15 –ാം കേരള നിയമസഭ

3 –ാം സമ്മേളനം

നക്ഷത്ര ചിഹ്നം ഇല്ലാത്ത ചോദ്യം നം. 6094 **09-11-2021 - ൽ മറുപടിയ്ക്ക്**

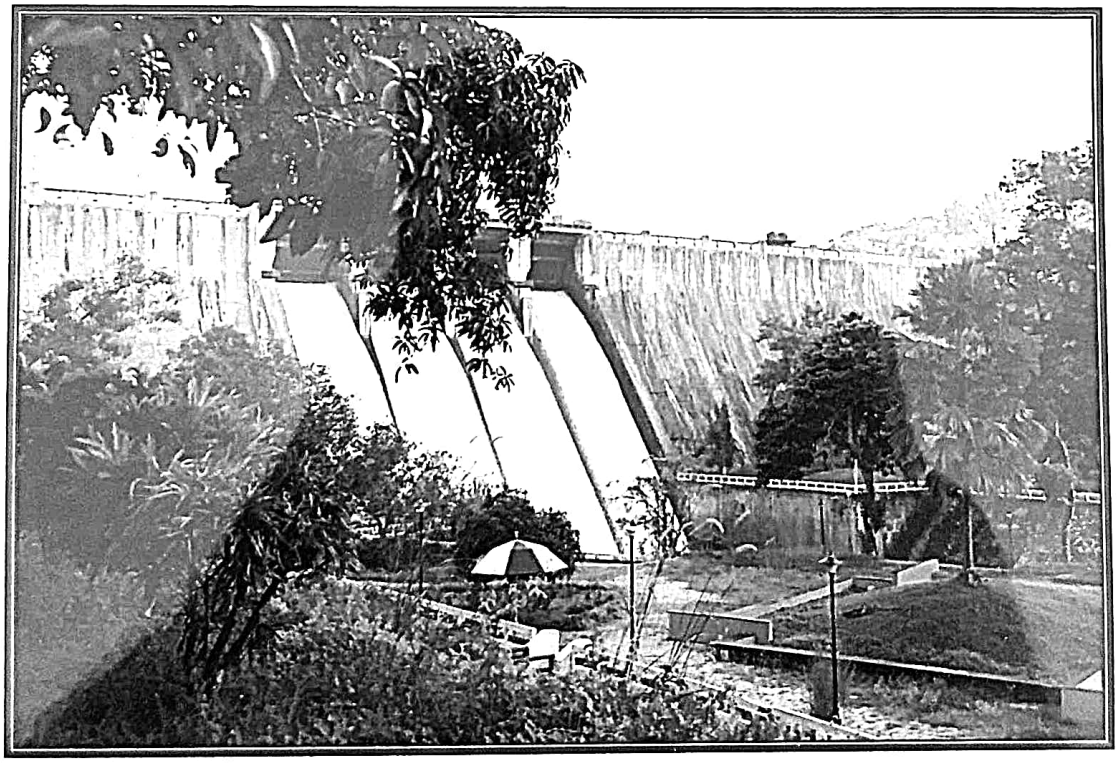
നെയ്യാർഡാമിൽ സംഭരണ ശേഷിയെ ബാധിക്കുന്ന കാര്യങ്ങൾ

ചോദ്യം		ഉത്തരം	
ശ്രീ സി കെ ഹരീന്ദ്രൻ		**Shri Roshy Augustine** **(ജലവിഭവ വകുപ്പ് മന്ത്രി)**	
(എ)	നെയ്യാർഡാമിൽ അടിഞ്ഞുകൂടിയിട്ടുള്ള മണലും എക്കലും നീക്കം ചെയ്യുന്നതിന് പദ്ധതിയുണ്ടോയെന്നും ഇത് സംബന്ധിച്ച് പഠനം നടത്തിയിട്ടുണ്ടോയെന്നും വ്യക്തമാക്കാമോ; ഉണ്ടെങ്കിൽ പഠന റിപ്പോർട്ടിന്റെ പകർപ്പ് ലഭ്യമാക്കാമോ;	(എ)	നെയ്യാർഡാമിൽ അടിഞ്ഞുകൂടിയിട്ടുള്ള മണലിന്റെയും എക്കലിന്റെയും അളവു പരിശോധിക്കുന്നതിനായി KERI പീച്ചി മുഖാന്തിരം 2019ൽ പഠനം നടത്തിയിരുന്നു. പ്രസ്തുത പഠന റിപ്പോർട്ട് അനുബന്ധമായി ചേർക്കുന്നു.
(ബി)	നെയ്യാർഡാമിന് സമീപമുള്ള റോഡ് പാർശ്വഭിത്തി തകർന്ന് അപകടാവസ്ഥയിലായ വിവരം ശ്രദ്ധയിൽപ്പെട്ടിട്ടുണ്ടോ; ആയത് വശങ്ങൾ കെട്ടി സംരക്ഷിക്കുന്നതിനുള്ള നടപടികൾ സ്വീകരിച്ചിട്ടുണ്ടോ; വിശദാംശം അറിയിക്കാമോ?	(ബി)	ഉണ്ട്. പ്രസ്തുത പ്രവൃത്തിയ്ക്കായുള്ള ടെണ്ടർ നടപടികൾ സ്വീകരിച്ചു വരുന്നു.

സെക്ഷൻ ഓഫീസർ

Report No.41- KERI / SEDIMENTATION / 10 / 2019

BATHYMETRIC STUDY OF NEYYAR RESERVOIR USING INTEGRATED BATHYMETRIC SYSTEM (IBS) & SUB BOTTOM PROFILER



Kerala Engineering Research Institute, Peechi
2019

EXECUTIVE SUMMARY

The Kerala Engineering Research Institute (KERI) is located at Peechi, Thrissur and it is the main research institute under Kerala State Irrigation Department. This institute takes studies and research works in the field of Civil Engineering for the State Government, Quasi Government Institutions and also for Private Organizations. It also undertakes externally funded research projects.

The Sedimentation Division under this institute conduct the Sedimentation studies of major Dams, rivers, lakes and large water bodies in the state. Related to the investigation on the desiltation of reservoirs, the sedimentation studies have a vital role. This report is the outcome of the sedimentation study conducted in Neyyar Reservoir using Integrated Bathymetry System (IBS) and Sub Bottom Profiler.

Neyyar reservoir is constructed across the river Neyyar, in Thiruvananthapuram Dist. The catchment area of the river above the dam site is 140Sq. km. which is entirely in Kerala state. The project consists of straight gravity type masonry dam with two canal system on either bank to irrigate an area of 15380ha which is distributed in Kerala and Tamilnadu. The maximum storage capacity of the reservoir is 106.188$Mm^3$for the full reservoir level of 84.734m from MSL.

Hydrographic Survey of Neyyar reservoir was initially conducted at WL 83.6 m in the year 2011 using IBS. It had been observed that the reservoir capacity was reduced by 7.374Mm^3 within a period of 47 years. The approximate rate of sedimentation was ***0.16%*** per year. The next study was conducted in 2015 using IBS and Sub Bottom Profiler at the WL 84.75m. The capacity was reduced by 8.843Mm^3at WL 84.75m within a period of 51 years. The capacity reduction rate was estimated as ***0.16%*** per year for 51years.

The present study is conducted at water level 83.5m using IBS and Sub Bottom Profiler. The original storage capacity of the reservoir corresponding to this water level is 95.157 Mm^3. From the IBS study, the present capacity obtained is 83.016 Mm^3, ie the capacity is reduced by 12.141 Mm^3 in 55 years. ie within 55 years of the dam life the capacity reduction rate is ***0.23 %*** per year.

From the previous studies in 2011 and 2015, the capacity corresponding to WL 83.5 m was obtained as 87.408 Mm^3 and 86.253Mm^3respectively. There was a capacity reduction of1.155Mm^3 in four years. Comparing the present study and 2015 study, the

capacity is reduced by 3.237 Mm^3 within the last four years ie the capacity reduction rate is ***0.85%*** ***.There is a huge increase in rate of sedimentation and this is the outcome of the unusual heavy floods occurred in 2018 and 2019. Also, there were huge landslides occurred in the catchment area during the floods.*** The Grain size analysis of 10 nos of disturbed soil samples is conducted. Sediment layer profile of the reservoir area at an interval of 100 m is obtained from the Sub Bottom Profiler.

ACKNOWLEDGEMENT

We express our gratitude to The Executive Engineer, Neyyar Division, Thiruvananthapuram, Asst. Executive Engineer, Asst. Engineer and Staff of, Neyyar Dam Section were particularly helpful for giving inspection Bungalow for staying and storing equipment etc.

