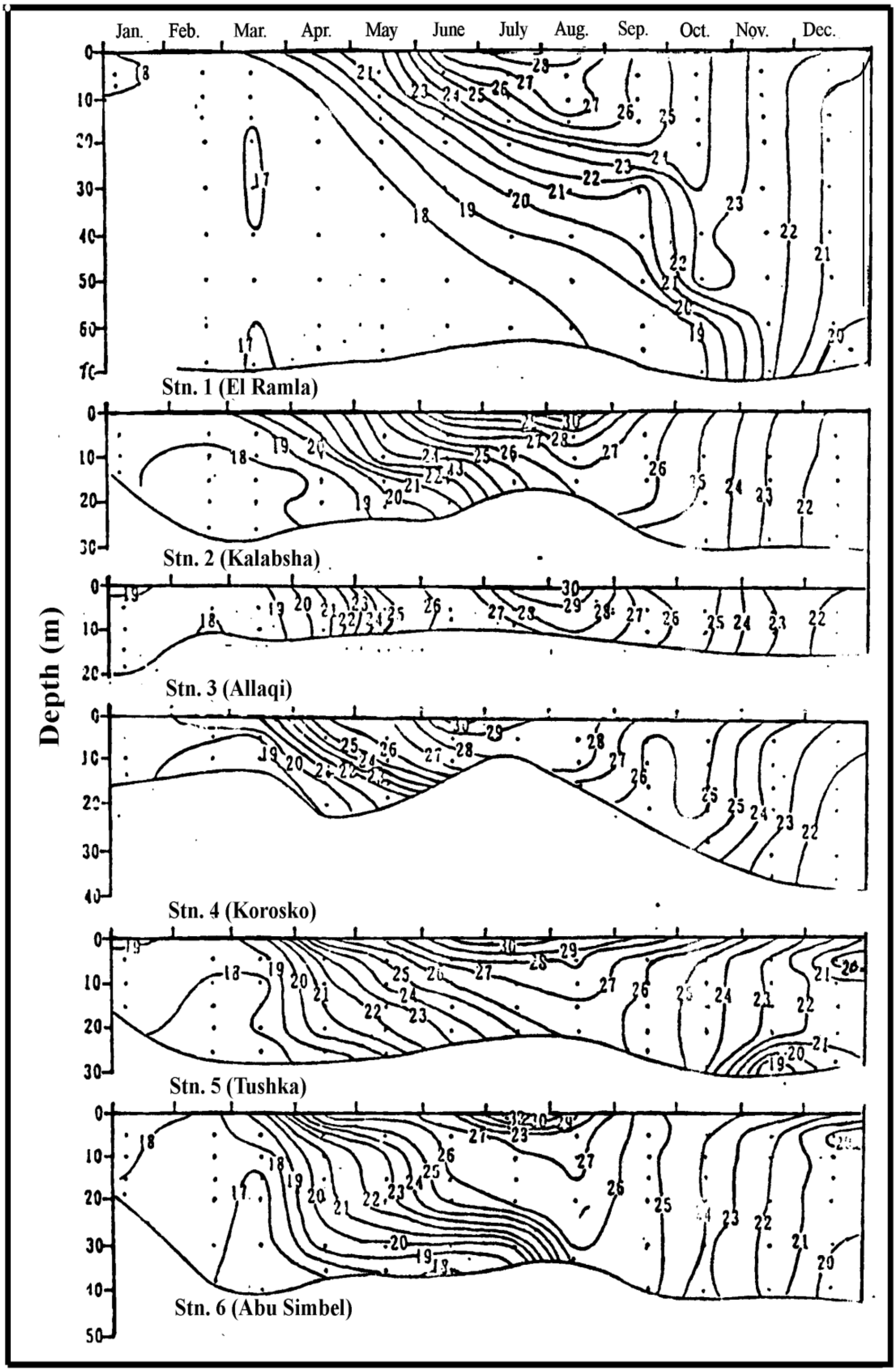

Fig. 32 **Vertical and seasonal variations of water temperature (°C) at six stations along the main channel of Lake Nasser in 1985 (Abdel-Rahman** & **Goma 1992c.) [**Refer to Fig. 4 for stations**].**

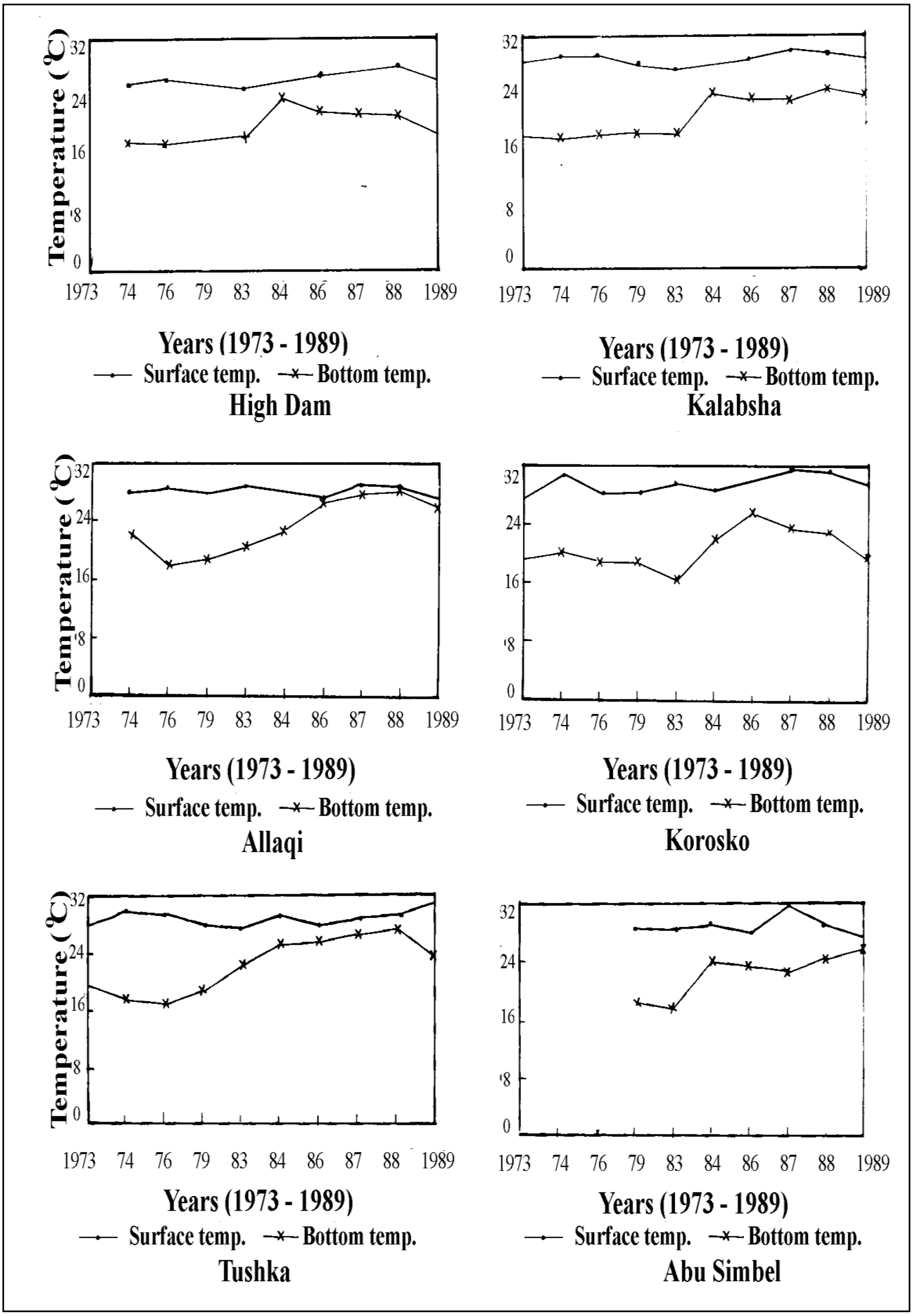

Fig. 33 **Mean surface and bottom water temperatures (°C) at six stations along the main channel of Lake Nasser during summer at different years [1973-1989] (Belal *et al.* 1992).**

