EVALUATION OF FLOODED AREAS UPSTREAM NEW NAGA HAMMADI BARRAGES

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ABSTRACT

New Barrages are currently under construction at Naga Hammadi (Egypt) in order to replace the Old Naga Hammadi Barrages located at 359 km downstream Aswan High Dam.

The new barrages provide hydropower generation in addition to enhancing the irrigation and navigational conditions already provided by the old barrages. The new Barrages are located downstream the old ones at El Dom island in a curved river reach. A flood flow of 7000 m^3/s (about 605 Million m^3/day) is considered as the maximum flood flow at the New Naga Hammadi Barrages and the maximum flood level upstream the New Barrages is designated as (67.05) m while the normal water level is (65.9) m. The bed levels may reach a minimum value of (52.0) m which may lead to bank heights in the order of 15.0 m. Indeed such high bank height needs special considerations in order to ensure full bank stability.

The construction and operation of the New Barrages is likely to result a number of environmental impacts, which will be attributed to the irrigation component of the project for a Barrage.

The main objective of the study is to map the extent of land to be inundated upstream the existing barrages due to higher headpond of the new Naga Hammadi Barrages.

The maps produced by the study will be used for reconnaissance surveys of the conditions on riverbanks and islands affected by the new headpond. They will also help in the planning of future mitigation measures and assessment of the need for compensation.

Keywords: New Naga Hammadi Barrages, flood flow, inundated, water level

INTRODUCTION

New barrages are currently under construction downstream old Naga Hammadi Barrages at 362.30 km downstream Aswan High Dam in order to replace the Old Naga

Hammadi Barrages located at 359 km downstream Aswan High Dam. The new barrages provide hydropower generation in addition to enhancing the irrigation and navigational conditions already provided by the old barrages. The new bararges are located downstream the old ones at El Dom island in a curved river reach as shown in Fig. 1.

A flood flow of 7000 m^3/s (about 605 Million m^3/day) is considered as the maximum flood flow at the New Naga Hammadi Barrages and the maximum flood level upstream of the New Barrages is designated as (67.05) m while the normal water level is (65.9) m.

The present headpond level of the existing Barrages, namely (65.4) m is assumed to be representative of the actual environmental conditions associated with the river and groundwater levels upstream the Barrages. The (0.5) m increase above this level to a constant level of (65.9) m will result in increased river levels upstream. This will result in localized impacts on the riverbanks and river islands and higher groundwater levels in parts of the river plain area over the Project Study Area (about 65 km upstream the Barrage.

The study will estimate and evaluate the flooded area upstream the existing Barrages due to higher headpond of the new Naga Hammadi Barrages according to recorded maximum water level measurements made at the gauge stations between Esna and Naga Hammadi for maximum discharges observed downstream Esna Barrages over fifteen years.