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THE SURVEY TEAM

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Sedimentation Study of Neyyar Reservoir Using Integrated Bathymetric System & Sub Bottom Profiler

1.INTRODUCTION

1.0 ABOUT THE INSTITUTE

The Kerala Engineering Research Institute (KERI), Peechi is one of the pioneering research institutions of its kind in our country which plays a vital part in fundamental and applied research studies in the field of Civil Engineering. KERI conducts studies and research in the field of Civil Engineering for the State Government, Quasi Government Institutions and Private Organizations. The institute also has undertaken projects funded by organizations like Central Board of Irrigation and Power (CBIP), Indian National Committee for Hydraulic Research (INCH). Further, KERI is carrying out the investigation on quantity and quality of sediment deposited in various reservoirs all over Kerala. This study has a vital role in the ongoing Desiltation work of reservoirs for the capacity improvement. The Sediment quantity assessment of the reservoirs is carried out by the Sedimentation Division under Hydraulic Research in KERI

Sedimentation Division conducts studies to compute the present capacity of reservoirs and other water bodies. Such studies are conducted using modern electronic method called 'Integrated Bathymetric System' (IBS). In order to ascertain the underwater profile of the sediment layer a modern sophisticated instrument called 'Sub Bottom Profiler' is used. From 2004 onwards, KERI has completed 40 studies using

IBS which includes Mullaperiyar, Kuttiyadi Dam, Malampuzha Dam, Kallada Dam, etc. Sub Bottom profiler was used for 16 of the above studies.

Sedimentation study of Neyyar reservoir was conducted in 2011 and 2015. Now the repeat study of Neyyar reservoir using IBS & Sub bottom profiler has been included in the action plan for 2019-20 in order to assess the effect of the extra ordinary floods occurred in the year 2018 and 2019. The expenditure incurred for the study is Rs.3,50,000/-.

2.OBJECTIVES

- *To quantify or determine the present capacity of Neyyar reservoir using IBS and prepare the present Stage – Capacity curve of the reservoir.*

- *To find the quantity of sediment and it's Distribution in the reservoir using Sub Bottom Profiler.*

- *To observe the influence of the heavy flood in August 2018 and 2019 in the reservoir sedimentation.*

- *Study the soil particle distribution of sediment deposit in the reservoir area.*

APPENDIX - I

NEYYAR PROJECT

SALIENT FEATURES

1.	Name	:	Neyyar
2.	Location		
	Longitude	:	77^0 09"E
	Latitude	:	$8^0$32"N
3.	Year of starting	:	1952
4.	Year of completion	:	1964
5.	Type of Dam	:	Straight Gravity masonry dam
6.	Maximum height of dam	:	50.60 m
7.	Length of Masonry dam	:	294.83 m
8.	Catchment area	:	140.00 Sq.Km.
9.	Maximum Storage	:	106.188 Mm^3
10.	Dead storage	:	10.524 Mm^3
11.	Water spread area	:	9.10 Sq.km.
12.	Full reservoir level	:	84.734m from MSL
13.	Minimum Draw Down level	:	65.00 m
14.	Normal bed level	:	46.93 m
15.	Purpose	:	Irrigation and drinking

3.METHODOLOGY

3.0 RESERVOIR SEDIMENTATION

Reservoir sedimentation is a process of filling of the reservoir behind a dam with sediment carried by the streams. When the water flows from the upstream of catchment, it erodes the catchment area and transports this soil through streams. These sediments will deposit either upstream of the reservoir or in the still water of the reservoir. This will reduce the water holding capacity of the reservoirs.

The nature of the material in the catchment area, the slope of the catchment area and the topography of the streams are the factors influencing the sedimentation. Heavy rainfall falling on erodible material on a steep slope with little ground cover resulting from overgrazing or wildfire is a recipe for substantial sediment transport and significant reservoir sedimentation.

3.1 INTEGRATED BATHYMETRIC SYSTEM

The System

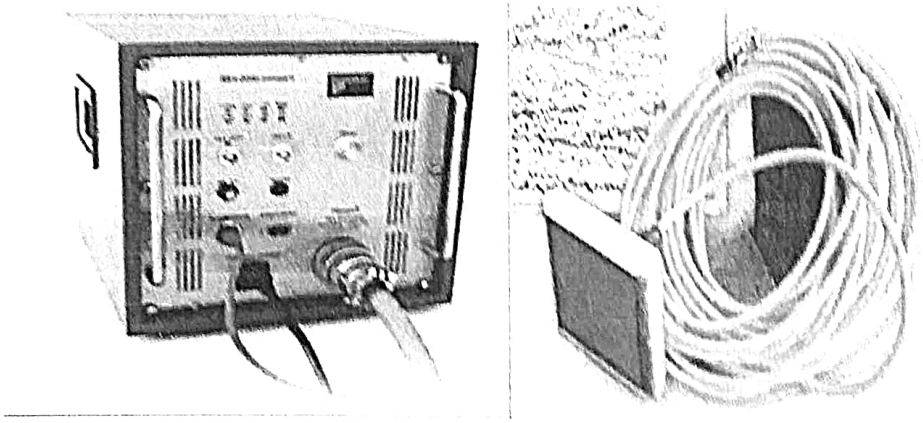
Traditionally reservoir sedimentation has been studied by carrying out bottom topographic survey using boat, sextant, ranging rods, echo-sounder etc. Naturally, this involved lot of time and the outcome was susceptible to human error because of the monotony of work.

Integrated Bathymetric system has been found to be an ideal solution to all the above rigorous work. The system consists of modern sophisticated electronic equipment. Data collection, processing and calculations are done by means of computer software. The results are more accurate than the Conventional survey methods.

3.2 EQUIPMENTS USED

3.2.1 Sub Bottom Profiler

The system SES-2000 sub-bottom profiler, which is a mobile parametric sediment sounder, was used for bathymetric and sub-bottom profiling survey. The SES-2000 hardware component and transducers are shown in plate 1. The compact design with a user-friendly control unit allows the survey even in small and shallow waters with all the advantages of the parametric acoustics. The system offers the possibility to store data digitally and gives reliable results during online data processing. The system is primarily designed for shallow geophysical surveys. The tolerance of the system for 100 kHz frequency is 0.02 m + 0.02% of water depth and for 10 kHz it is 0.04 m + 0.02% of water depth. The compact design without integrated industrial PC components results in an affordable and reliable instrument for sub bottom profiling applications.



Top- side Unit Transducer

Plate 1 Sub Bottom Profiler

Both the primary high frequency (HF) signal (100 kHz) and the secondary low frequency (LF) signal (6–12 kHz) are recorded. Penetration can reach up to 50 m in soft sediments. Advantages of the parametric acoustic system include: (i) narrow beam width at low frequencies; (ii) deep penetration with high resolution of sediment layers and objects and (iii) accurate depth measurements with the high frequency signal. The variant SES-2000 compact is designed for shallow water depth applications near the shore and inland waters down to 400 m.

3.2.2 DGPS SIMRAD MX-610

DGPS MX- 610(refer Plate.2) is highly reliable and it receives correction from a permanent reference station which is approved by Govt. of India, Dept. of Light house and Light ship. It can also track up to 12 satellites to achieve maximum positional accuracy. The received position is transferred to Echo Sounder and Sub Bottom Profiler.

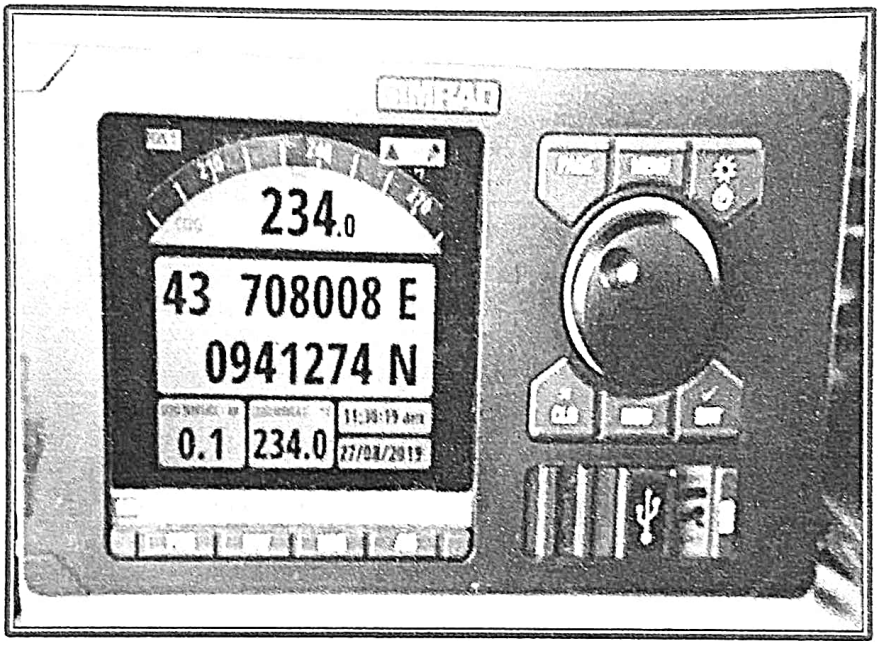


Plate 2. DGPS SIMRAD MX-610

3.2.3 MIDAS Surveyor Echo-sounder

The MIDAS Surveyor is a revolution of small boat survey work with an integral GPS receiver (plate 3). It logs and displays DGPS position data in WGS 84 or Local Grid. This Echo-sounder is designed to measure under water depth up to 1200m. Accuracy of instrument is 1centi meter. A dual frequency echo-sounder is specified to distinguish between fluff top depth and the consolidated bottom. The high frequency (200 KHz) is used to detect the top of the mud/sediment. Under favorable conditions the low frequency signal (33 KHz) can penetrate into the bottom and reveal information about the bottom structure.