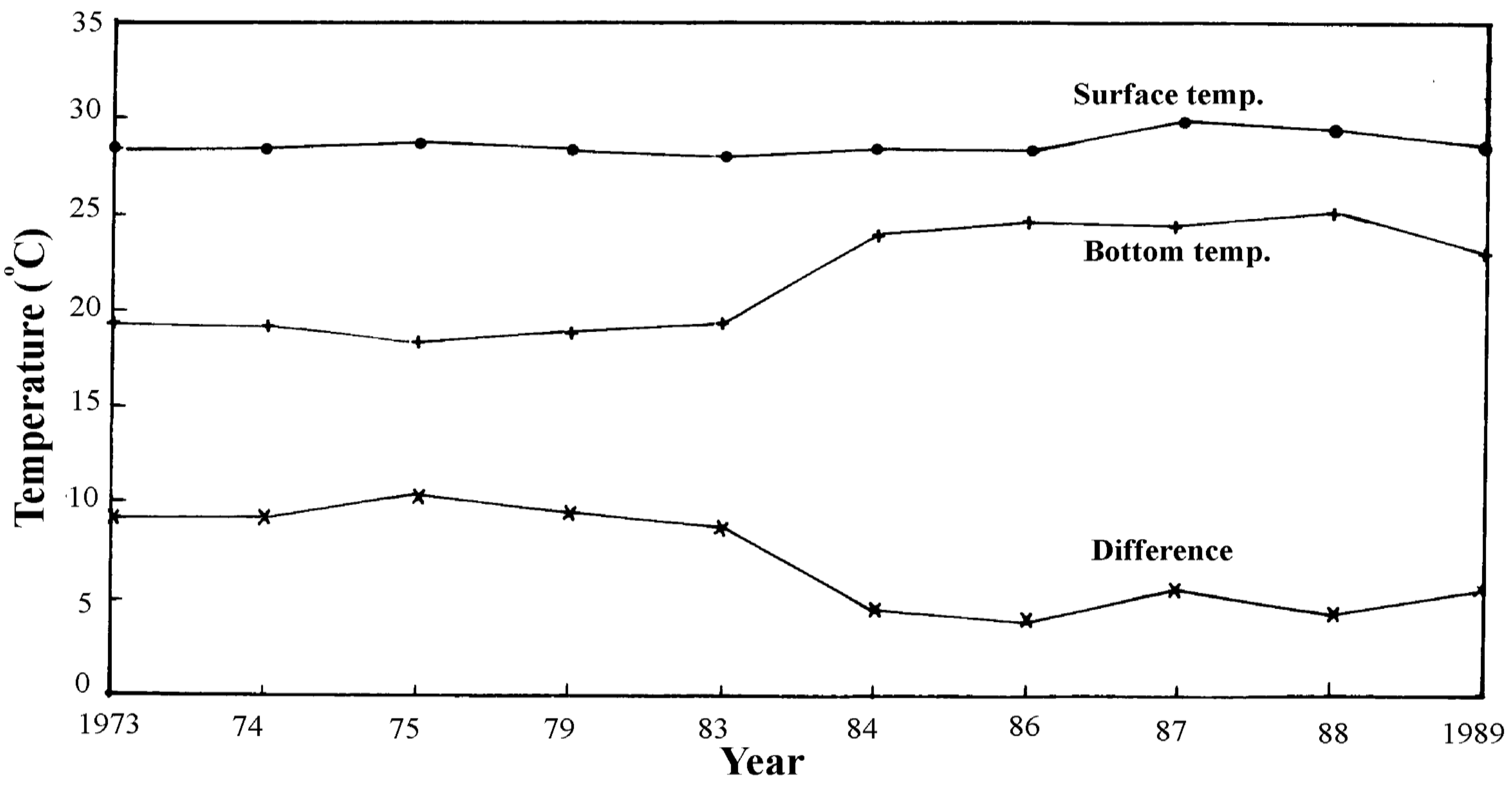

Fig. 34 **Mean surface and bottom water temperatures (°C) of the main channel of Lake Nasser during summer at different years [1973 - 1989] (Belal *et al.* 1992).**

Considering the vertical distribution of water temperature at six stations in Lake Nasser in winter (January) and summer (August) during the period 1987 - 1992 (Tables 19 - 24), the lowest water temperatures were recorded in January, the highest in August. However, the highest surface water temperature (33.3 °C) was recorded in August 1988 at Korosko (Table 22), the lowest (14.75 °C) at 50 m depth at Abu Simbel in January 1992.

The water temperature decreases sharply with depth in summer (August), (Tables 19 - 24) at all stations during the whole period (1987 - 1992). In winter, the water columns are well mixed with almost homogenous temperature. Table 25 shows ranges and differences (surface - deepest) of water temperature at six stations in January and August during 1987 - 1992, indicating remarkable differences in summer and suggesting sharp stratification in the water column.

Fishar (1995) studied the seasonal variations of air, surface water and bottom water temperatures at the eastern side, main channel and western side of Lake Nasser during 1993 (Fig. 35) and his results are summarized as follows:

1. In winter, the average value of surface water temperature along the eastern side, main channel and the western side are 20.35, 20.51 and 21.17 °C respectively, no thermal stratification is observed, as the temperature shows slight difference between surface and bottom water (Fig. 35). The temperature differences between surface and bottom water temperatures are 0.22, 1.57 and 0.96 °C at the eastern side, the main channel and the western side, respectively.

2. In spring, a slight increase in surface water temperature is observed in the eastern and western sides, while a pronounced decrease in the bottom water temperature of the main channel is recorded. The difference between surface and bottom water temperatures is clear especially in the main channel.

3. In summer, the surface and bottom water temperatures attain their maximum average values recorded during 1993. The highest temperature values (33.5 and 30.3 °C), are recorded in the surface and bottom water of the western stations of Maryia and eastern station of Singari.

4. In autumn, the surface and bottom water temperatures, decrease more than their corresponding summer values by about 1.92 °C and 1.99 °C (Fig. 35).

Table 19 Vertical variation of water temperature at El Ramla station during January and August (1987-1992).

Depth (m)	Water temperature (°C)											
	1987*		1988*		1989*		1990*		1991**		1992**	
	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.
0	17.5	27.2	17.8	29.90	17.5	28.2	17.50	27.90	19.40	28.0	16.44	28.49
5	17.2	26.9	17.70	29.42	17.3	27.2	17.54	27.55	19.39	26.82	16.44	27.80
10	17.2	25.2	17.70	28.30	17.0	26.1	17.53	26.18	19.12	25.88	16.35	27.56
15	17.1	25.1	17.60	27.12	16.9	25.3	17.43	24.07	19.12	24.29	16.27	24.87
20	17.2	24.4	17.60	25.85	17.0	22.6	17.49	22.25	19.19	23.72	16.30	20.13
30	17.1	21.6	17.70	23.68	17.0	20.3	17.44	19.37	19.39	22.82	16.25	19.56
40	17.1	20.7	17.60	20.86	17.0	17.8	17.49	18.72	19.12	20.27	16.61	17.19
50	17.1	20.5	17.5	19.38	16.9	16.9	17.44	18.30	19.07	19.10	16.30	17.07
60	17.1	---*	17.5	18.85	17.0	16.5	17.32	18.13	19.03	18.51	16.14	16.92
70	17.0	---	---	---	16.9	16.4	17.32	18.06	19.03	18.34	16.02	16.89
75	---	---	---	---	---	---	17.18	---	---	---	---	---
80	---	---	---	---	---	---	---	---	---	---	16.96	---

* Abdel-Rahman & Goma (1995a, b, c & d). ** Abdel-Rahman (1995a & b) [For stations refer to Fig. 4]. (---)* not recorded.

Table 20 **Vertical variation of water temperature at Kalabsha station during January and August (1987-1992).**

Depth (m)	Water temperature (°C)											
	1987*		1988*		1989*		1990*		1991**		1992**	
	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.
0	17.1	31.4	18.0	31.5	17.1	29.7	17.90	31.4	20.50	29.30	16.70	30.45
5	17.2	28.8	17.62	30.20	16.9	29.1	17.81	28.38	19.49	28.23	16.53	29.44
10	17.1	27.5	17.50	28.86	16.9	28.2	17.81	28.18	19.41	27.88	16.50	29.22
15	16.9	25.0	17.37	27.59	16.7	26.1	17.60	24.71	19.33	25.15	16.24	25.99
20	16.9	---	17.29	26.40	16.8	---	17.64	22.58	19.39	14.60	16.27	22.99
30	16.7	---	17.35	---	---	---	17.55	20.42	19.33	22.97	16.20	20.07
40	---	---	---	---	---	---	17.59	18.93	19.64	20.31	16.58	18.54
50	---	---	---	---	---	---	17.53	18.42	19.21	18.82	16.10	17.48
60	---	---	---	---	---	---	17.47	18.29	19.21	18.51	15.96	17.04
70	---	---	---	---	---	---	17.52	18.11	19.18	18.49	16.07	16.90
75	---	---	---	---	---	---	17.32	---	19.12	---	---	---
80	---	---	---	---	---	---	---	---	---	18.41	16.00	16.75

* Abdel-Rahman & Goma (1995a, b, c & d). ** Abdel-Rahman (1995a & b) [For stations refer to Fig. 4].

Table 21 **Vertical variation of water temperature at Allaqi station during January and August (1987-1992).**

Depth (m)	Water temperature (°C)											
	1987*		1988*		1989*		1990*		1991**		1992**	
	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.
0	16.2	29.7	17.00	29.80	16.9	30.8	17.90	27.50	19.60	28.10	16.40	30.32
5	16.9	29.3	16.89	30.02	16.8	30.8	17.76	27.59	19.11	28.05	16.48	29.12
10	16.9	---	16.75	29.32	16.8	28.7	17.77	27.62	19.69	27.87	16.49	29.03
15	16.8	---	---	---	16.7	27.3	17.66	25.28	19.67	27.61	16.39	28.74
20	---	---	---	---	16.5	---	17.66	---	---	---	16.44	23.66
30	---	---	---	---	---	---	---	---	---	---	16.72	19.62
40	---	---	---	---	---	---	---	---	---	---	16.53	17.78
50	---	---	---	---	---	---	---	---	---	---	16.39	16.84
60	---	---	---	---	---	---	---	---	---	---	16.46	16.79
70	---	---	---	---	---	---	---	---	---	---	16.39	16.57

* Abdel-Rahman & Goma (1995a, b, c & d). ** Abdel-Rahman (1995a & b) [For stations refer to Fig. 4].

Table 23 **Vertical variation of water temperature at Tushka station during January and August (1987-1992).**

Depth (m)	Water temperature (°C)											
	1987*		1988*		1989*		1990*		1991**		1992**	
	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.
0	18.0	31.8	18.80	33.30	18.0	32.1	18.90	29.10	21.10	30.50	16.80	29.50
5	18.1	28.8	18.19	30.02	17.94	28.9	18.72	28.80	20.98	29.00	17.51	29.12
10	18.0	28.4	18.11	29.89	17.69	28.8	18.72	28.48	20.92	28.50	17.51	28.61
15	18.0	27.1	18.06	29.77	17.60	26.3	17.61	26.43	21.08	26.52	17.34	26.87
20	18.0	26.8	18.01	27.93	17.62	26.1	18.63	25.52	20.48	26.23	17.64	26.29
30	17.6	---	---	26.30	16.50	21.2	18.53	19.67	20.54	24.52	16.91	28.20
40	---	---	---	23.44	---	---	---	---	---	---	---	---
50	---	---	---	---	---	18.7	18.32	18.59	20.40	21.56	16.27	20.42
60	---	---	---	---	---	---	18.11	18.17	19.52	19.64	16.19	24.19
70	---	---	---	---	---	---	17.96	18.04	---	18.63	16.12	19.52

* Abdel-Rahman & Goma (1995a, b, c & d). ** Abdel-Rahman (1995a & b) [For stations refer to Fig. 4].

Table 22 **Vertical variation of water temperature at Korosko station during January and August (1987-1992).**

Depth (m)	Water temperature (°C)											
	1987*		1988*		1989*		1990*		1991**		1992**	
	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.	Jan.	Aug.
0	16.6	30.0	17.30	30.80	16.40	33.2	17.60	29.10	19.60	30.20	17.20	31.13
5	16.6	29.5	16.82	29.86	16.2	29.2	17.63	28.20	19.76	28.50	16.63	28.57
10	16.6	28.6	16.71	29.25	16.2	27.1	17.63	27.65	19.71	28.03	16.38	27.58
15	16.5	27.7	16.68	29.35	16.1	26.5	17.64	26.21	19.80	28.23	16.38	26.22
20	16.4	---	16.73	29.14	16.1	24.6	17.64	23.68	19.65	27.26	16.31	26.17
30	16.3	---	---	28.37	---	24.6	17.54	19.64	19.66	25.28	16.02	20.56
40	---	---	---	---	---	---	17.54	18.72	19.65	22.22	15.87	18.46
50	---	---	---	---	---	---	17.34	18.19	19.45	19.19	15.16	17.42

* Abdel-Rahman & Goma (1995a, b, c & d). ** Abdel-Rahman (1995a & b) [For stations refer to Fig. 4].

