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A Short Note on the Sediment Regime of the Nile River

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INTRODUCTION

In the present note an attempt is made to study in brief the sediment regime of the Nile River with the object of determining the effect of the closure of the High Aswan Dam in 1964 on both the cultivated area in Egypt and the Nile Delta Shore. Owing to the great reservoir capacity of the High Dam, the annual sediment load brought by the Nile during its flood from its higher sources is totally deposited in the reservoir lake. In this way the cultivated area in Egypt, as well as the Nile Delta shore have both been deprived of their usual share of sediment.

The loss of sediment usually fed to the cultivated area with irrigation water has to be substituted with fertiliser, the amount of which will depend on the amount and nature of the lost sediment.

Also the loss of sediment usually fed to the Nile Delta Shore through the two Nile, branches before the High Dam, has resulted in an adverse shore evolution, since it is on the whole of an erosive nature.

It is the object of this note to determine the appropriate share of sediment loss in both the cultivated area and the Nile Delta shore seperately. The determination of the actual sediment loss in both cases is of vital importance, since the remedial measures will depend completely on the actual figures of sediment loss. In this procedure we shall only rely on actual measurements taken for several years and averaged over the whole period so as to give a reliable average value.

SEDIMENT MEASUREMENTS

Sediment investigations started on the Nile in 1929, in connection with sediment deposition in the Low Aswan Dam reservoir when used for

flood protection or power generation. This sediment depositon resulted in a loss of capacity of the dam, which will be evaluated through direct measurement.

Systematic collection of samples for the determination of the quantity of sediment in suspension in the Nile water were made by the Physical Department and later by the Nile Control Department (Ministry of Irrigation, Cairo), almost uninterruptedly since 1929. Mechanical analyses to determine the percentage of the different constituents of the suspended load were also made. Before 1929 no actual sediment measurements have been made.

The sediment content is measured in parts per million by weight and is seperated by a sedimentation process into sand, silt, and clay. For the whole flood the proportion of the constituents are given in Table (I)reproduced form a paper by Simaika (1), (i.e. Ref No. 1).

The observations were taken at Halfa at the tail of the reservoir about 360 kilometers above the dam and at Gaafra some 30 kilometers below it. After the second hightening of the Low Aswan Dam, ovservations were taken at Kajnarty about 45 kilometers to the south of Halfa which is in the backwater of the reservoir.

Table I- Perentage of the constituents of Nile sediment

Coarse sand	(0.2 - 2.0 m/m)	none or traces
Fine sand	(0.02- 0.2 m/m)	30%
Silt	(0.002-0.02m/m)	40%
Clay	less than 0.002)	30%

Sediment passing Halfa:

In the paper already cited(1) Simaika gives the average measured quantity of sediment passing Halfa or Kajnarty at the tail of Aswan reservoir since 1929 as follows:

Table II- Suspended matter in the Nile passing Halfa or Kajnarty at the tail of Aswan reservoir

		Silt concentration parts/million by weight	Total solids passing (in million tons)	
				Monthly
Jan.	1 - 10	93	0.11	
	11 - 20	82	0.09	0.29
	21 - end	74	0.08	
Feb.	1 - 10	64	0.06	
	11 - 20	59	0.05	0.15
	21 - end	57	0.04	
March	1 - 10	53	0.03	
	11 - 20	51	0.03	0.11
	20 - end	52	0.04	
April	1 - 10	50	0.04	
	11 - 20	49	0.04	0.13
	21 - end	48	0.04	
May	1 - 10	41	0.03	
	11 - 20	39	0.02	0.08
	21 - end	39	0.02	
June	1 - 10	39	0.02	
	11 - 20	43	0.03	0.09
	21 - end	49	0.04	
July	1 - 10	70	0.07	
	11 - 20	128	0.21	1.81
	21 - end	418	1.52	
Aug.	1 - 10	1450	19.61	
	11 - 20	2861	19.61	56.22
	21 - end	3425	28.95	
Sep.	1 - 10	3260	26.20	
	11 - 20	2449	18.35	56.64
	21 - end	1827	12.12	
Oct.	1 - 10	1371	8.14	
	11 - 20	971	4.80	15.54
	21 - end	671	2.60	
Nov.	1 - 10	397	1.23	
	11 - 20	267	0.59	2.15
	21 - end	187	0.34	
Dec.	1 - 10	136	0.21	
	11 - 20	118	0.17	0.53
	21 - end	108	0.15	
Annual Total			134 Million tons	