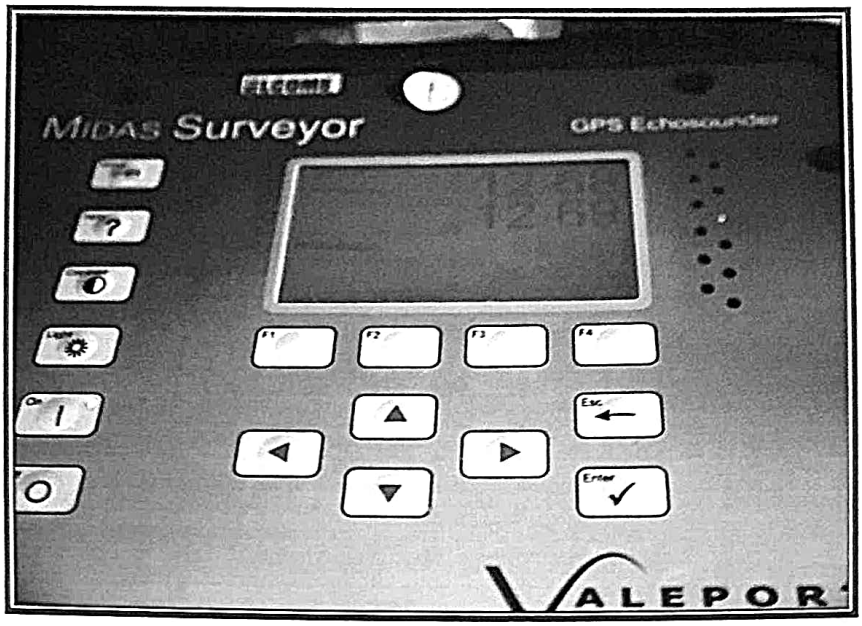


Plate 3. MIDAS Surveyor Echo Sounder

3.2.4 Survey Boat

A Fiber Reinforced Plastic (FRP) boat with two 60 HP petrol out board engines is used as the Survey Boat. The boat has dimension of 7.5mX 2.66mX 1.20m and 8 persons capacity with the equipment. The boat with all the survey equipment is referred as the 'mobile station'. For the power supply, two solar panels of 80Watt each are mounted on the roof of the boat (plate.4).Plate. 5 shows the equipment setup for data collection.

Plate 4. FRP Boat

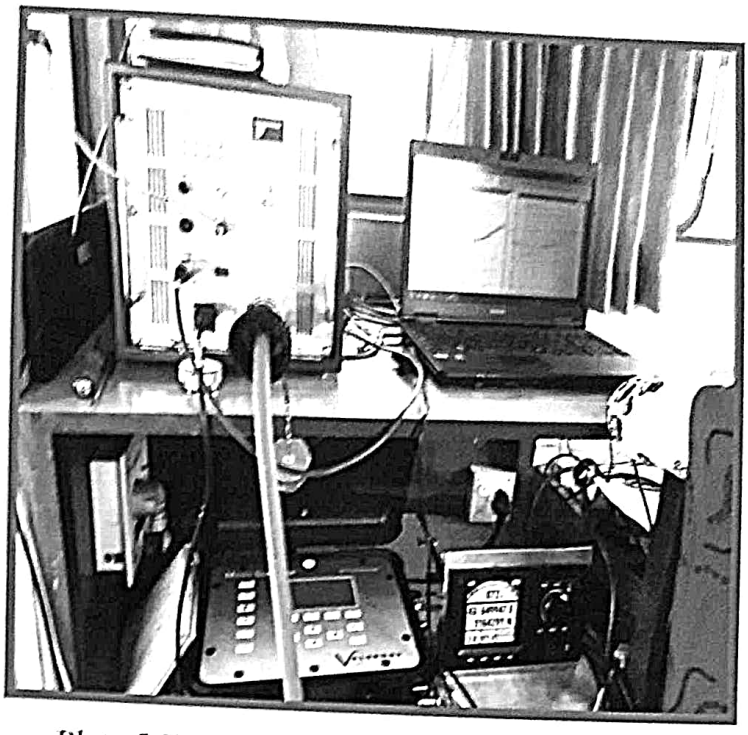


Plate 5 Equipment set up inside the Boat

3.3 LAUNCHING OF BOAT

The survey boat is launched and retrieved with the help of tractor and trailer.

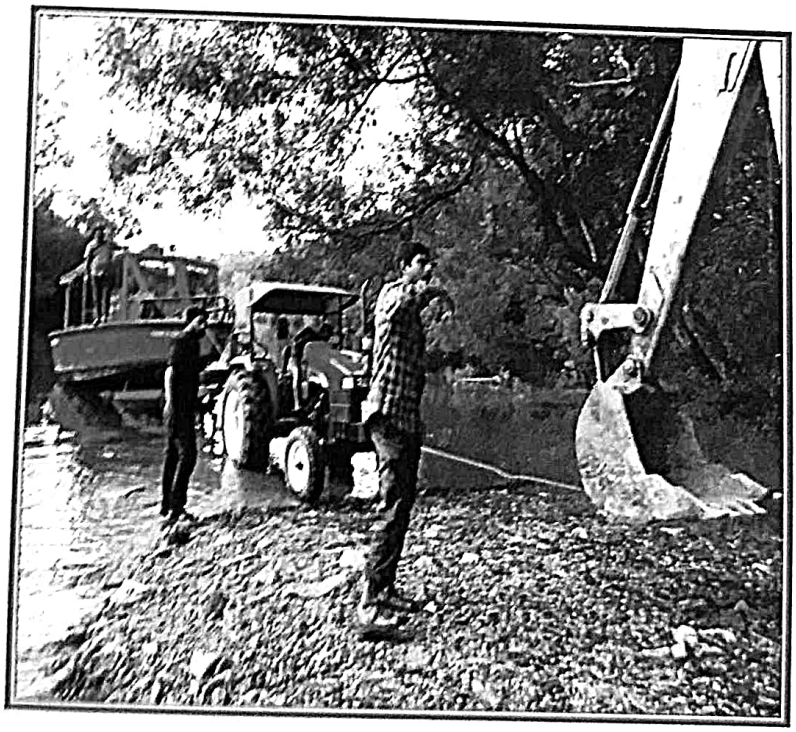


Plate 6 Retrieval of Boat

3.4 SOFTWARE

- **QINSY SOFTWARE**

  This software is used for data collection and processing in IBS survey. The Bathymetric software supports NMEA 0183 compatible devices. Local grid UTM (WGS-84) is the projection supported by this software.

- **SESWIN**

  This software is used for the data collection in Sub Bottom Profiler.

- **I.S.E. 2.9.2**

  This is the post processing software used for analyzing the data collected from sub bottom profiler.

- **Surfer software**

  Surfer is a graphic program used for calculating the volume based on the logged data from the IBS and Sub Bottom Profiler.

3.5 DATA COLLECTION

The mobile station consists of the DGPS and its antenna, Echo sounder, Sub Bottom Profiler and the transducers, etc is mounted on the FRP boat. The transducer of Sub Bottom Profiler is permanently fixed at the center of the boat. The traducer of Echo sounder is connected to the left side of the boat and is detachable. Proper connections are made between this equipment and the laptops for the data collection. The boat is sailed along the planned track with a speed of 3 to 4 knots. The data from the Echo sounder and Sub Bottom Profiler is collected simultaneously through two laptops as shown in Plate 7.

For IBS Survey, the laptop loaded with QINSY survey software is used. There are three modules in the QINSY Software. Data Acquisition, Data Processing and Data export/ import.

The system **SES-2000**(Sediment Echo Sounder)Sub Bottom Profiler is a parametric (non-linear) dual frequency echo sounder. The instrument simultaneously transmits two signals of slightly different high frequencies; their interaction creates a new low frequency signal. It has a large bandwidth and a short signal length, which

allows good use in very shallow water and results a high (~15 – 20 cm) vertical resolution at acceptable sub-bottom penetration up to 10 m or more. Some favourable near sub-bottom seismic and geological conditions permit to achieve a vertical resolution up to 10 cm.