Table 25 **The ranges and differences in water temperatures at six stations (1987 - 1992).**

Year	Month		El Ramla	Kalabsha	Allaqi	Korosko	Tushka	Abu Simbel
1987	January	**Depth (m)**	0 - 70	0 - 30	0 - 15	0 - 27	0 - 27	0 - 37
		Range (ºC)	17.0 – 17.5	16.7-17.2	16.2-16.9	17.6-18.1	16.3 - 16.6	15.8 - 16.8
		Diff. (ºC)	0.5	0.5	0.7	0.5	0.3	1.0
	August	**Depth (m)**	0 - 50	0-15	0-5	0 - 20	0 - 15	0 - 20
		Range (ºC)	20.5 – 27.2	25.0-31.4	29.3-29.7	26.8-31.8	27.7 - 30.0	32.1 - 28.6
		Diff. (ºC)	6.7	6.4	0.4	5.0	2.3	5.5
1988	January	**Depth (m)**	0 - 65	0-30	0 -10	0 - 20	0 - 20	0 - 35
		Range (ºC)	17.5 – 17.8	17.29-18.0	16.75-17.00	18.01-18.80	16.68 - 17.30	16.29 -16.50
		Diff. (ºC)	0.3	0.71	0.25	0.79	0.26	0.21
	August	**Depth (m)**	0 - 60	0 -20	0 -10	0 - 35	0 - 30	0 - 25
		Range (ºC)	18.85 – 29.90	26.40-31.5	29.32-30.02	23.44-33.30	28.37-30.80	29.05 - 32.20
		Diff. (ºC)	11.05	5.10	0.70	9.86	1.43	3.15
1989	January	**Depth (m)**	0 - 70	0 -20	0 -20	0 - 30	0 - 25	0 - 30
		Range (ºC)	16.9 – 17.5	16.7 – 17.1	16.5 – 16.9	16.5 – 18.0	16.1 – 16.4	15.8 – 15.9
		Diff. (ºC)	0.6	0.4	0.4	1.5	0.3	0.1

Table 24 **Vertical variation of water temperature at Abu Simbel station during January and August (1987-1992).**

Depth (m)	1987* Jan.	1987* Aug.	1988* Jan.	1988* Aug.	1989* Jan.	1989* Aug.	1990* Jan.	1990* Aug.	1991** Jan.	1991** Aug.	1992** Jan.	1992** Aug.
	Water temperature (°C)											
0	16.8	23.2	16.5	32.20	15.80	28.50	17.50	27.50	19.20	29.00	15.70	29.18
5	16.1	28.6	16.33	29.27	15.90	28.40	17.31	27.66	19.28	28.70	15.75	27.57
10	16.0	27.8		29.20	15.90	27.30	17.11	27.08	19.25	27.91	15.82	27.46
15	15.9	27.4	16.37	29.20	15.80	26.90	17.01	26.45	19.44	27.99	15.80	27.20
20	16.0	23.1	16.29	29.14	15.90	26.80	16.99	24.24	19.24	27.59	15.86	27.00
25	15.9	---	--	29.05	---	---	---	---	---	---	---	---
30	15.9	---	16.29	---	15.80	---	17.01	20.20	19.05	25.57	15.07	22.33
35	---	---	16.37	---	---	---	---	---	---	---	14.92	---
40	15.8	---	---	---	---	---	16.90	19.01	19.80	21.02	14.92	18.26
50	---	---	---	---	---	---	---	18.83	19.26	20.26	14.75	17.67

* Abdel-Rahman & Goma (1995a, b, c & d). ** Abdel-Rahman (1995a & b) [For stations refer to Fig. 4].

Cont. ***Table 25***

Year	Month		El Ramla	Kalabsha	Allaqi	Korosko	Tushka	Abu Simbel
1990	**August**	**Depth (m)**	0 - 70	0 - 15	0 - 15	0 - 40	0 - 30	0 - 20
		Range (ºC)	16.4 - 28.2	26.1-29.7	27.3 - 30.8	18.7 - 32.1	24.6 - 33.2	26.8 – 28.5
		Diff. (ºC)	11.8	3.6	3.5	3.4	8.6	1.7
	January	**Depth (m)**	0 - 75	0 - 70	0 - 20	0 - 60	0 - 50	0 - 40
		Range (ºC)	17.18 - 17.54	17.32 - 17.90	17.66 - 17.90	17.96 - 18.90	17.34 -7.64	16.90-17.50
		Diff. (ºC)	0.36	0.58	0.24	0.94	0.30	0.60
	August	**Depth (m)**	0 - 70	0 - 70	0 - 15	0 - 60	0 - 50	0 - 50
		Range (ºC)	18.06 - 27.90	18.11 - 31.40	25.28 - 27.62	18.04 - 29.10	18.19 – 29.10	19.05-19.80
		Diff. (ºC)	9.84	13.29	2.34	11.06	10.91	8.83
1991	**January**	**Depth (m)**	0 - 70	0 - 75	0 -15	0 - 50	0 - 50	0 - 50
		Range (ºC)	19.03 - 19.40	19.12 - 20.50	19.11 -19.69	19.52 - 21.10	19.45 - 19.80	20.26-29.00
		Diff. (ºC)	0.37	1.38	0.58	1.58	0.35	0.75
		Depth (m)	0 – 70	0 - 80	0 - 15	0 - 60	0 - 50	0 - 50
		Range (ºC)	18.34 - 28.00	18.41 - 29.30	27.61 - 28.10	18.63 - 30.5	19.19 – 30.20	14.75-15.86
		Diff. (ºC)	9.66	10.89	0.49	11.87	11.01	8.74
1992	**January**	**Depth (m)**	0 - 80	0 - 80	0 - 70	0 - 60	0 - 50	0 - 50
		Range (ºC)	16.02– 6.96	16.00 -16.70	16.39 - 16.72	16.12 - 17.64	15.16 –17.20	14.75-15.86
		Diff. (ºC)	0.94	0.70	0.33	1.52	2.04	1.11
	August	**Depth (m)**	0 - 70	0-80	0 - 70	0 - 60	0 - 50	0 - 50
		Range (ºC)	16.89 – 28.94	16.75 - 30.45	16.57- 30.32	19.52 - 29.50	17.42 - 31.13	17.67-29.18
		Diff. (ºC)	12.05	13.70	13.75	9.98	13.71	11.51

N.B. Data are adopted from Abdel- Rahman & Goma (1995a, b, c & d) and Abdel- Rahman (1995a & b) [For stations refer to Fig. 4].

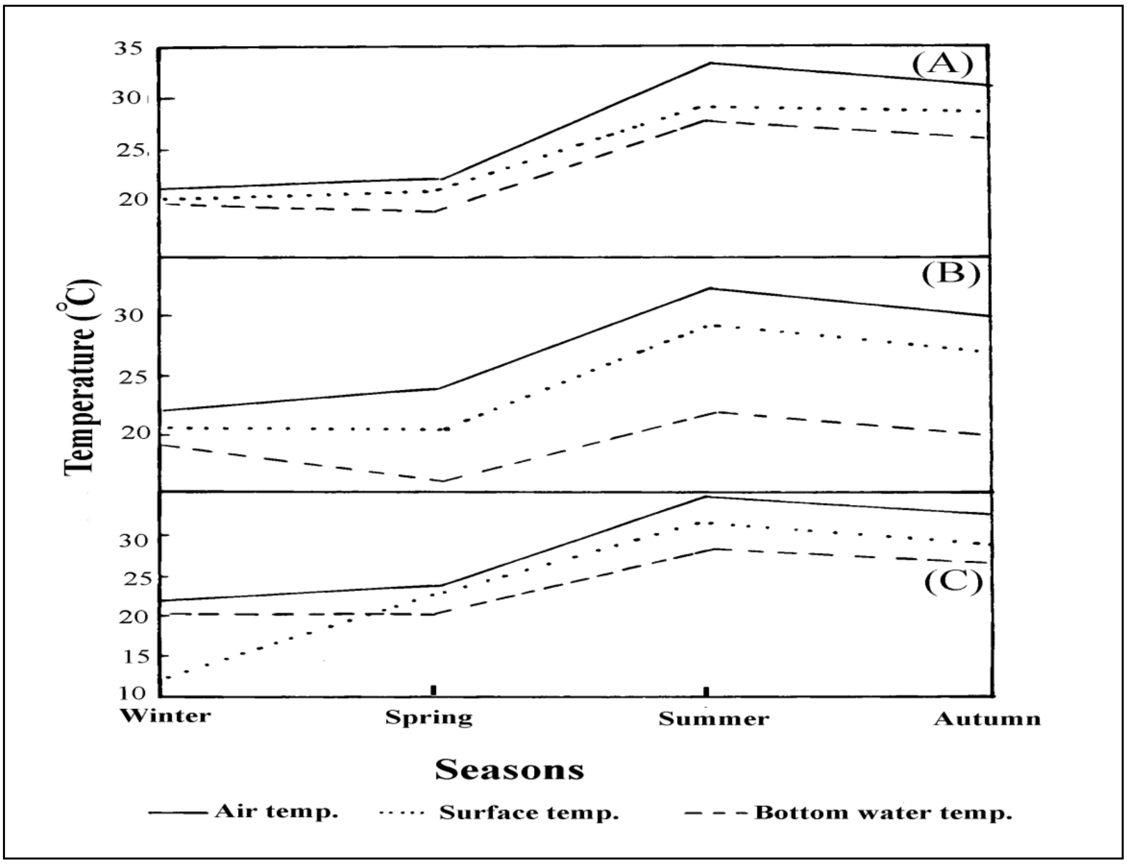

Fig. 35 **Seasonal variations of air, surface water and bottom water temperatures in A: eastern side, B: main channel and C: western side of Lake Nasser during 1993 (Fishar 1995) [**For localities refer to Fig. 15**].**

TRANSPARENCY

The Main Channel. The transparency of the Lake is affected by three important factors : (1) the inflowing turbid water of the River Nile, (2) the development of phytoplankton, and (3) vertical water movement (wind action). The inflowing Nile water, especially during the flood period, is very turbid, rich in suspended inorganic and organic matter and has a brownish-greyish colour. On the arrival of the flood into the Lake the Secchi transparency diminishes within a few hours from 70-140 cm to 20-30 cm or even to 5 -10 cm. The border line between flood water and old water is sometimes very sharp, but the silt content is still remarkable (100-500 mg/l).