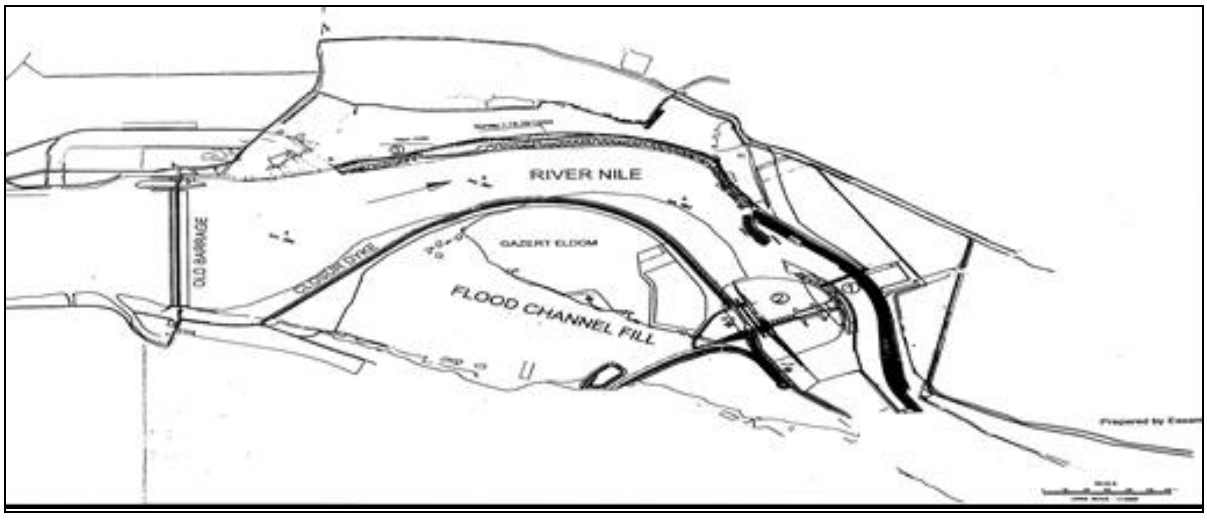

Figure (1) : The new bararges are located downstream the old ones at El Dom island

STUDY AREA

The study area is located along the river reach between Naga Hammadi and Esna Barrages. The distance between the two Barrages is 192.85 km. Upstream of the Naga Hammadi Barrage; a number of large cities are established. These include Naga Hammadi, Dishna, Qena, and Luxor. The study area covers a distance of project study area about (65) km upstream of the existing Naga Hammadi Barrage, as far as Dishna City as shown in figure (2).

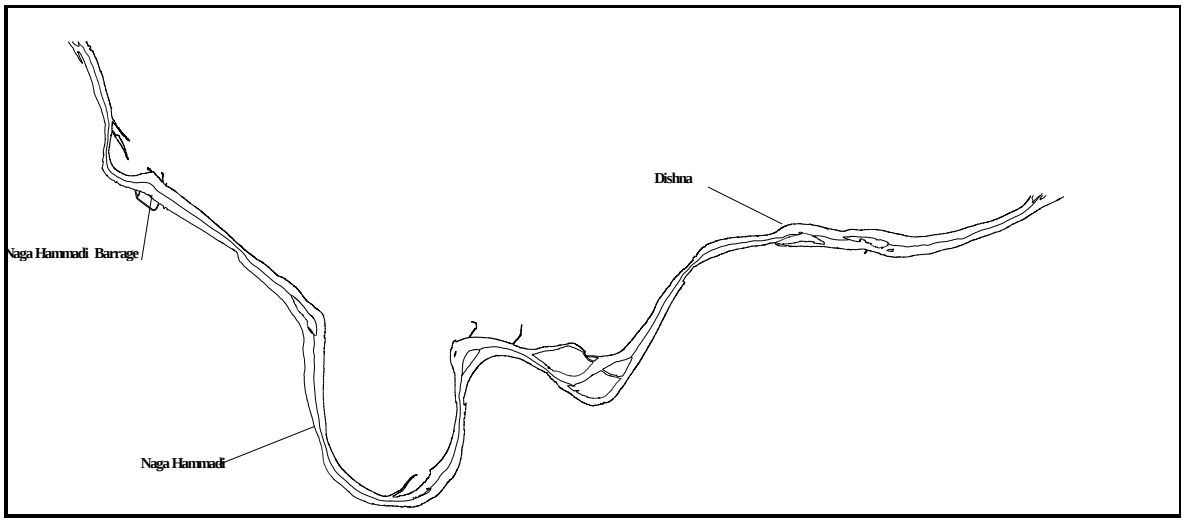

Figure (2) : Study Area which Extended from Naga Hammadi Barrage to Dishna City

OBJECTIVE

The main objective of the study was to map the expected of land to be inundated (flooded) upstream of the existing barrage due to the headpound of the new Naga Hammadi Barrages using actual maximum water levels passing through previse years. The maps produced by the study will be used for reconnaissance surveys of the conditions on riverbanks and islands affected by the new headpond. They will also help in the planning of future mitigation measures and the assessment of necessary compensation.