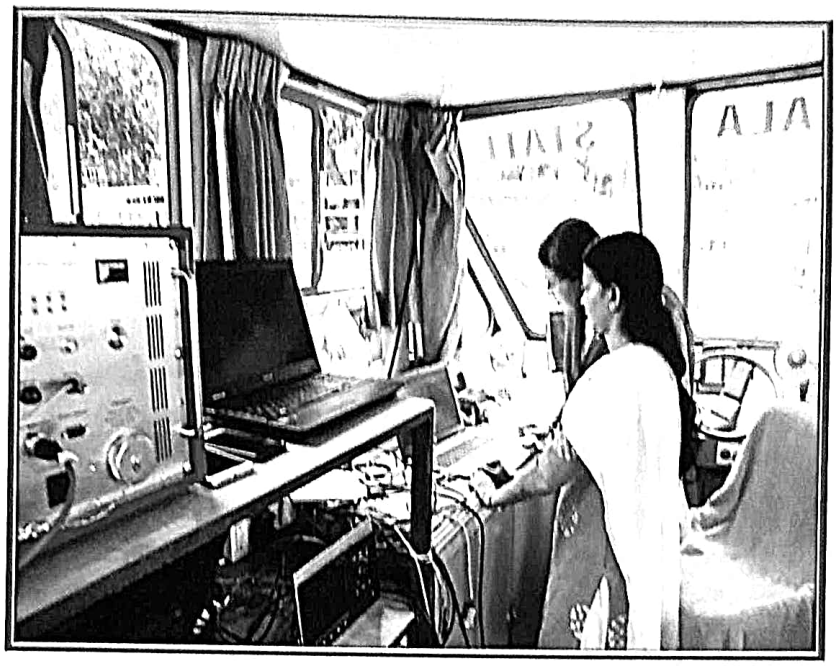


Plate .7 Chart planning for Data collection

Parametric (non-linear) sound generation allows designing acoustical systems with small transducer dimensions and narrow sound beams at low frequencies. An Innomar SES-2000 parametric transducer has an active area of 20 by 20 cm and provides a beam width of less than four degrees (at 3dB), valid for all adjustable low frequencies between 5kHz and 15 kHz. The transmit directivity of the parametric sound beam does not show any significant side lobe characteristic, which reduces ambiguities during the interpretation of individual reflectors. Short transmit signals of single sinusoidal cycles without any ringing and high ping rates of up to 50 pings per second are further advantages. They contribute to a high spatial resolution of this acoustical system and permit to apply it in a shallow basin. Innomar's software tool ISE provides near real-time processing of the collected SES data. The operation procedure can be tuned on-line. A value of the sound velocity in water is used to convert sound travel time to the depth. The depth values are screened online.

4. STUDY AREA

4.0 ABOUT THE STUDY AREA

4.1 Location

The project is situated 31km east of the Thiruvananthapuram city, and then can be reached by a good motor able road. The nearest railway station and airport are at Thiruvananthapuram.

The location map of the area is shown in Fig 4.1

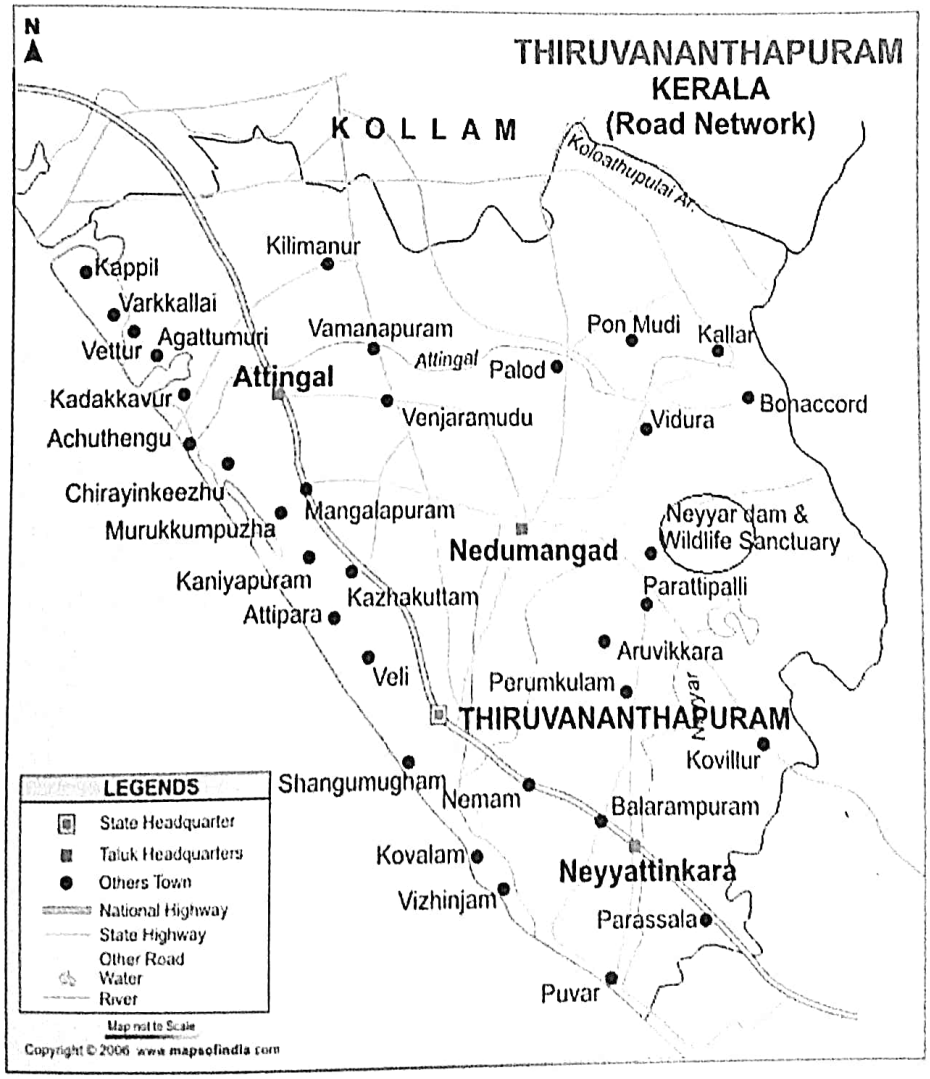


Fig.4.1. Location Map of Neyyar Reservoir

4.2. History of the Project

Neyyar Irrigation Project, one of the commissioned major irrigation project in Kerala, aims at the harnessing the river Neyyar for the purpose of irrigation. This was the first major irrigation project taken up in the erstwhile Travancore- Cochin State, under the first five year plan. The idea of utilizing the water of the river Neyyar for production purpose and long been under the consideration of the Govt. as early as first decade of this country. Originally it was conceived as a hydroelectric power project. But later this idea was abandoned, since it was found to be uneconomical. History of the project was starts with 1937, when the Italian Engineer Omedeo, first proposed that such a scheme was feasible. This project was started in 1951 and partially commissioned in 1964. The whole project is completed in 1973.

4.3. The Neyyar river basin and its Catchment

The river Neyyar is the southernmost river in Kerala State. The project consists of straight gravity type masonry dam across Neyyar River and two canal system on either bank to irrigate an area of 15380ha. Including 3725ha.in TamilNadu.11555ha. of this ayacut lies in southern part of Thiruvananthapuram city. There are two distinct rainfall seasons wise, the south west monsoon and north east monsoon. Precipitation and temperature play an important role of cultivation of the Command Area.

The catchment area consists of mainly of reserve forest. But it is seen that a lot of unauthorized persons are staying in the catchment area and are cultivating. The extent of such cultivation is reported to be about 400ha. Further about 200ha. Consisting of seven hill tribes and these areas are also being cultivated. The rest of the area is being reserve forest.

The main reason for sedimentation is the unauthorized cultivation of catchment area and also due to various hydro meteorological factors such as intensity of rainfall, temperature etc.

5. HYDROGRAPHIC SURVEY

5.0 SURVEY PROCEDURE

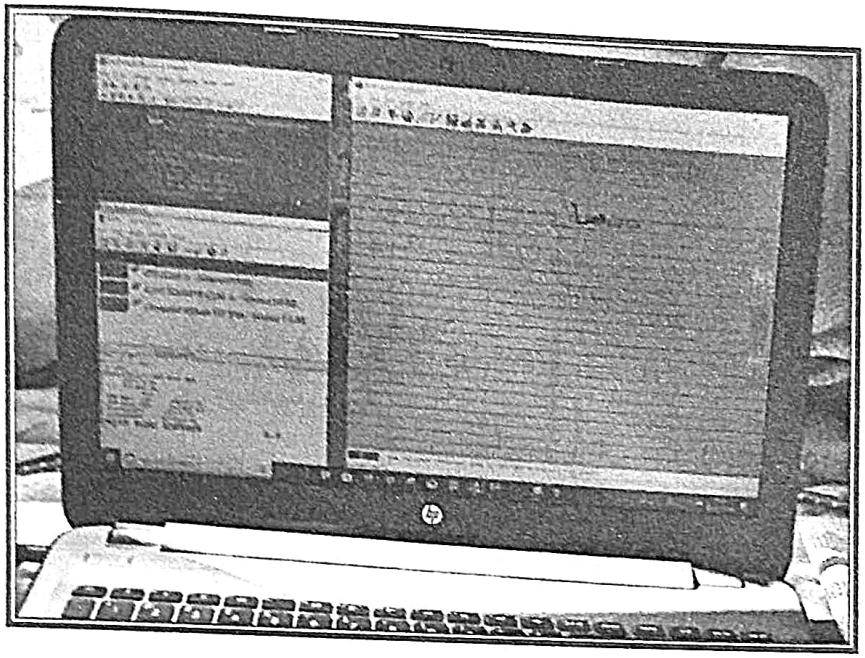


Fig.5.1 Data Acquisition in QINSY

By using the QINSY software chart is prepared by taking UTM (Universal Transverse Mercator: -A special transverse Mercator grid which divides the world in to 6^{0} zones of Longitude.) co-ordinate of two points for drawing a reference line which extend up to the boundary of the reservoir area. With these coordinates of two points reference line is drawn. Segment lines are drawn parallel to this reference line at an interval of 75cm such that the entire reservoir area can be covered.