Along the progressing flood continuous sedimentation takes place within the Lake, accompanied by gradual reduced turbidity. Ultimately the optical border line between flood water and old water disappears. In areas where the sedimentation has already been completed there is a permanent high transparency in the deeper water layers, of about 300 to 600 cm. In these areas the transparency of the epilimnion is controlled mainly by the phytoplankton. If the phytoplankton density is poor, usually from December to February, the transparency ranges between 200 and 400 cm. As soon as a remarkable algal development starts, usually in March or April, the transparency is reduced to 80-130 cm or even to values of 50 to 70 cm, in case of a dense water bloom.

Under special conditions, i.e. strong long lasting wind blowing from the shore towards the deep water areas of temperature homogenity, an upwelling current is readily formed, lifting water masses very poor in plankton to the surface. Under such conditions, as on 18/3/74, an extremely high transparency of 754 cm was recorded. After a few days of calm weather the transparency dropped because of renewed and rapid phytoplankton development when conditions became normal again.

An obvious indicator of change of water conditions in man-made lakes is the turbidity, measured by a Secchi disk. High turbidity can be caused by suspended inorganic and organic materials (seston) transported by inflowing waters, or by dense plankton communities. The increased turbidity caused by seston tends to mark the beginning of flood waters through the Lake. These waters being rich in nutrients, plankton blooms soon develop, an additional source of turbidity. In the early years of Lake Nasser filling, a strong "water colouration" appeared in the second half of the flood season, caused mainly by *Volvox* colonies. In Volta Lake *Microcystis* water blooms developed shortly after the flood arrival and transparency was reduced in both cases.

In Lake Nasser the effect of flood is manifested in the arrival of turbid water in July/August starting from the southernmost part of the reservoir and extending northwards to cover Lake Nubia and only the southernmost sector of Lake Nasser. Hurst (1957) pointed out that about 100 million tons of suspended sediments are carried annually with the Nile water on entering Egypt. During flood the transparency of water is few centimeters in the southern part of Lake Nubia, as compared with other regions. From February to April, the transparency difference between Lake Nasser and Lake Nubia is not wide and could be attributed to different plankton loads. The highest transparency appeared only near the High Dam in February 1973, after a few days strong wind drifted the surface water layer with its phytoplankton, causing its replacement by clearer deep water (Fig. 36, Latif 1984a).

The monthly variations of transparency at six stations on Lake Nasser during 1983, 1984, 1986 to 1988, 1991 and 1992 are shown in Tables 26 and 27 and Figs. 37-39. The results indicate that at the beginning of the Nile flood, the quantities of the sediments increase greatly, as shown in the minimum reading of the Secchi disk of 0.5 m at Abu Simbel (Tables 26 and 27) located at the most southern region of the Lake. The average value of suspended matter found at the Egyptian borders during the flood period (August-October) amounted to 1.6 kg/m^3 (Elster & Vollenweider 1961). The maximum reading of Secchi disk was 6.0 m at Korosko in February (Table 26). The monthly average value of transparency varied from 1.3 m in September to 3.5 m in March. The mean annual value was 2.3 m (Abdel-Rahman & Goma 1992b, Table 26). Along the different stations of Lake Nasser, limited variations in transparency were observed and ranged from 0.9 at Abu Simbel in November to 4.9 m at El Ramla in January (Table 27).

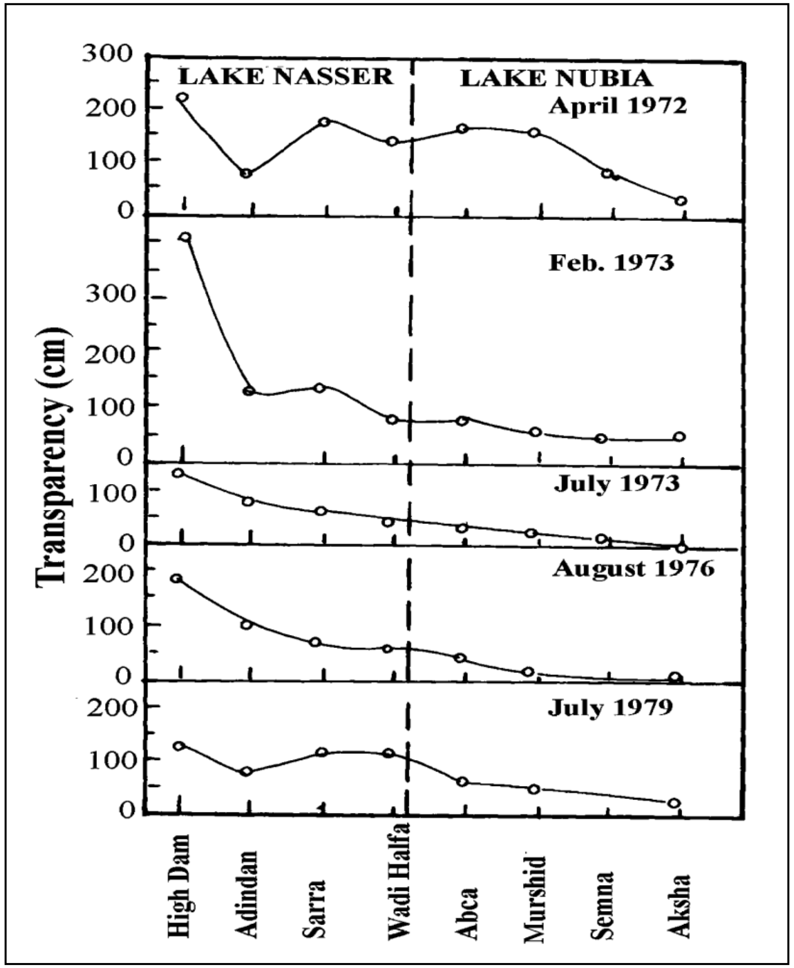

Fig. 36 **Transparency values (cm) of Lake Nasser and Lake Nubia at some selected months (Latif 1984a).**

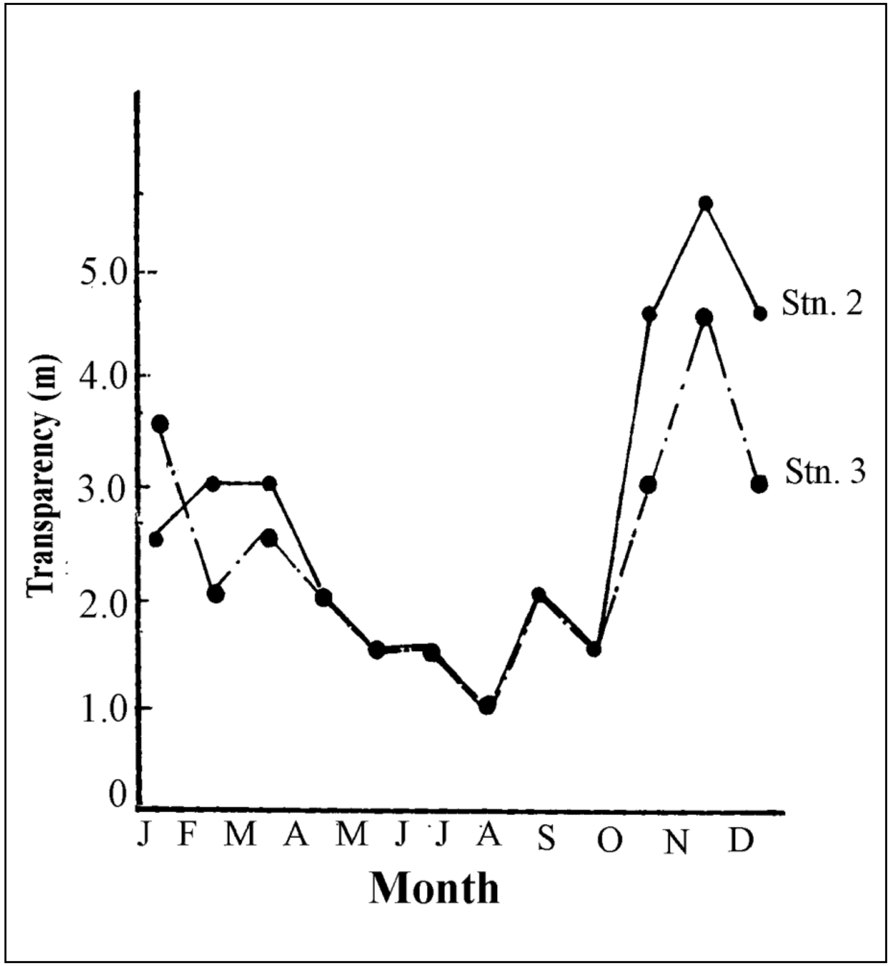

Fig. 37 **Monthly variations of transparency at stations 2 and 3 (Kalabsha & Allaqi) in 1983 (Goma & Abdel-Rahman 1992a)**
[For stations refer to Fig. 4**].**