BACKGROUND

Naga Hammadi Barrages Development Consultants (NHBD) estimated the areas subject to inundation as a result of the higher headpond of the new Naga Hammadi Barrages in the distance from existing barrages to Dishna (49 km) along the Nile River. In this study the water surface profiles generated by a hydraulic model (HEC-2) for two different flow scenarios, winter maximum flow of 1600 m^3/s and summer maximum flow of 2600 m^3/s.The total predicted land loss was given as about

(1400 feddans) during the peak flow. According to some limitations based on the assumptions made in the model and on data input, this study was carried out to predict the flooded areas using actual maximum water made at the gauge stations between Esna and Naga Hammadi for maximum discharges observed downstream Esna Barrages over fifteen years.

DATA COLLECTION AND PROCESSING

1. Topographic Data

The best available topographic data for the river at present is the 1:10000 topographic map series produced in 1987-1979 by Kenting Earth Sciences for the River Nile Institute. These maps offer sufficient terrain information along the river channel to predict the inundated areas.

2. Hydrological Studies

The hydrology of the River Nile below the High Aswan Dam (HAD) has been greatly simplified by the regulation of the reservoir. Actually, all releases are made to meet downstream demands and the amounts are regulated by agreements with upstream users of Nile water.

The hydrological studies include discharges and water levels up and downstream old Naga Hammadi Barrages which were recorded from 1942 to 2000. These historical data are important to define the magnitude and difference before and after HAD construction.

2-1 Discharges

The condition controlling the maximum amount of water that would have to be released at Naga Hammadi Barrage is an emergency condition where the reservoir at HAD would have to be drawn down to relieve the pressure on the dam. This release has been set by MWRI at a maximum of 7000 m^3/s for a headpond level at the barrage of (67.4) m.

Flow downstream Naga Hammadi Barrages is regularly measured at Samata 22 km downstream of the barrage. These measurements are used to maintain up – to date stage – discharge. Curves used to estimate flow on a daily basis. Figure (3) shows a plot of yearly maximum discharge downstream Naga Hammadi during the years from 1942 to 2000.

The striking feature of the maximum flow is the abrupt decrease brought about by construction of HAD. Before 1965, the maximum discharge varied from 8000 to 10000 m^3/s. After 1967, maximum discharge varied from 1620 to 2570 m^3/s.

The magnitude of the release to the River Nile can be controlled under most conditions through operation of the various outlet facilities at the HAD. The main constraint is that the maximum reservoir level must not exceed (183) m. The flood release which is based on a low probability inflow to Lake Nasser with a recurrence interval of 10000 years and also implicit considers the operation of HAD, is considered appropriate the design of new Naga Hammadi Barrages (NHB). During this inflow flood, the discharge downstream would be maintained at a maximum of 5700 m^3/s for headpond level at the barrages of (65, 9) m.

2-2 Water Surface

The analysis was performed on the basis of maximum water levels measurements recorded at the 6 gauge stations upstream NHB (Table 1).

Calculation of water surface profiles along a 177 km reach upstream of Naga Hammadi Barrages to Esna was required in order to assess the extent and magnitude of the backwater influence resulting from the present NHB headpond level, which is (65.40) m during the high flow and the future headpond level of (65.90) m. Actual maximum and minimum water levels upstream NHB for 42 years from 1963 to 2004 which presented in Table 2 was applied for this purpose.

Table 2 illustrates that the maximum water level upstream NHB was (67.85) m at 18 and 19 of September in 1963 and dropped to (66.65) m in 1967 which continued for 9 days from 24 October to first of November before the operation of High Aswan Dam.

After the operation of the High Aswan Dam (HAD) for 36 years from 1968 to 2004, the maximum water level observed at upstream of NHB was (65.90) m in 1979 and continued for 16 days from 30 June to 15 July.

The maximum water level measurements, which is (65.85) m was obtained through 1990, 1991, 1992 and 1993. This water level continued for 38 days from 24 June to the end of July in 1990 and continued 6 days in 1991 in the period form 27 June to 2July. During 1992 it continued for 12 days from 18 to 29 June. Finally in 1993 the maximum water level (65.85) m was measured for 33 days from 29 May to the end of June.

Through the period from 1994 to 2004, the maximum water level upstream Naga Hammadi Barrage was (65.70) m in 1997 decreased to (65.37) m in 2004.