The survey was conducted along the predetermined segment lines after setting the data logging software to record the data from the Echo Sounder at 2m intervals. The boat was sailed along the track maintaining a speed of 3 to 4 knots. The depth of water and its corresponding position is recorded simultaneously at each point. The software enables generation of depth profile and overviews using the data recorded (Fig.5.1).

The data is then edited to eliminate spurious readings caused due to violent winds and waves using the data processor in QINSY. (Fig.5.2)

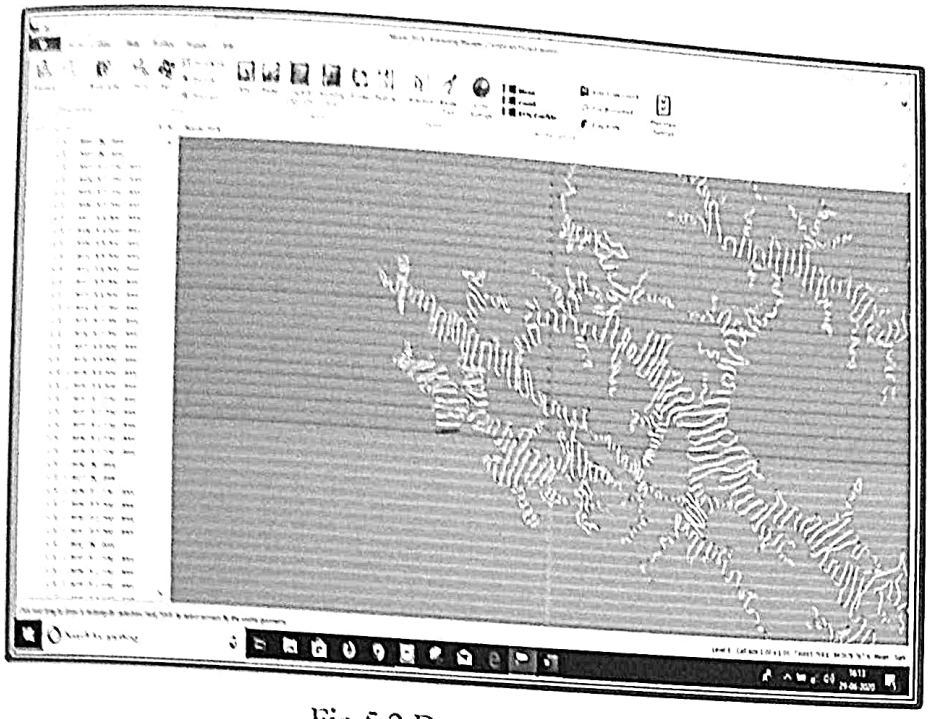


Fig.5.2 Data processing

All the validated data (fig.5.3) are exported using Data Export program and it is processed in Surfer Software. This exported data converts into grid data by triangulation with linear interpolation method.

Using the grid data contour maps are drawn and volume is calculated at specified intervals.

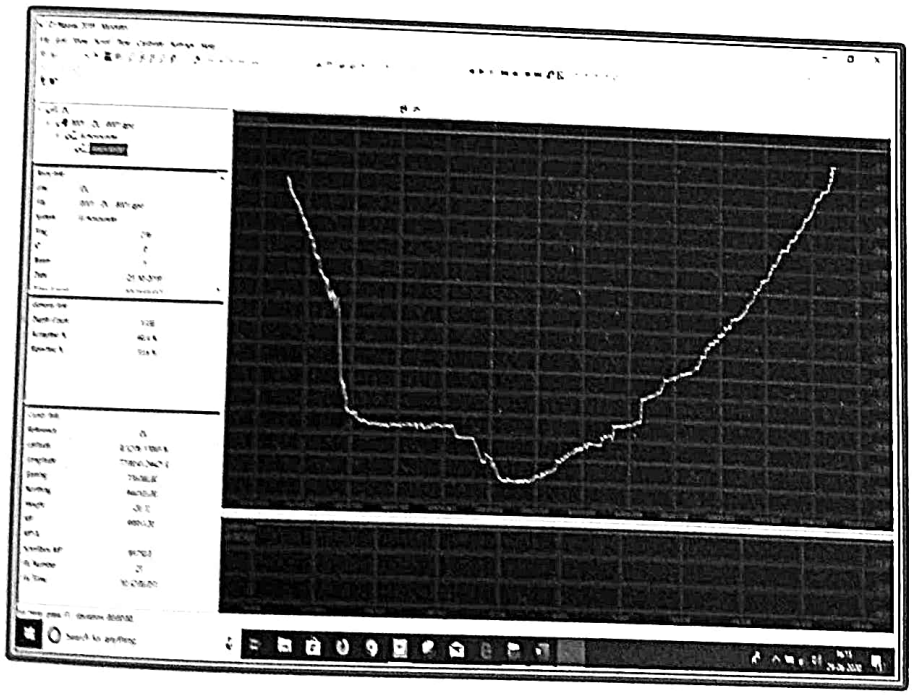


Fig.5.3 Data Validation in QINSY

During the same time of HBS Survey, the data from the Sub Bottom Profiler, connected to the GPS was acquired through the SESWIN software. The continuous bottom profile of the survey line obtained at the time of survey itself as shown in Fig.5.4

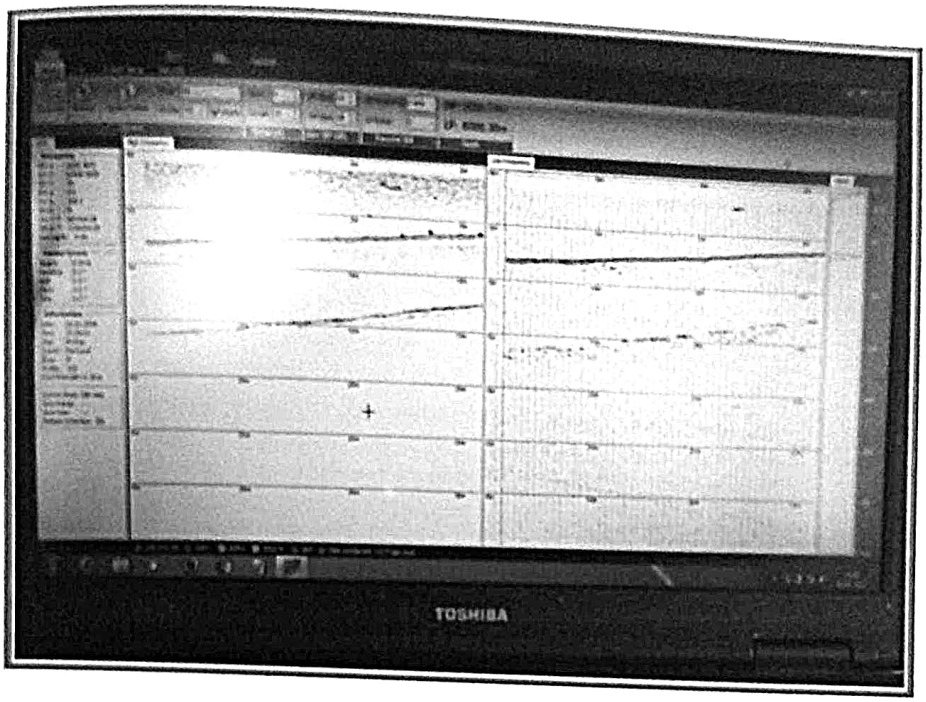


Fig.5.4 Data Collection in Sub Bottom Profiler

The figure.5.5 shows the plan of the survey lines covering the whole area of Neyyar reservoir.