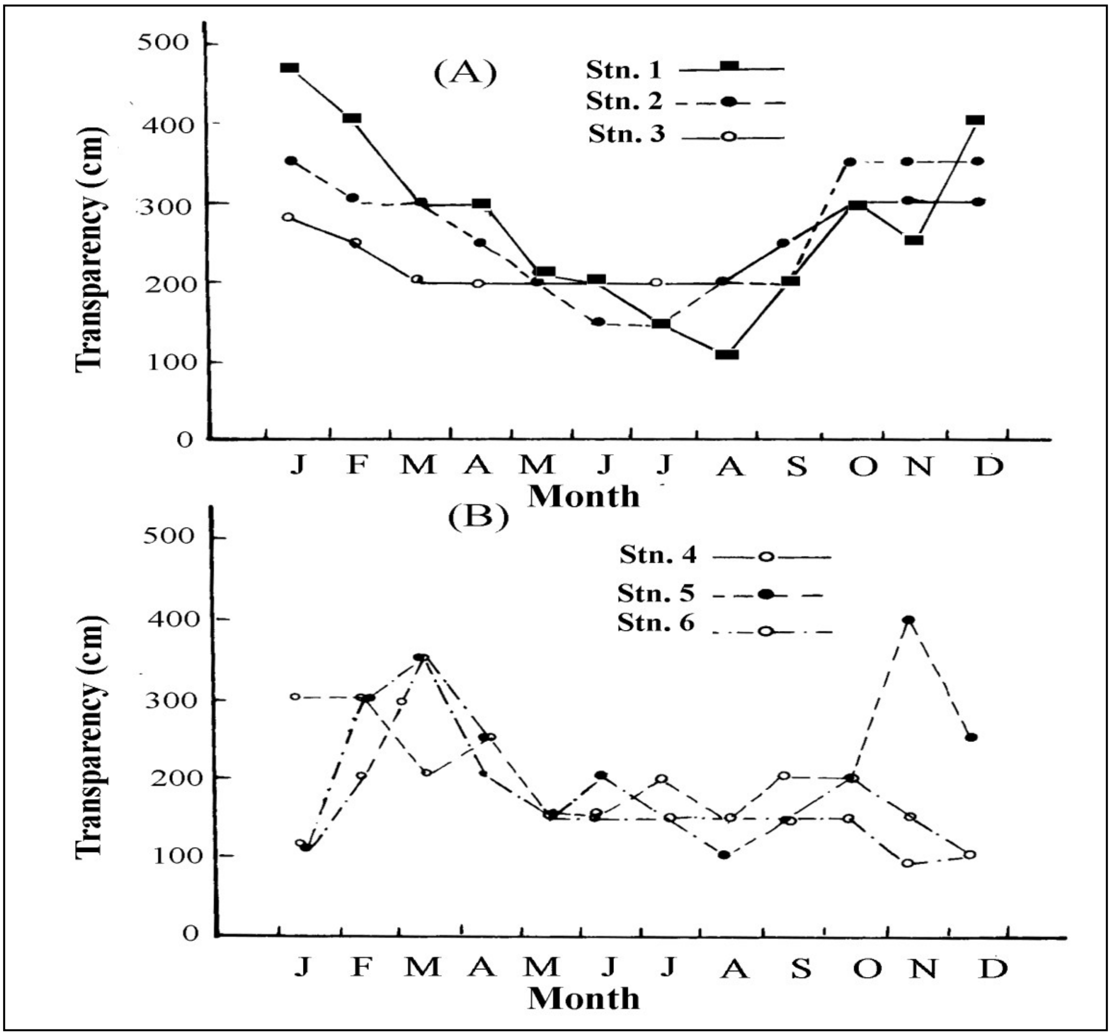

Fig. 38 **The monthly variations of transparency (cm) at six stations of Lake Nasser in 1984 (Goma & Abdel-Rahman 1992b).**

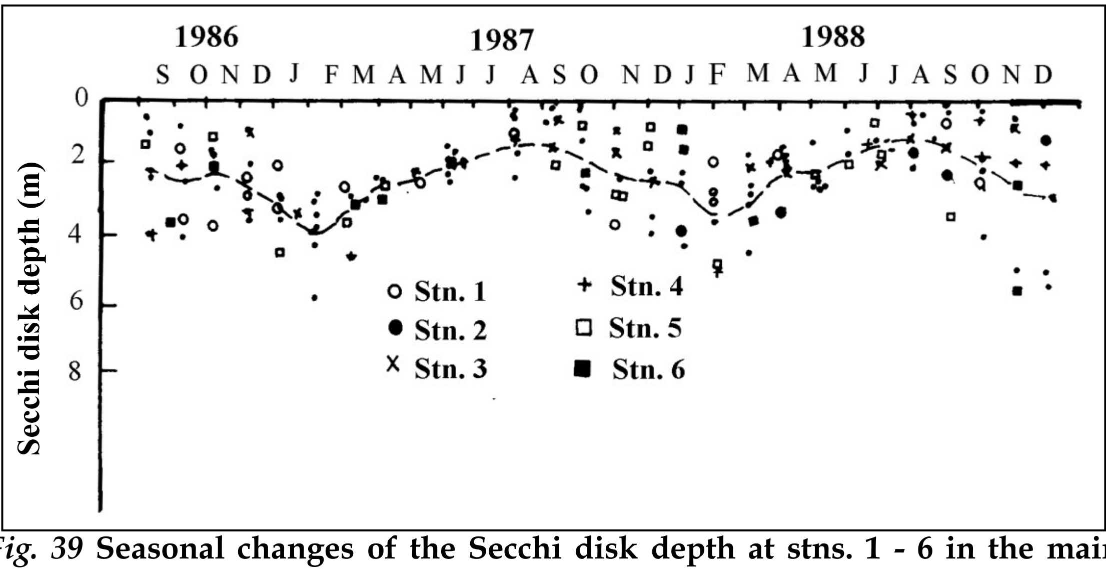

Fig. 39 **Seasonal changes of the Secchi disk depth at stns. 1 - 6 in the main channel of Lake Nasser. The line is for averages of the six stations (Habib *et al.* 1996). [**For stations refer to Fig. 4**].**

From March to September 1984 the transparency was relatively low (1.2 - 3.0 m) at stations of El Ramla, Kalabsha and Allaqi (Figs. 38 and 39) which might be attributed to the abundance of phytoplankton. In winter (December - February) higher transparency values were recorded (Habib *et al.* 1996). Transparency values were low (0.9 - 2.0 m) at Tushka and Abu Simbel except during March. The low values of transparency in the southern region of the Lake might be related to the effects of flood waters bearing large amounts of sediments (Goma & Abdel-Rahman 1992a, Habib *et al.* 1996). Habib *et al.* (1996) pointed out that the level of suspended solids was high (1.0-59.0 g/m^3) at stations 4-6 in the southern region, and low (0.5-10.0 g/m^3) at stations 1-3 in the northern region of the Lake during 1986-1988. The patterns of suspended solids were similar among stations 1-3 and stations 4-6. Rapid increases in suspended solids were recorded in April and May at stations 1-3, whereas at stations 4-6 rapid increases were observed in August and September in 1987 and 1988. The monthly variations of transparency at stations Kalabsha and Allaqi on the main channel of Lake Nasser during 1983 show a maximum value in November and a minimum in May and September (Fig. 37) (Goma & Abdel-Rahman 1992a). Slight difference in transparency measurements between the two stations (El Ramla and Kalabsha) was observed (Fig. 38). The transparency was the same at the two stations during April to September.

***Table* 26 Monthly and mean annual variations of transparency (m) at six stations of Lake Nasser in 1983. (**maximum, *minimum) [**For stations refer to Fig. 4**].**

Month	Stations						Monthly average
	1	2	3	4	5	6	
Jan.	3.5	2.5	3.5	3.5	2.0	1.0	2.7
Feb.	3.5	3.0	2.0	6.0**	3.0	3.0	3.4
Mar.	4.0	3.0	2.5	4.5	3.0	4.0	3.5**
April	3.0	2.0	2.0	2.0	3.0	4.0	2.7
May	1.5	1.5	1.5	1.5	1.5	2.0	1.6
June	3.0	1.5	1.5	1.0	2.5	1.0	1.8
July	1.5	1.0	1.0	3.0	1.0	1.0	1.4
Aug.	2.0	2.0	2.0	1.3	1.0	1.0	1.6
Sept.	1.5	1.5	1.5	1.5	1.5	0.5*	1.3*
Oct.	3.0	4.5	3.0	1.0	2.0	0.8	2.4
Nov.	3.0	5.5	4.5	2.0	1.5	1.5	3.0
Dec.	3.5	4.0	3.0	2.0	2.0	1.5	2.7
Mean annual	**2.8****	**2.7**	**2.3**	**2.4**	**2.5**	**1.8***	**2.3**

Studies by various investigators on seasonal patterns of Secchi disk readings indicated high values during the low temperature period and lower values during high temperature period (Habib *et al.* 1987 and 1996, Habib & Aruga 1988, Fishar 1995). There seems to be a tendency for Secchi disk depth to be lower in the southern region and higher in the northern region of the Lake which may be correlated with the decrease of suspended solids with water flow along the main channel (Fig. 40).

The Secchi disk depth was significantly correlated with suspended solids in a hyperbolic manner, when the two parameters were plotted on linear scales (Fig. 40 - Habib *et al.,* 1996).

Table 27 **Monthly changes of transparency at six stations of Lake Nasser during different years (unit : m).**

Month	Year	El Ramla	Kalabsha	Allaqi	Korosko	Tushka	Abu Simbel
Jan.	**1984**	4.7	3.5	2.8	3.0	1.0	1.0
	91	4.9	3.0	2.5	2.7	1.6	1.7
	92	3.9	4.1	4.1	3.9	2.9	1.9
Feb.	**1984**	4.0	3.0	2.5	3.0	3.0	2.0
	91	5.7	3.0	3.0	3.1	2.3	2.1
	92	3.7	4.1	3.3	4.1	1.9	1.3
Mar.	**1984**	3.0	3.0	2.0	2.0	3.5	3.5
	91	5.0	3.8	2.5	3.2	2.7	3.3
	92	5.8	4.2	3.5	2.7	3.0	2.9
April	**1984**	3.0	2.5	2.0	2.5	2.5	2.0
	91	3.3	2.6	2.1	2.0	2.1	2.1
	92	4.8	4.4	3.8	3.2	3.0	2.1
May	**1984**	2.1	2.0	2.0	1.6	1.5	1.5
	91	2.1	2.7	1.9	1.8	2.1	1.8
June	**1984**	2.0	1.5	2.0	1.5	1.5	2.0
	91	1.9	1.8	1.5	1.6	1.5	1.6
July	**1984**	1.5	1.5	2.0	2.0	1.5	1.5
	91	2.2	2.1	2.1	1.6	1.5	1.4
	92	2.7	1.7	2.1	1.3	2.0	1.5
Aug.	**1984**	1.2	2.0	2.0	1.5	1.0	1.5
	91	3.1	3.0	1.8	0.9	0.6	0.6
	92	3.2	4.1	2.2	2.0	1.5	---
Sept.	**1984**	2.0	2.0	2.5	2.0	1.5	1.5
	91	3.8	3.8	1.6	0.5	0.5	0.3
	92	4.8	3.6	2.5	1.3	0.6	0.3
Oct.	**1984**	3.0	3.5	3.0	2.0	2.0	1.5
	91	4.8	3.2	2.8	2.1	1.2	0.6
	92	4.0	3.3	2.5	1.3	1.7	1.4
Nov.	**1984**	2.5	3.5	3.0	4.0	1.5	0.9
	91	4.8	2.9	3.0	1.6	1.0	0.8
	92	4.6	4.7	2.6	2.7	1.0	0.5
Dec.	**1984**	4.0	3.5	3.0	2.5	1.0	1.0
	91	3.9	3.0	3.8	2.8	1.2	0.9

1984 (Goma & Abdel-Rahman 1992b). 1991 (Abdel-Rahman 1995a).
1992 (Abdel-Rahman 1995b). [For stations refer to Fig. 4].