Sediment passing Gaafra:

Part of the sediment passing Halfa settles in the Low Aswan Dam reservoir, the remaining part is released through the dam sluices to the down-stream. Measurements at Gaafra will detect the released quantity of sediment. Fahmy (2) gives the average sediment passing Gaafra for 27 years (from 1929 to 1955). His results are shown in Table III.

Table III- Annual sediment quantity passing Gaafra (average 1929 - 1955)

	Silt concentration parts /million by weight	Total solids passing (in million tons)	
			Monthly total
1 - 10	58	0.05	
Jan. 11 - 20	57	0.06	0.18
21 - end	58	0.06	
1 - 10	61	0.06	
Feb. 11 - 20	54	0.05	0.15
21 - end	48	0.04	
1 - 10	45	0.04	
March 11- 20	43	0.03	0.10
21 - end	42	0.03	
1 - 10	42	0.03	
April 11- 20	43	0.03	0.10
21 - end	47	0.04	
1 - 10	54	0.05	
May 11 - 20	59	0.05	0.17
21 - end	65	0.07	
1 - 10	75	0.09	
June 11 - 20	95	0.11	0.36
21 - end	122	0.16	
1 - 10	170	0.25	
July 11 - 20	259	0.42	2.08
21 - end	554	1.41	
1 - 10	1720	6.90	
Aug. 11 - 20	2912	18.21	52.87
21 - end	3764	27.76	

Sep.	1 - 10	3000	23.51	53.68
	11 - 20	2525	18.24	
	21 - end	1862	11.93	
Oct.	1 - 10	1292	7.40	12.62
	11 - 20	790	3.76	
	21 - end	482	1.46	
Nov.	1 - 10	183	0.52	0.90
	11 - 20	120	0.23	
	21 - end	98	0.15	
Dec.	1 - 10	88	0.12	0.28
	11 - 20	74	0.10	
	21 - end	60	0.06	
Annual total				123.50 million tons

From Tables II and III, we may come to the conclusion that 10.5 million tons were annually trapped in the Low Aswan Dam reservoir. Moreover Table III shows clearly that the majority of sediment load passing Gaafra lies in three months only (namely Aug., Sep. and October). The total sediment passing Gaafra during these 3 months amounts to 119.2 million tons or 97% of the amount brought during the whole year. This last conclusion may help in determining the amount of sediment consumed by the cultivated area if the ratio of water used in irrigation to the total Nile supply during these three months is known.

Agricultural requirements of water before High Dam:

Before the High Dam, the variation in the cultivated area was very slow. Therefore we may safely assume that the irrigation water required for the cultivated area during the period under question (1929 - 1955) during which we are making our sediment calculations, is constant. Ahmed (3) makes a thorough analysis of the Nile water income, the storage scheme and the agricultural requirements. We here reproduce a very illuminating figure from his paper (Fig.1).