It can be concluded that the maximum water level (65.85) m was obtained for a long period enough to effect the water surface profile along the reach upstream Naga Hammadi Barrage.

RESULTS AND DISCUSSION

1. Area Affected

Accurate water surface profile was derived upstream Naga Hammadi Barrages with a headpond level of (65.85) m to asses the impact of New Naga Hammadi Barrages.

To estimate the affected land on river islands and riverbanks due to the higher headpond of the new barrages, the water levels transferred to 1:10000 maps prepared during the study, covering the river reach between the upstream existing barrage and Dishna City (49 km) as shown in figure (4).

The total predicted affected land will be about 1486 feddans, made up of both swamp and dry land as shown in table (3).

2. The Management Lines

The Management Lines provide a tool for the protection of the Nile and the control of all development along its banks. However, to make protection of important areas and development meaningful, a long-term strategy for the entire river is needed and any short-term plans should not conflict with long term plans.

Management Lines comprise two components, namely ***river channel lines*** which correspond to the conveyance section required to discharge the peak irrigation release from the HAD as stipulated by the MWRI (3000 m^3/s), and **terrace *lines*** which convey the peak emergency release from the HAD (7000 m^3/s).The latter corresponds approximately to the old Nile flood plain and therefore will vary from these only where morphological changes such as erosion force their deviation in a landward direction. In effect, the definition of management lines creates three classes of land:

(i) areas outside the boundary of the terrace lines which are normally not within the control of the MWRI.

(ii) land between the river channel and terrace lines which could be released for low intensity use such as lowland agriculture, fish farming, temporary structures, and recreational activities.

(iii) land inside the river channel lines which should normally be held by the Government with its use only permitted after exhaustive study by the MWRI.

In this study, the establishment of the management lines (channel and terrace lines) for the reach between Esna and Naga Hammadi Barrages was based on the water surface profiles related to discharges of 259.2 $m.m^3/d$ and 350 $m.m^3/d$ which is considered as the emergency future discharge. The water levels based on these discharges were determined along the area study. Figure (5) illustrates the water levels corresponding

to the future maximum discharge and the observed maximum discharge which is released in previous years. Also the graph shows the water levels according to the consultant study. From the graph, the water levels based on the observed maximum discharge which are the same as to the operation water levels for the New Barrages are located under the water levels which related to the maximum future discharge. This means that the inundated land (about 1446 feddans) located between channel line and the line corresponding to the discharge of 350 $m.m^3/d$. The MWRI has the responsibility to control all development within the area defined by these two lines which could be released for low intensity use such as lowland agriculture, fish farming, temporary structures, and recreational activities.

CONCLUSIONS

Naga Hammadi Barrages Development Consultants (NHBD) study was revised during this paper.

The estimated areas subjected to inundation as a result of the higher headpond of the new Naga Hammadi Barrages were evaluated according to the actual measured water levels values.

These areas were verified and their status regarding river management lines were determined.

An area of about 1486 feddans was considered to be flooded after the operation of the new Naga Hammadi Barrages, and the status of these areas is defined to be within the river terrace lines in the distance from existing barragse to Dishna (49 km) along the Nile River. The MWRI has the responsibility to control all development within the area defined by these two lines which could be released for low intensity use such as lowland agriculture, fish farming, temporary structures, and recreational activities.

Table (1): Actual maximum and minimum water levels upstream NHB for 42 years from 1963 to 2004