Mohamed, I. (1996b) showed that transparency in the main channel of Lake Nasser during 1992 had a maximum value of Secchi disk depth (5.8 m) at stn. 1 in March, and minimum values (0.3 and 0.4m) at stn. 6 in August and September. The latter author pointed out that transparency was usually low during the period of high chlorophyll *a* concentration and high during the period of low chlorophyll *a* concentration. Mohamed, I. (1996b) concluded that transparency is due to the presence of both phytoplankton and suspended substances.

Studies on the seasonal variations of Secchi disk readings in Lake Nasser during 1993 (Fig. 41) showed that the Secchi disk depth was high in winter especially in the main channel, where an average value of 278.50 cm was recorded (Fishar 1995). The Secchi disk readings slightly decreased in spring, when average readings of 238.8, 252 and 237.22 cm were recorded for the eastern side, western side and the main channel respectively. It seems that both eastern and western sides of the Lake are more turbid than the main channel. Furthermore, a sharp decrease in transparency value (180.3 cm for the entire Lake in average) was observed in summer, which may be attributed to the new arrival of flood. During autumn, transparency increases slowly and reaches an average of 201.7 cm for the entire Lake (Fishar 1995).

Habib *et al.* (1996) showed that the ignition loss of suspended solids was high (i.e. 25 - 98%) at the northern region (stns. 1-3) and low (i.e. 6-92%) at the southern stations (stns. 4-6) (Fig. 43). Variations of ignition loss were high at stns. 1-3 as compared with those of stns. 4 -6. Rapid increase of ignition loss was observed in August and September at stns. 1-3 in 1987 and 1988, whereas rapid decreases were found at stns 4-6.(southern region) in the same period. These differences may be due to differences of variation in proportion of inorganic suspended solids to the particulate organic matter or to the total suspended solids in the Lake. The patterns of seasonal changes of ignition loss (Fig. 43) were quite different from those of suspended solids (Fig. 42). It is concluded that there are large seasonal variations in the proportion of inorganic suspended solids to the total suspended solids or to the particulate organic matter.

The Khors. Elewa (1987a) mentioned that the transparency in five khors of Lake Nasser (Amicol, Manam, El Birba, Singari and Tushka) was high during the cold season and was lowered by flood turbid water especially in the southern khors at Tushka.

Habib (1995c) described the seasonal changes of the Secchi disk depth, suspended solids and ignition loss at four stations in Khor El Ramla (Figs. 44 - 47). The Secchi disk depth was lowest (1.2 m) in August 1986 at stn. 6, and highest (4.8 m) in February 1987 at stn. 11. The Secchi disk depth was mostly low at stns. 4 and 6, whereas it was high at stns. 10 and 11. The suspended solids were high (5 - 11.5 g/m^3) at stns. 4 and 6 (inside the khor) and comparatively low (i.e. 04-5.2 g/m^3) at stns.. 10 and 11 in the main channel and eastern side of the Lake (Fig. 46). The patterns of seasonal changes of suspended solids are similar among stns. 4 and 6, and also similar among stns. 10 and 11. However, the patterns at stns. 10 and 11 are clearly different from those at stns. 4 and 6 (Habib 1995c).

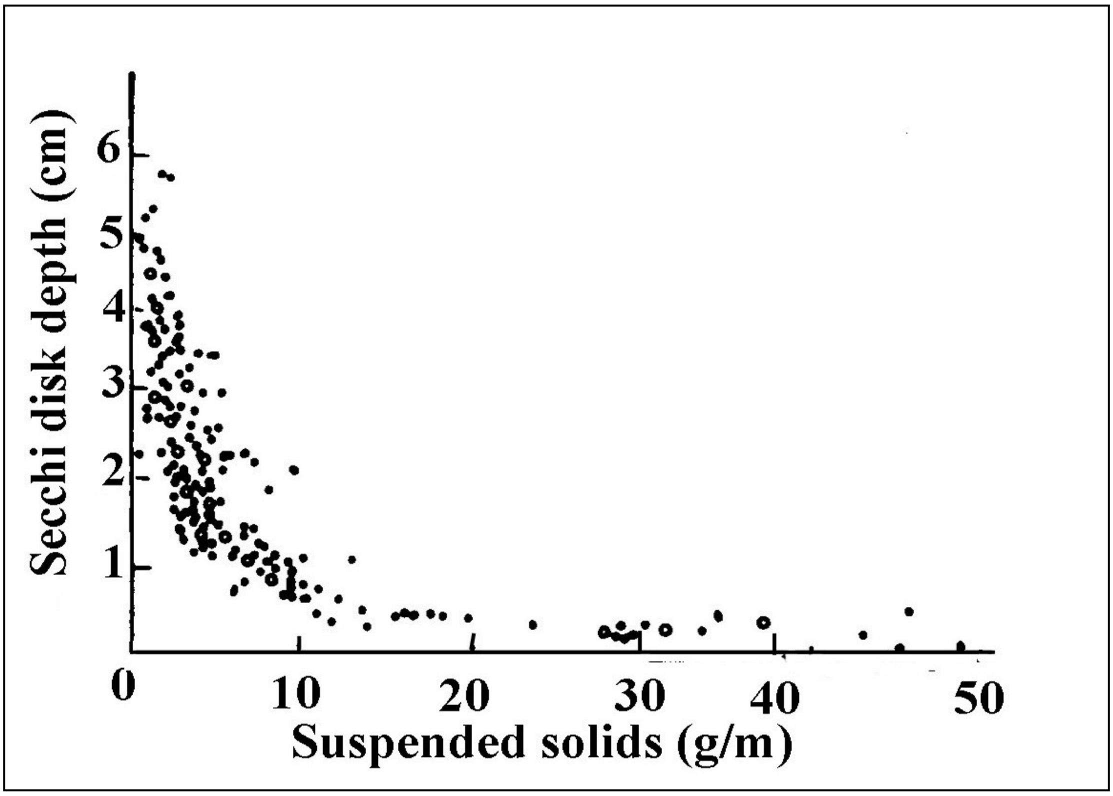

Fig. 40 **Relationships of the Secchi disk depth to the suspended solids at stns. 1-6 in the main channel of Lake Nasser. (o) surface; (•) 2m. (Habib *et al.* 1996)** [For stations refer to Fig. 4].

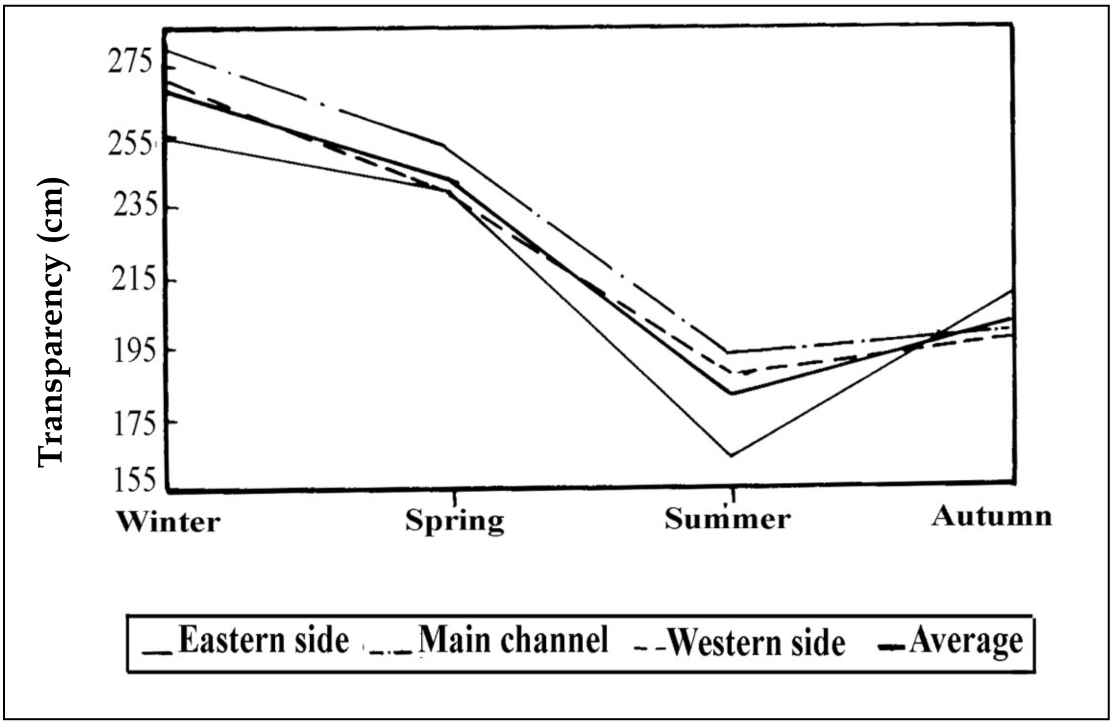

Fig. 41 **Seasonal variations of transparency in Lake Nasser during 1993. (Fishar 1995).**

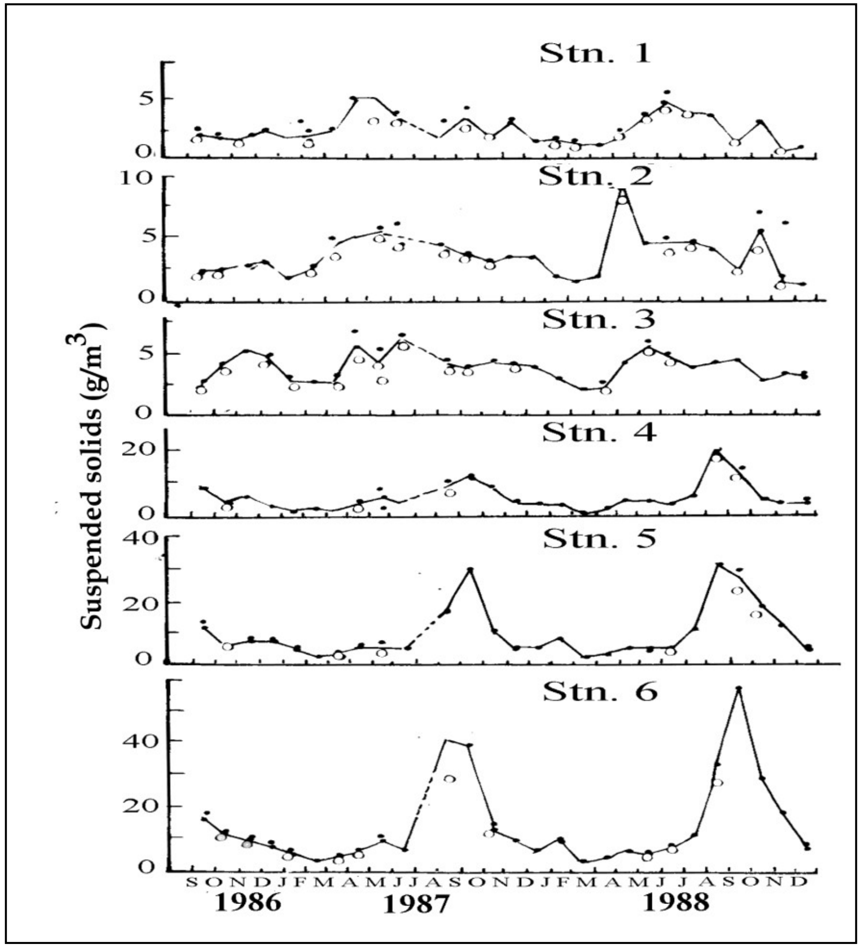

Fig. 42 **Seasonal changes of the suspended solids at stns. 1 - 6 in the main channel of Lake Nasser. Lines are for averages of the surface (○) and 2m (•) depth (Habib *et al.* 1996). [**For stations refer to Fig. 4**].**