AIMED ON RECENT DEVELOPMENTS IN NILE CONTROL

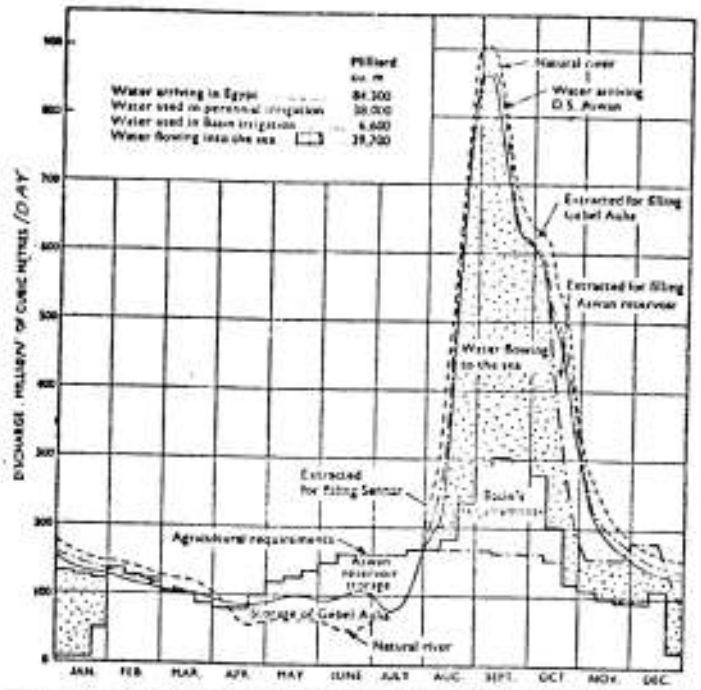

FIG. 1.—WATER ARRIVING AT ASWAN AND RESERVOIR ABSTRACTIONS IN A NORMAL YEAR (1957)

From Fig. (1) we find that the average daily water consumption released from Aswan to meet the agricultural requirements during the three months of Aug., Sep. and October which brings 97% of the sediment load as already mentioned are as follows:

Aug.	200	million m^3/day	giving	6.2	milds m^3
Sep.	300	"	"	"	9.0	"	"
Oct.	200	"	"	"	6.2	"	"

These figures may be compared with the total water supply of the Nile during the same months in an average year. The monthly reports of the High Dam Authority (4) may be consulted for this data. In an average year

like 1971, these monthly reports give the monthly discharges entering the reservoir lake during the above three months as follows:

Aug.	15.870	milds m^3
Sep.	19.637	" "
Oct.	8.858	" "

Sediment consumed by the cultivated area

The amount of sediment reaching the cultivated area may then be simply calculated in the following manner:

Aug.	$\frac{6.2}{15.87}$	x 52.87	= 20.8	million tons	
Sep.	$\frac{9.0}{19.637}$	x 53.68	= 24.8	"	"
Oct.	$\frac{6.2}{8.858}$	x 12.62	= 8.8	"	"
For remaining 9 months			= 4.3	"	"
Total			58.7	"	"

Or about 48% of the sediment passing Gaafra.

Note that the amount consumed by the area of Upper Egypt ($\frac{1}{3}$ total cultivated area of Egypt) is 22 million tons per year according to actual measurements at Gaafra and Cairo.

Sediment reaching the Mediterranean:

Out of 123.5 million tons passing Gaafra, 58.7 million tons subside on the cultivated area and the remaining 64.8 million tons pass to the Mediterranean through the two Nile branches at Rosetta and Damietta. Out of this latter quantity, only the sand fraction contributes in building the shore. The percentage of sand in the Nile sediment according to Table I is 30%. Therefore the amount of sand replenishment to the beach by the Nile before the High Dam was 19.4 million tons per year. This is comparable to the measured loss from the shore by direct sounding and profile studies, which amount to 19 million m^3 per year (average of 1972 to 1976) for the shore strip lying between depth contours 0 and 6 m.

Conclusion:

From direct measurements we arrive at the following:

Average annual sediment passing Halfa in million tons	134.0
" " " " Gaafra " " "	123.5
" " " deposited in the L.Aswan reservoir in million tons	10.5
Average annual sediment deposited on the cultivated area in Egypt before H.D.	58.7
Average annual sediment reaching the Mediterranean in million tons	64.8

The amount of sediment that may settle on the River bed between Gaafra and the Mediterranean has been neglected.

References

1- Simaika, Y.M. "Degradation of the Nile Bed due to the Interception of Silt in the High Aswan Reservoir", Commission Internationale des Grandes Barrages, Dixieme Congres, Montreal 1970, Q 38, R 60. "Enclosed"

2- Fahmy, A. "A note on the Effect of Sediment on the Capacity of the High Dam Reservoir", Research and Experimental Station, Ministry of Irrigation, Cairo, Feb. 1974 (Arabic text). "Enclosed" in Arabic.

3- Abd El Aziz Ahmed, "Recent Developments in Nile Control", Paper No. 6102, Proceedings of the Institution of Civil Engineers, London, Oct. 1960.

4- Monthly Reports of High Dam Authority, Ministry of Irrigation 1978. (Arabic text).