No.	Year	Maximum water levels (m)	Minimum water levels (m)	No.	Year	Maximum water levels (m)	Minimum water levels (m)
1	1963	67.85	61.87	22	1984	65.60	63.30
2	1964	67.73	63.00	23	1985	65.80	63.30
3	1965	67.35	63.85	24	1986	65.80	65.00
4	1966	65.50	63.08	25	1987	65.80	63.00
5	1967	66.65	63.10	26	1988	65.65	63.57
6	1968	65.35	63.25	27	1989	65.85	64.35
7	1969	65.40	63.20	28	1990	65.85	64.50
8	1970	65.40	63.50	29	1991	65.85	64.50
9	1971	65.50	64.07	30	1992	65.85	64.50
10	1972	65.50	63.80	31	1993	65.85	63.00
11	1973	65.55	63.50	32	1994	65.45	63.30
12	1974	65.50	63.90	33	1995	65.40	63.50
13	1975	65.48	63.80	34	1996	65.40	63.50
14	1976	65.50	63.50	35	1997	65.70	63.50
15	1977	65.60	63.60	36	1998	65.45	64.80
16	1978	65.60	63.50	37	1999	65.40	65.00
17	1979	65.90	63.00	38	2000	65.40	65.00
18	1980	65.80	63.00	39	2001	65.40	65.00
19	1981	65.50	63.00	40	2002	65.40	64.40
20	1982	65.80	63.00	41	2003	65.37	64.50
21	1983	65.80	63.00	42	2004	65.50	64.60

Table (2): Maximum water levels and water levels for Q = 350 m m^3/d in the Distance from upstream Naga Hammadi to Downstream Esna Barrages

Gage Name	km from Rode	km from Aswan Dam	Max water level (m)	Water level at Q= 350 m.m^3/d (m)
Qena 6/1/1993	640.3	286.7	68.80	70.34
	639	288	68.74	70.27
	638	289	68.69	70.22
	637	290	68.65	70.17
	636	291	68.60	70.12
	635	292	68.56	70.07
	634	293	68.51	70.02
	633	294	68.47	69.97
	632	295	68.42	69.92
	631	296	68.37	69.87
	630	297	68.33	69.82
	629	298	68.28	69.77
	628	299	68.24	69.72
	627	300	68.19	69.67
	626	301	68.15	69.62
	625	302	68.10	69.57
	624	303	68.05	69.52
	623	304	68.01	69.47
	622	305	67.96	69.41
	621	306	67.92	69.36
	620	307	67.87	69.31
	619	308	67.82	69.26
	618	309	67.78	69.21
	617	310	67.73	69.16
	616	311	67.69	69.11
	615	312	67.64	69.06
	614	313	67.60	69.01
	613	314	67.55	68.96
	612	315	67.50	68.91
	611	316	67.46	68.86
	610	317	67.41	68.81
	609	318	67.37	68.76
	608	319	67.32	68.71
	607	320	67.28	68.66
	606	321	67.23	68.61
	605	322	67.18	68.56
	604	323	67.14	68.50
	603	324	67.09	68.45

Table (2) Continued: Maximum water levels and water levels for Q = 350 m m^3/d upstream NHB

Gage Name	km from Rode	km from Aswan Dam	Max water level (m)	Water level at Q = 350 m.m^3/d (m)
	602	325	67.05	68.40
	601	326	67.00	68.35
	600	327	66.95	68.30
	599	328	66.91	68.25
	598	329	66.86	68.20
	597	330	66.82	68.15
	596	331	66.77	68.10
	595	332	66.73	68.05
El Taref 6/1/1993	594	333	66.68	68.01
	593	334	66.65	67.96
	592	335	66.62	67.92
	591	336	66.58	67.88
	590	337	66.55	67.84
	589	338	66.52	67.79
	588	339	66.49	67.75
	587	340	66.46	67.71
	586	341	66.42	67.66
	585	342	66.39	67.62
	584	343	66.36	67.58
	583	344	66.33	67.53
	582	345	66.30	67.49
	581	346	66.26	67.45
Naga Hammadi 7/1/1990	580.55	346.45	66.25	67.43
	579	348	66.20	67.36
	578	349	66.17	67.32
	577	350	66.14	67.28
	576	351	66.11	67.23
	575	352	66.08	67.19
	574	353	66.05	67.15
	573	354	66.02	67.11
	572	355	65.99	67.06
	571	356	65.96	67.02
	570	357	65.93	66.98
	569	358	65.90	66.93
	568	359	65.86	66.89
U.S Naga Hammadi 5/1/1993	567.52	359.48	65.85	66.87

Table (3): Predicted affected land on Riverbanks and Islands in the Study Area (Between existing barrages km 567.5 and river km 616.8)