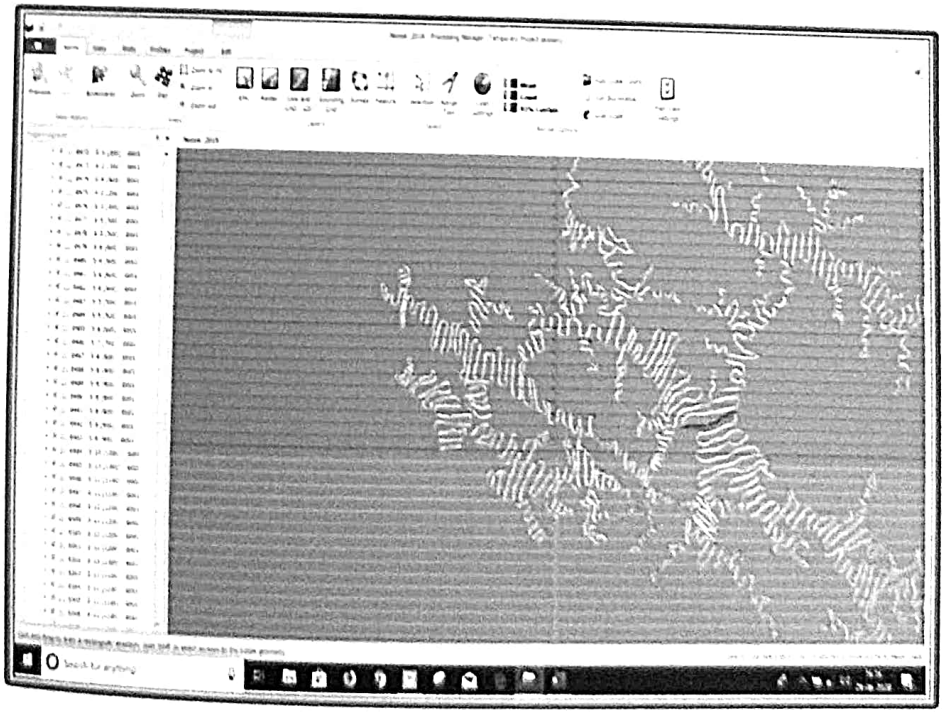


Fig.5.5 Plan of Neyyar Reservoir showing sections surveyed

One typical survey line 1-1 is marked in the above figure. The cross-sectional details of the above line obtained from the HRI and Hub Bottom Profiler are shown in following figures 5.6 and 5.7.

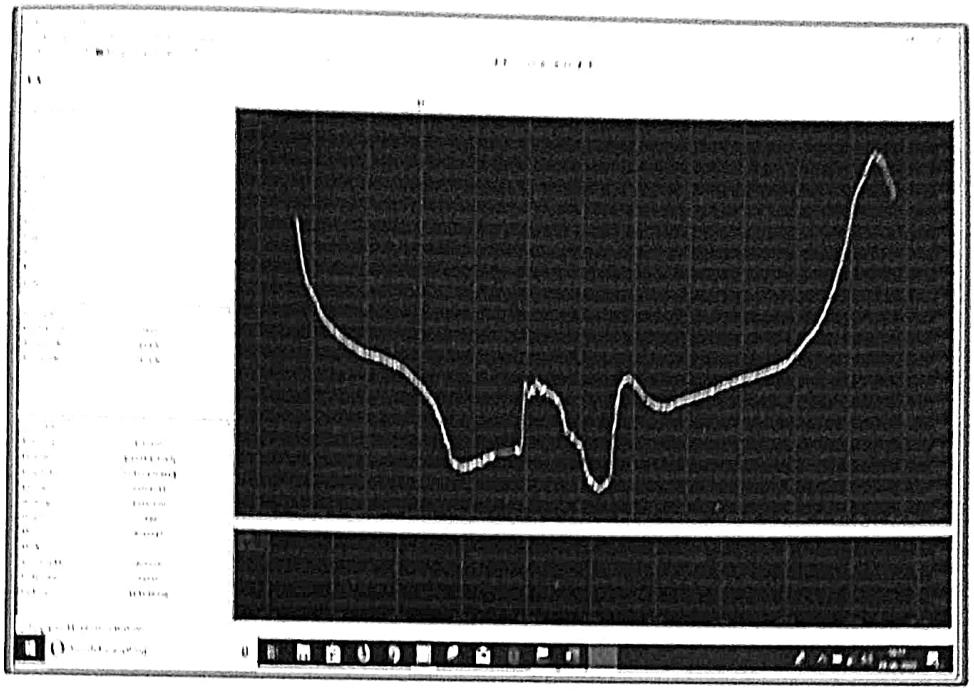


Fig.5. 6 Profile 1-1 in HBS {(E 739207.446, N 944447.769) (E 738671.357, N 944318.386)}

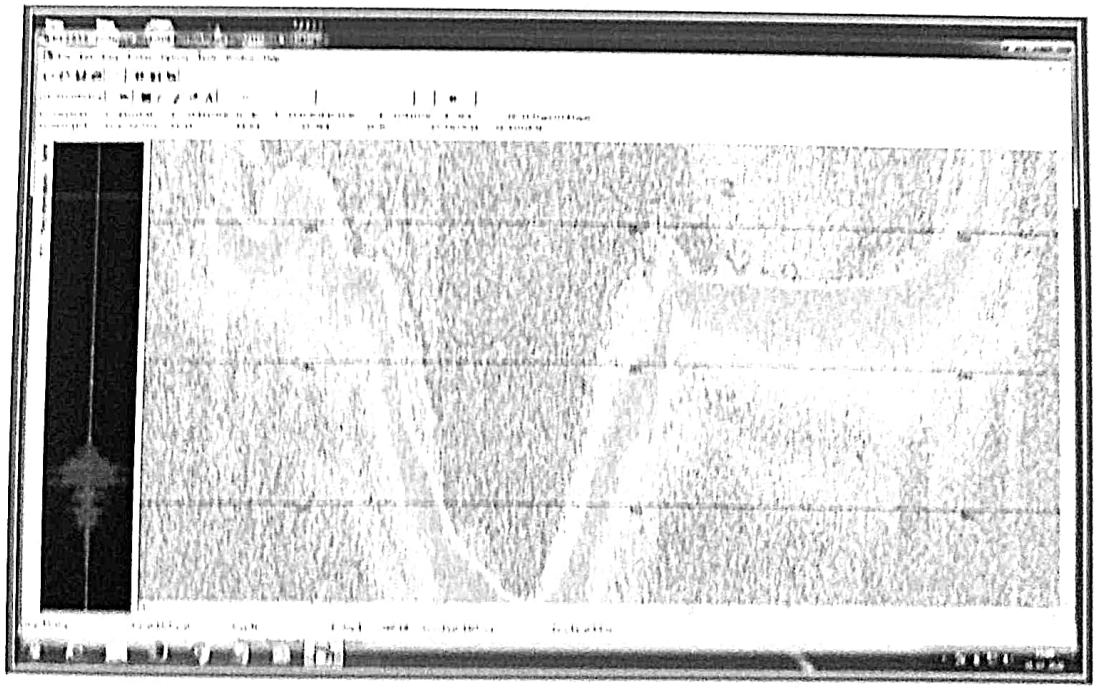


Fig.5. 7 Profile 1-1 in SBP{(E 739207.446, N944447.769) (E 738671.357, N 944318.386)}

The reservoir area map digitized from the IBS data in Surfer software is shown in fig.5.8.