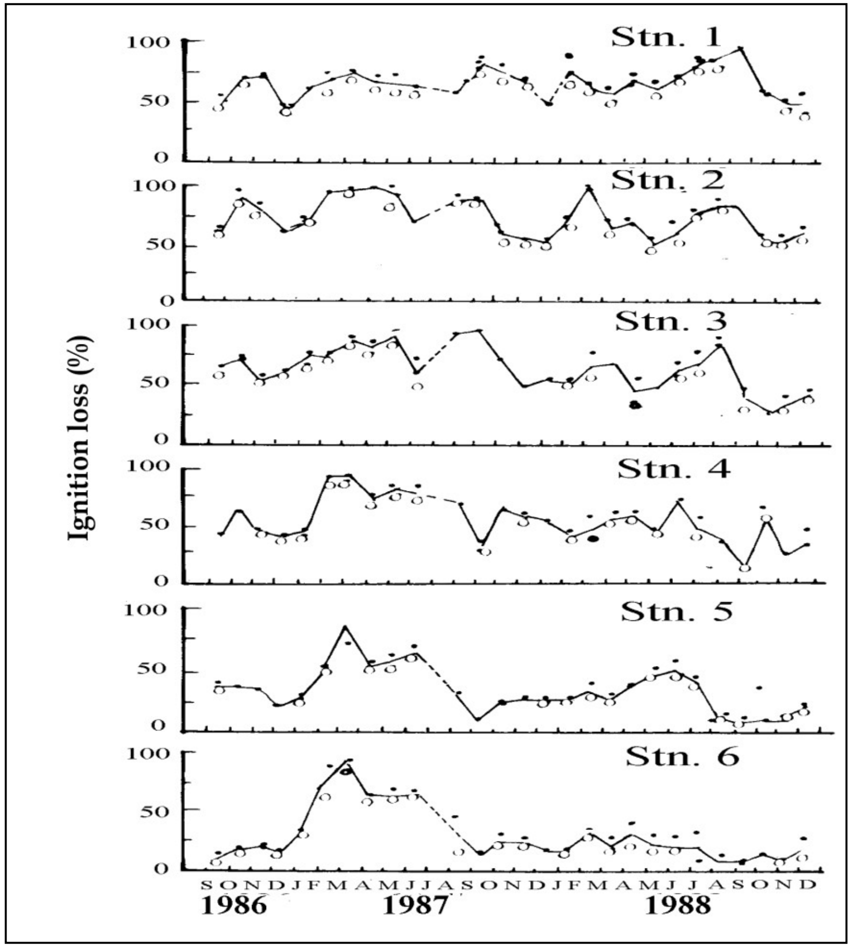

Fig. 43 **Seasonal changes of the ignition loss of suspended solids at stns. 1 - 6 in the main channel of Lake Nasser. Lines are for averages of the surface (○) and 2m (•) depth (Habib *et al.* 1996) [**For

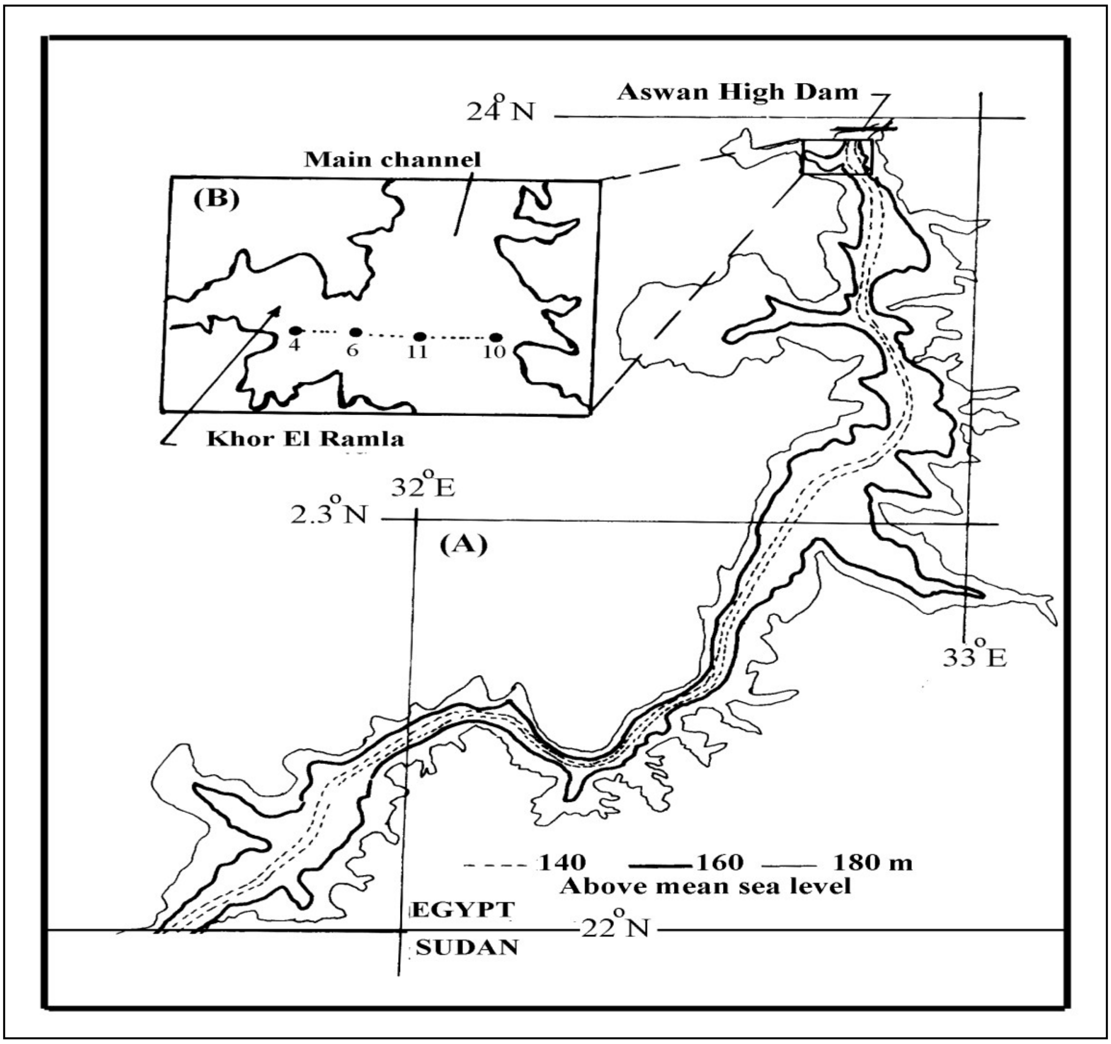

Fig. 44 **Map of Lake Nasser showing the locations of stations Habib 1995c).**

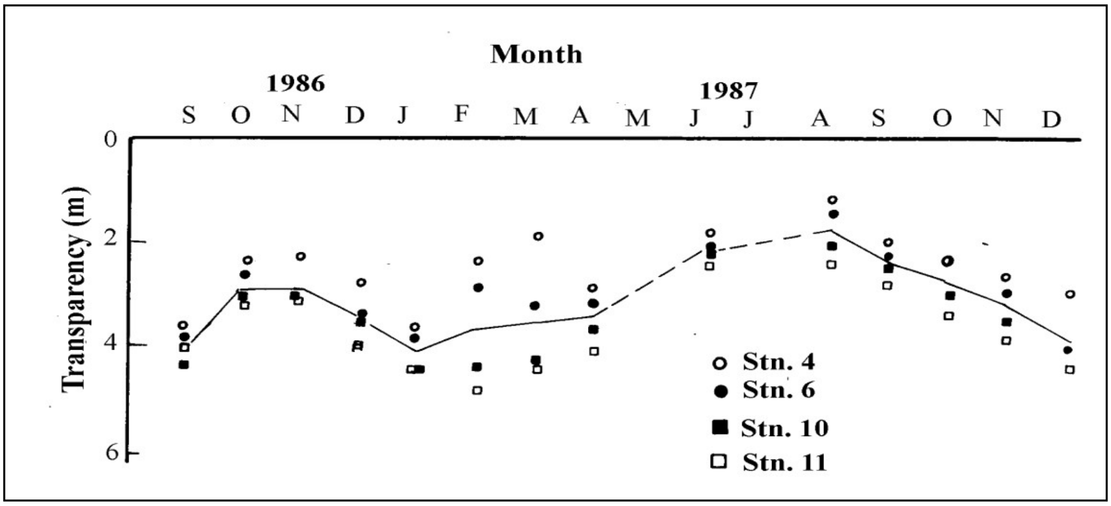

Fig. 45 **Seasonal changes of the transparency at stns. 4, 6, 10 and 11 in Khor El Ramla of Lake Nasser. The line is for averages of the four stations (Habib 1995c). [**For stations refer to Fig. 44**].**