	Area of Islands (m^2)	Area Left Bank (m^2)	Area Right Bank (m^2)	Total area (m^2)
	690599.70	53542.15	60018.03	
	134215.53	234880.19	54105.90	
	303849.75	105235.78		
	195013.15	173888.40		
	553986.54	12593.05		
	7054.71	400084.02		
	414473.86	30602.02		
	232582.47			
	1183684.96			
	126320.73			
	1200729.74			
Sum (m^2)	**5042511.14**	**1010825.62**	**114123.93**	**6167460.69**
Total area = 6167460.69 (m^2) = 1468.44 (feddans)				

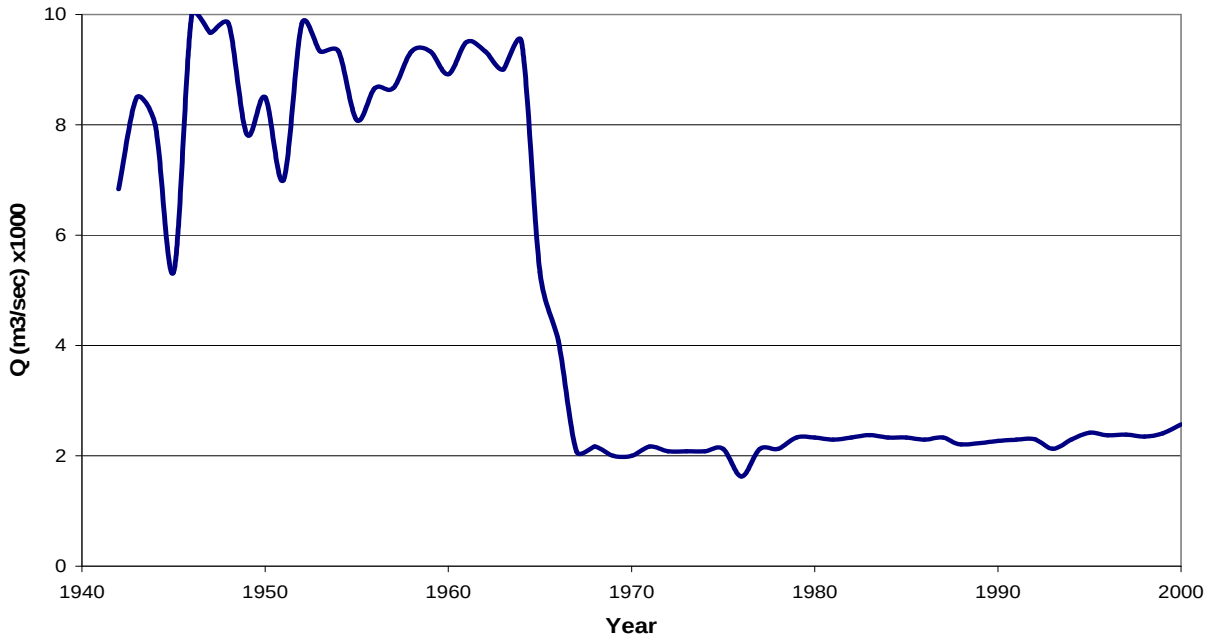

Figure (3): yearly maximum discharge downstream Naga Hammadi during the years from 1942 to 2000