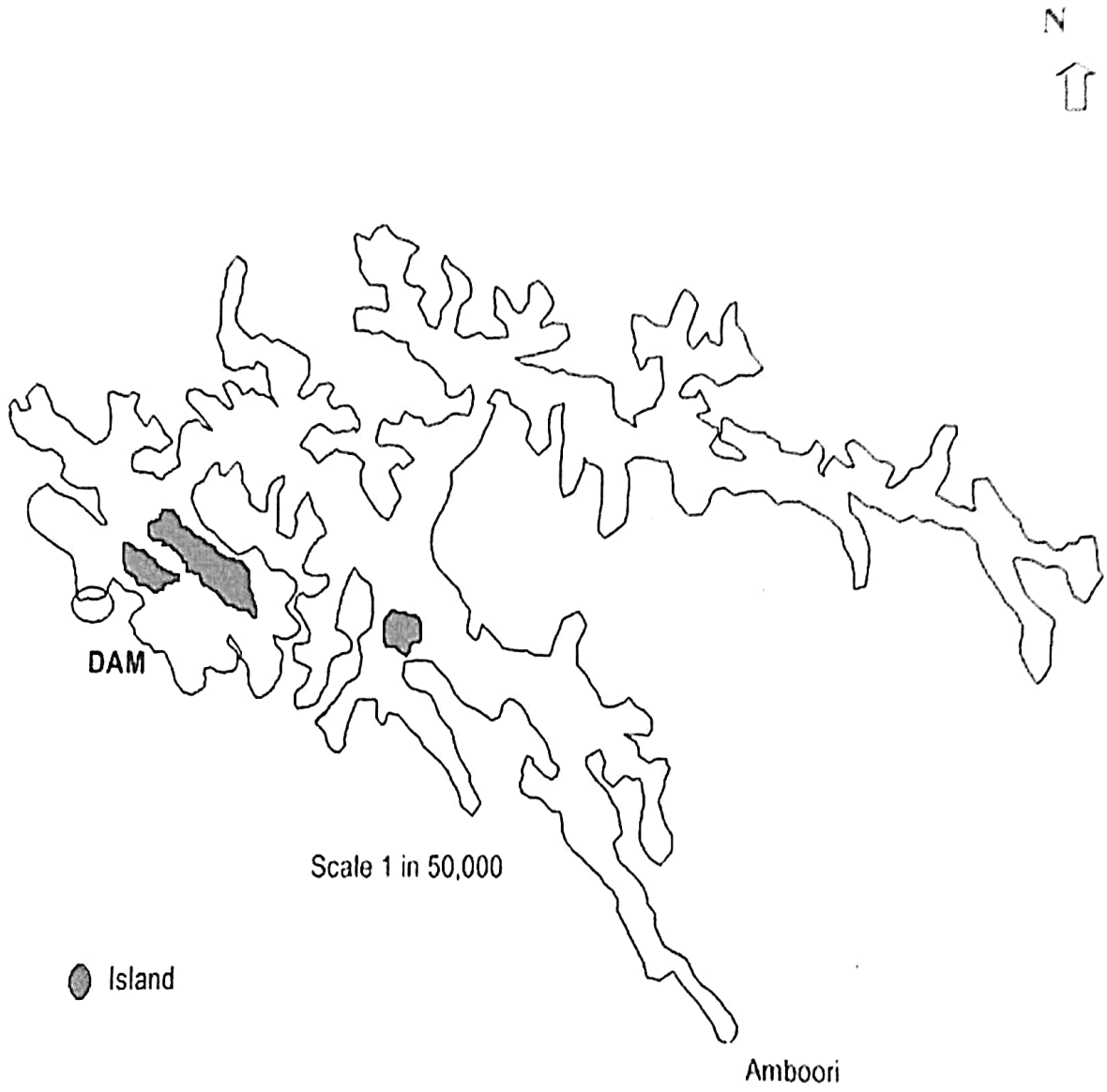


Fig.5. 8 Water spread area of Neyyar Reservoir (Surveyed Portion)

6. ESTIMATION OF CAPACITY

6.0 ESTIMATION OF CAPACITY

The survey is carried out at water level of 83.5 m. The original water holding capacity at this level is 95.157Mm^3. As per the current IBS study the volume at the same level is estimated as 83.016Mm^{3}and the corresponding water spread area is 9.03 Sq.km. Total capacity reduction of the reservoir is 12.141 Mm^{3}in 45 years, i.e. the reduction in capacity at the specified level is 12.76%. The capacity reduction is due to the presence of sediment deposit. In the previous studies conducted in 2011 and 2015, the reservoir capacity corresponding to this level was 87.408Mm^3&86.253Mm^3 and water spread area was 9.43Sq.km & 7.87Sq.km respectively.

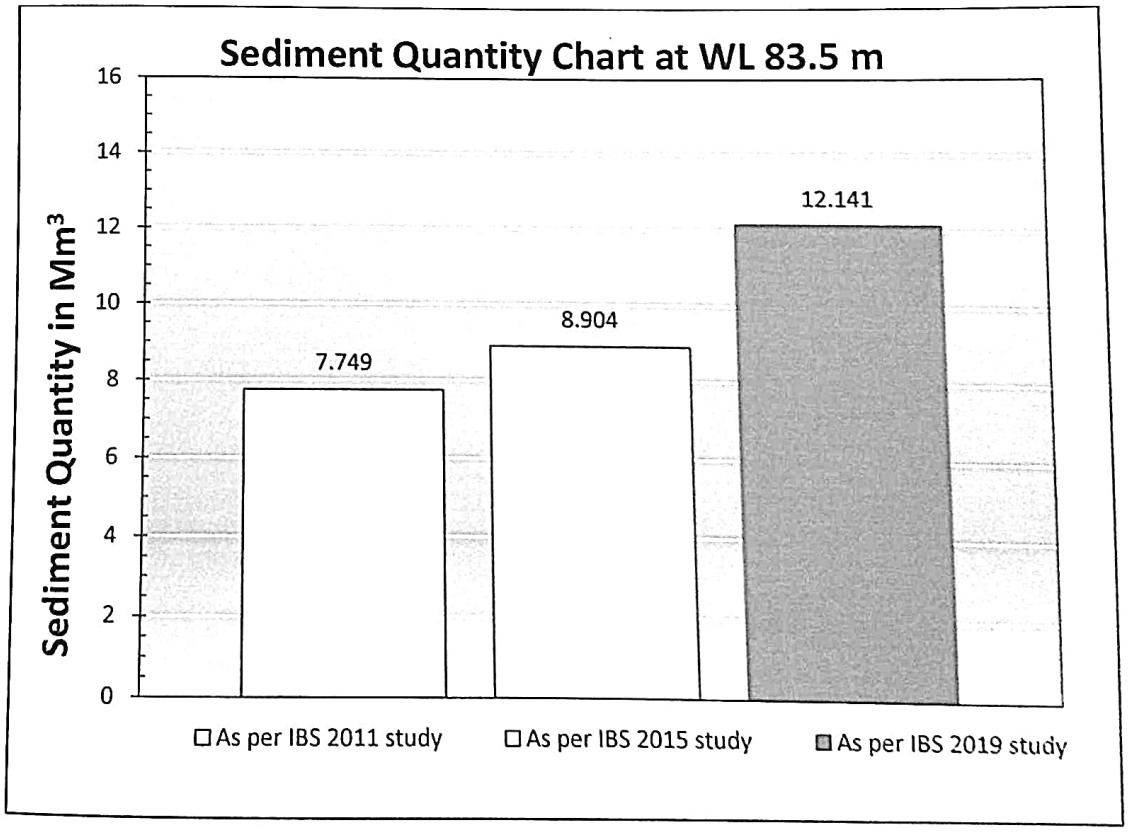


Fig.6.1 Increase in Sediment quantity

Table 6.1 shows the comparison in capacity of the reservoir between the three consecutive studies conducted in 2011, 2015 and 2019 and Fig 6.1 shows its graphical representation.

Table 6.1 Capacity reduction of the reservoir at WL 83.5 m

Year of Study	Capacity	Reduction in Capacity w.r.t Original Volume (95.157 Mm^3)	
		In Mm^3	In Percentage
2011	87.408	7.749	8.14
2015	86.253	8.904	9.36
2019	83.016	12.141	12.76