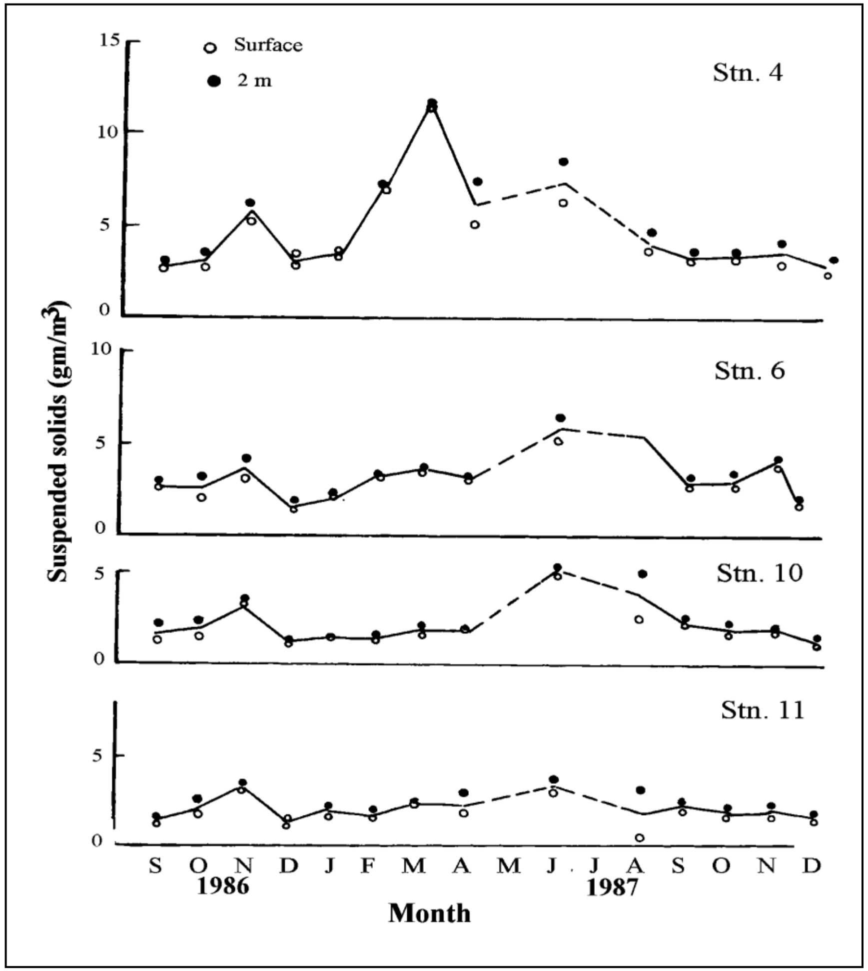

Fig. 46 **Seasonal changes of the suspended solids at stns. 4, 6, 10 and 11 in Khor El Ramla. Lines are for averages of the surface (○) and 2m (•) (Habib 1995c) [**For stations refer to Fig. 44**].**

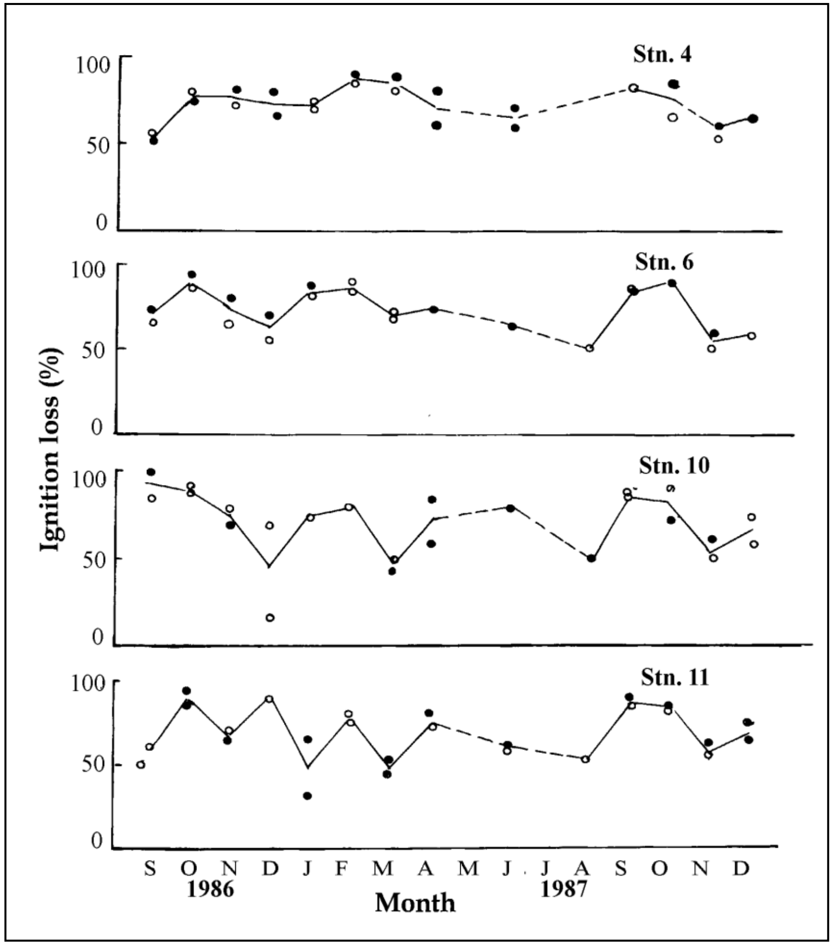

Fig. 47 **Seasonal changes of the ignition loss of suspended solids at stns. 4, 6, 10 and 11 in Khor El Ramla. Lines are for averages of the surface (○) and 2m (•) (Habib 1995c) [**For stations refer to Fig. 44**].**

Generally, the ignition loss was high (50 -95%) at stns. 4 and 6, and low (17 - 100%) at stns. 10 and 11 (Fig. 47). The patterns of seasonal changes of ignition loss were similar among stns. 4 & 6, and also among stns. 10 & 11. The suspended solids were significantly high during the flood season. The seasonal changes of the ignition loss were quite different from those of suspended solids. This suggests that there are great seasonal variations in the proportion of inorganic suspended solids to the total suspended solids or the particulate organic matter.

Mohamed, I. (1996a) mentioned that transparency in Khor El Ramla during 1990 had a maximum value of 5.3 m at stn. 10 in November, while the minimum value (1.1 m) was recorded at stns. 10 and 11 in May. Transparency was low during the period of high chlorophyll *a* concentration and high during the period of low chlorophyll *a* concentration. The latter author attributed the low transparency to the presence of phytoplankton as well as the suspended substances.

Table 28 **Monthly and mean annual variations of water colour (units) at six stations of Lake Nasser in 1983 and 1984 (in parentheses) (Goma & Abdel-Rahman 1992 a and b).**

Month	Stations						Monthly average
	1	2	3	4	5	6	
Jan.	15 (14)	14 (14)	15 (14)	14 (15)	14 (15)	17 (15)	14 (15)
Feb.	14 (14)	15 (14)	16 (14)	14 (14)	14 (14)	14 (14)	14 (14)
Mar.	14 (-)	14 (-)	15 (-)	14 (-)	14 (-)	14 (-)	14 (-)
April	14 (14)	15 (14)	14 (14)	14 (14)	14 (14)	13 (14)	14 (14)
May	15 (14)	16 (14)	15 (14)	14 (14)	15 (14)	14 (14)	14 (14)
June	14 (14)	14 (14)	14 (14)	13 (14)	15 (14)	15 (14)	14 (14)
July	14 (14)	14 (14)	14 (14)	14 (14)	14 (14)	14 (14)	14 (14)
Aug.	14 (14)	14 (14)	14 (14)	14 (14)	14 (15)	14 (14)	14 (14)
Sept.	14 (14)	15 (14)	14 (14)	14 (14)	15 (14)	15 (14)	14 (14)
Oct.	13 (15)	14 (15)	14 (15)	13 (14)	15 (15)	15 (14)	14 (15)
Nov.	14 (14)	14 (14)	14 (14)	15 (14)	15 (15)	15 (16)	14 (15)
Dec.	14 (14)	14 (14)	14 (14)	14 (14)	14 (15)	15 (15)	14 (14)
Mean annual	14	14	14	14	14	14	14

Apparent colour of the lake							
Unit	**1 - 2**	**3 - 4**	**5 - 7**	**8 - 10**	**11 - 15**	**16 - 19**	**20 - 22**
Colour	Blue	Greenish blue	Bluish green	Green	Greenish yellow	Yellow	Brown

For stations refer to Fig. 4.

WATER COLOUR

Studies on the monthly and mean annual variations of water colour at six stations on Lake Nasser during 1983 and 1984 (Goma & Abdel-Rahman 1992a and b) showed, more or less, identical values (Table 28). Monthly variations ranged from a minimum of 13 units in October 1983 at station 1 to 17 units at station 6 in January 1983. In 1984, a maximum value (16 units) was recorded at the same station but in November. The water colour of the Lake is mainly greenish yellow (14 units) in most stations and throughout the year. This might be attributed to the abundance of phytoplankton (Goma & Abdel-Rahman 1992b).

CONCLUSIONS

In warm and cold seasons surface water temperatures are not far from those of the air. The difference between surface and bottom temperatures in riverine environments is found to be slight, while the difference increases with impoundment. In Lake Nasser, the water columns are well mixed during winter, with almost homogenous temperature. A decrease in water temperature with depth of the Lake becomes clear in spring.

Thermal stratification becomes more prominent in summer time, with wide difference in temperature between surface and bottom at all stations of Lake Nasser and even during different years. The distruction of stratification in the Lake takes place in autumn and winter.

Transparency (Secchi disk reading) in Lake Nasser shows regional, seasonal and vertical variations. Secchi disk readings are highest during winter in the main channel (average 278.5 cm), showing a slight decrease in spring (average 252 cm). Slightly lower values are recorded in the eastern and western sides of the Lake. In summer (July - September) a sharp decrease in transparency throughout the entire Lake is recorded, which is attributed mainly to the arrival of flood water rich in suspended material. In autumn a slow increase of transparency occurs throughout the entire Lake.

The lowest transparency is recorded in the southernmost stations during flood. The ignition loss of suspended solids is high at the northern region and low at the southern. It seems that both eastern and western sides of the Lake are more turbid than the main channel. Furthermore there are great seasonal variations in the proportion of inorganic solids to the total suspended solids or to particulate matter.

In khors, the highest transparency is recorded in winter and reaches its minimum during flood. The southernmost khors are more turbid than the northern. Suspended solids are usually higher in khors compared with those in the main channel and sides of the Lake. Apparently the total suspended solids and phytoplankton play an important role in determining transparency of water (Secchi disk depth) of the Lake.

Under certain conditions, especially long lasting wind blowing from the shore, an upwelling current could be formed bringing water masses poor in plankton from deeper water to the surface, thus leading to exceptionally high transparencies, i.e. 7.4 m or more.