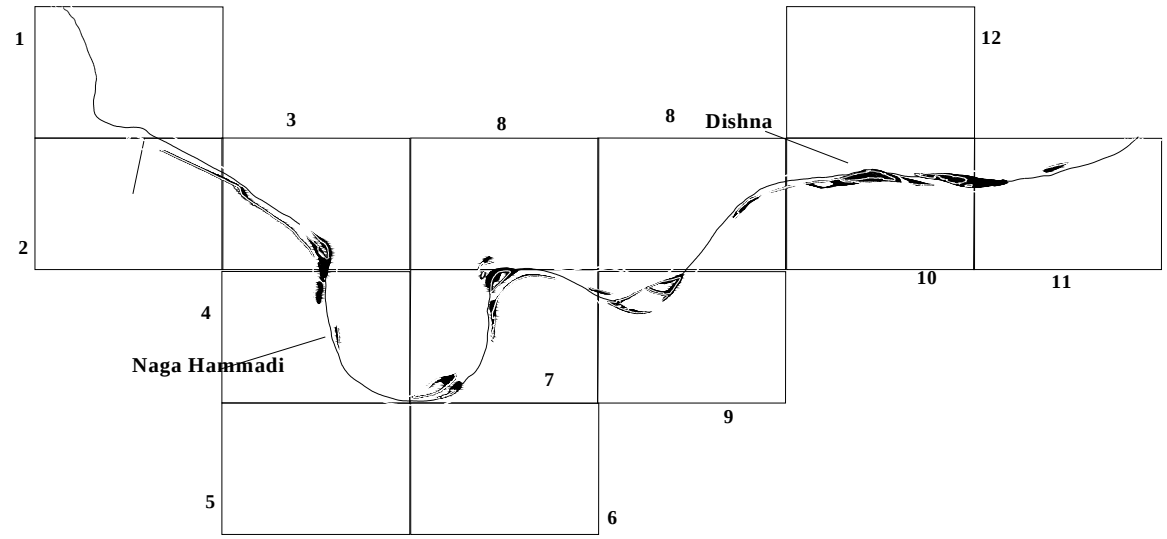

Figure (4): Flooded area upstream old Naga Hammadi Barrages

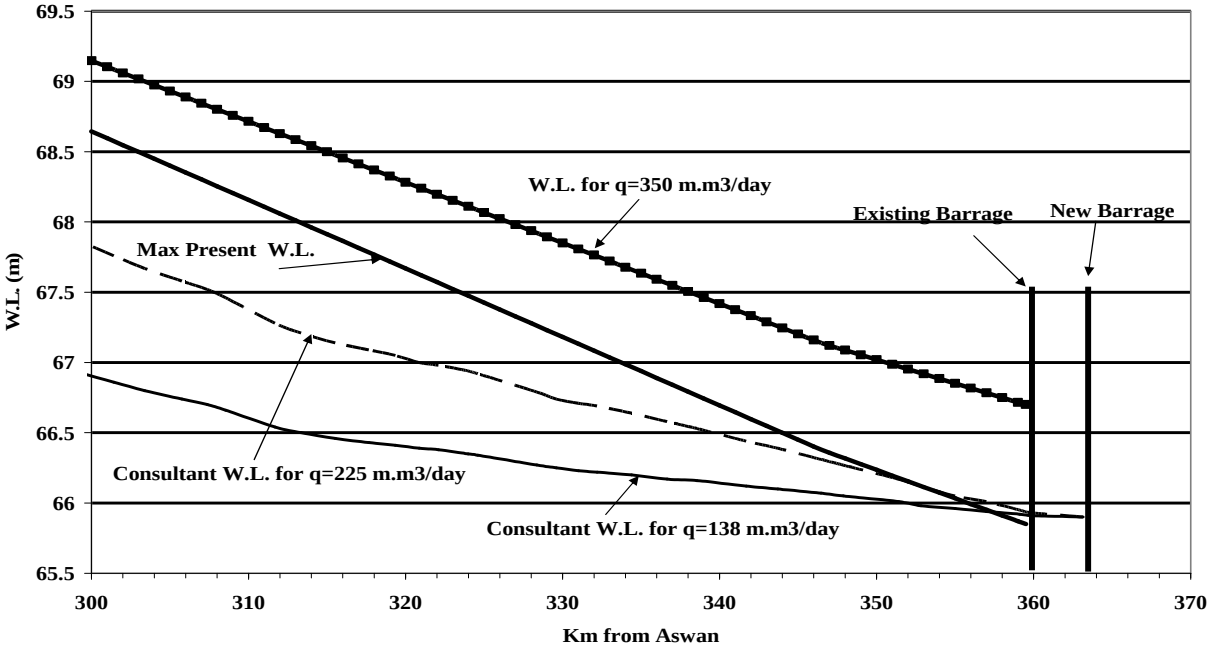

Figure (5): Maximum present water level, Consultant water levels and water level corresponding to the future discharge 350 m.m^3/d upstream old Naga Hammadi Barrages