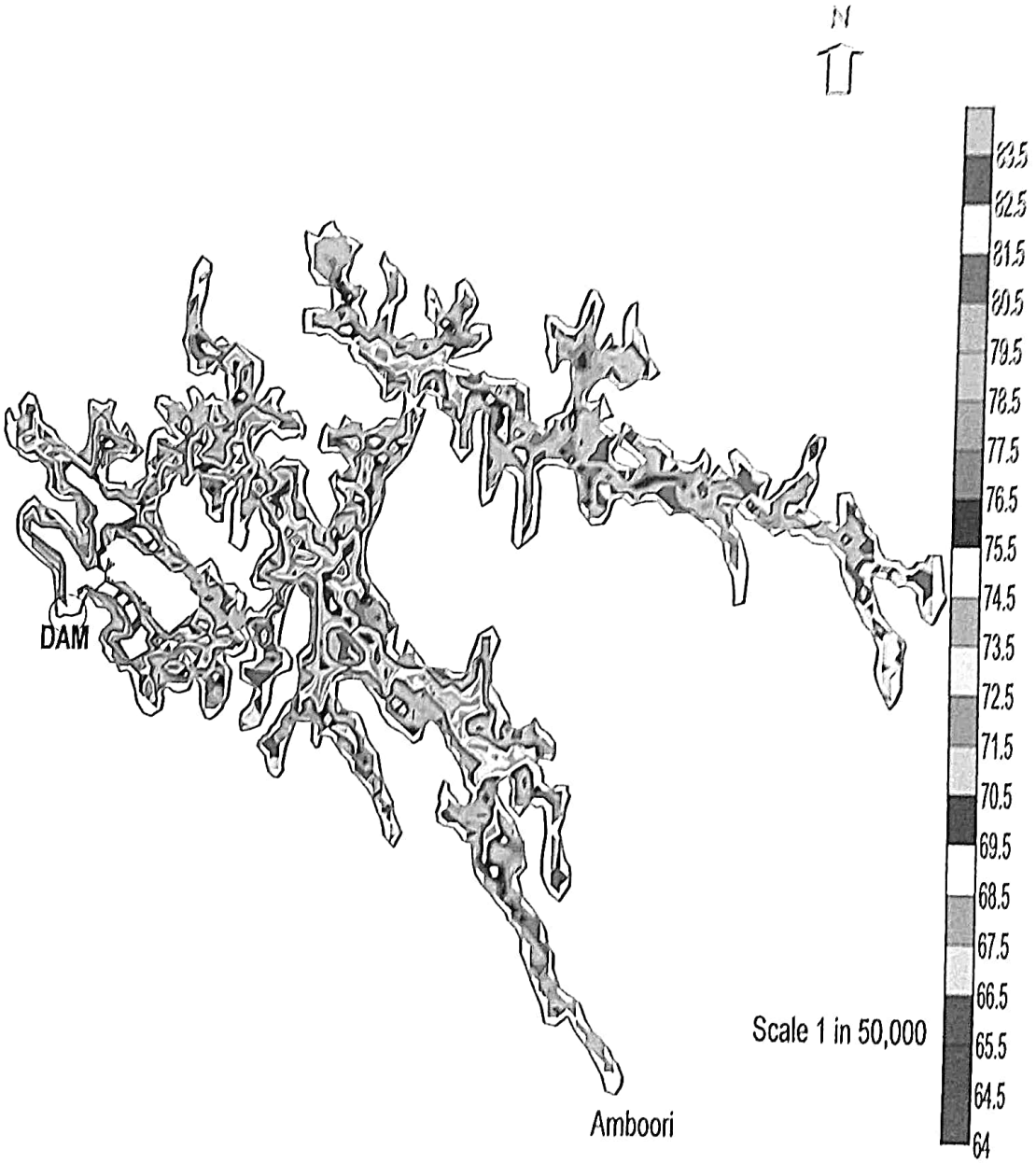


Fig.6.2 Contour Map based on IBS Survey

6.1 CAPACITY AT DIFFERENT WATER LEVEL

Reservoir volume at different water levels can be found out using the IBS data in SURFER software. The present capacity at different level is compared with the original and IBS result in 2011 & 2015and is shown in Table 6.2.

Table 6.2 Reservoir capacity at different water levels.

Sl. No.	Water Level	Water Holding Capacity				Percentage Reduction In Capacity
		Original	IBS Survey 2011	IBS Survey 2015	IBS Survey 2019	
	(m)	(M. Cub. m)	(M. Cub. m)	(M. Cub m)	(M. Cub m)	%
1	83.5	95.157	87.408	86.253	83.016	12.76
2	83	91.337	81.146	80.648	76.835	15.88
3	82.5	87.605	74.907	74.907	70.664	19.34
4	82	84.213	68.75	68.75	64.555	23.34
5	81.5	81.343	62.767	62.767	58.617	27.94
6	81	78.376	56.101	56.101	52.981	32.40
7	80.5	75.403	51.551	51.551	47.694	36.75
8	80	72.443	46.449	46.449	42.823	40.89
9	79.5	69.463	41.739	41.739	38.431	44.67
10	79	66.577	37.442	37.442	34.526	48.14
11	78.5	63.79	33.562	33.562	31.051	51.32
12	78	61.004	30.053	30.053	27.956	54.17
13	77.5	58.221	26.903	26.903	25.188	56.74
14	77	55.436	24.099	24.099	22.712	59.03
15	76.5	52.63	21.603	21.603	20.493	61.06
16	76	50.086	19.369	19.369	18.498	63.07
17	75.5	47.634	17.367	17.367	16.697	64.95
18	75	45.628	15.582	15.582	15.063	66.99
19	74.5	43.4	13.984	13.984	13.584	68.70
20	74	41.171	12.55	12.55	12.245	70.26
21	73.5	38.942	11.272	11.272	11.028	71.68
22	73	36.77	10.134	10.134	9.932	72.99
23	72.5	34.727	9.121	9.121	8.947	74.24
24	72	32.684	8.22	8.22	8.064	75.33
25	71.5	30.641	7.422	7.422	7.276	76.25
26	71	28.59	6.717	6.717	6.567	77.03
27	70.5	26.556	6.099	6.099	5.941	77.63
28	70	24.552	5.556	5.556	5.387	78.06
29	69.5	22.703	5.076	5.076	4.896	78.43
30	69	20.853	4.647	4.647	4.456	78.63

31	68.5	19.004	4.26	4.26	4.058	78.65
32	68	17.155	3.912	3.912	3.695	78.46
33	67.5	15.536	3.593	3.593	3.359	78.38
34	67	14.457	3.295	3.295	3.046	78.93
35	66.5	13.378	3.016	3.016	2.751	79.44
36	66	12.297	2.754	2.754	2.474	79.88
37	65.5	11.255	2.506	2.506	2.213	80.34
38	65*	10.524	2.27	2.27	1.968	81.30
39	64.5	9.794	2.047	2.047	1.739	82.24
40	64	9.063	1.836	1.836	1.525	83.17

*Dead Storage Level

The original storage capacity curve is compared with the same obtained from the IBS surveys in 2011, 2015 and 2019 and is shown in Fig.6.3.

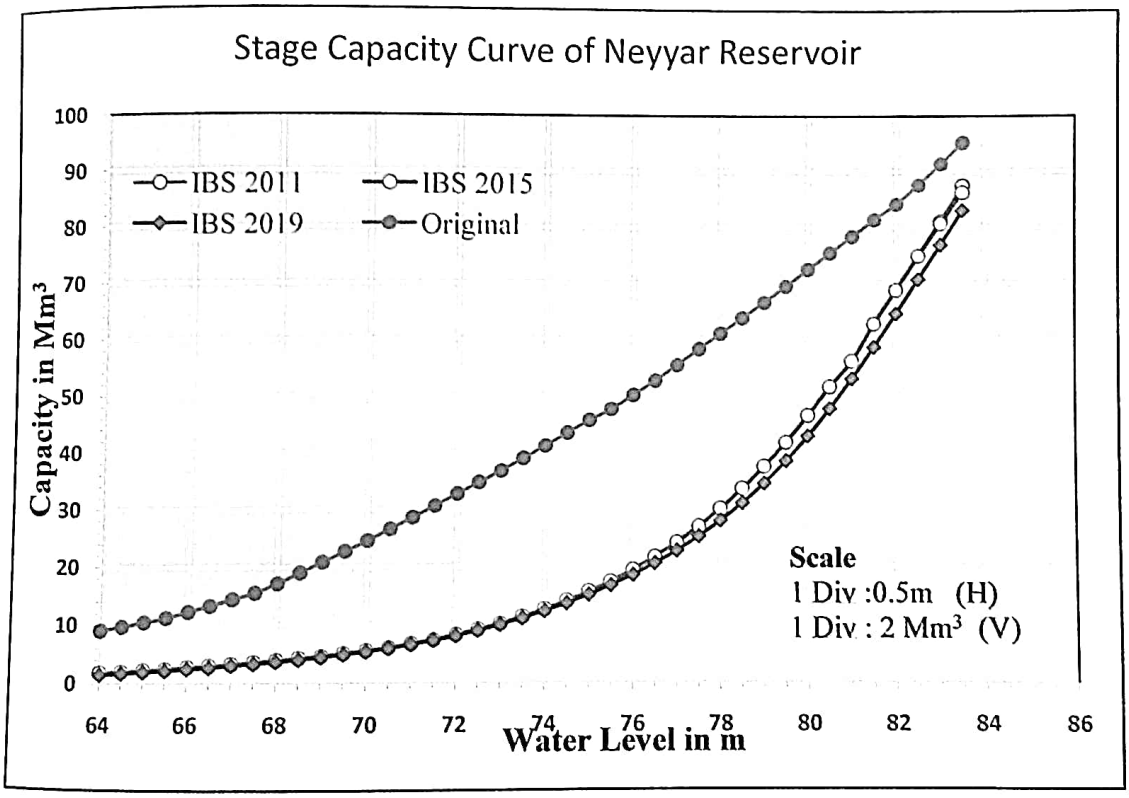


Fig.6.3 Water Level v/s Water holding capacity curve

6.2 WATER SPREAD AREA AT DIFFERENT WATER LEVEL

The present water spread area at different level is compared with the previous IBS studies in 2011 & 2015 and is shown in Table6.3. Fig.6.4 shows its graphical representation.

Table 6.3 Water spread area at different water levels.

Sl. No.	Water Level	Water Spread Area		
		IBS Survey 2011	IBS Survey 2015	IBS Survey 2019
	m	Sq Km	Sq Km	Sq Km
1	83.5	9.43	7.87	9.03
2	83	9.42	7.85	9.03
3	82.5	9.41	7.84	9.01
4	82	9.28	7.81	8.94
5	81.5	9.03	7.73	8.73
6	81	8.71	7.56	8.41
7	80.5	8.29	7.28	7.99
8	80	7.78	6.93	7.47
9	79.5	7.28	6.51	6.84
10	79	6.71	6.08	6.25
11	78.5	6.16	5.64	5.69
12	78	5.62	5.38	5.17
13	77.5	5.11	5.21	4.71
14	77	4.61	4.8	4.27
15	76.5	4.17	4.04	3.87
16	76	3.78	3.72	3.53
17	75.5	3.42	3.42	3.21
18	75	3.09	3.14	2.93
19	74.5	2.79	2.88	2.67
20	74	2.51	2.64	2.43
21	73.5	2.26	2.43	2.2
22	73	2.03	2.23	1.99
23	72.5	1.82	2.04	1.79
24	72	1.61	1.84	1.6
25	71.5	1.43	1.65	1.43
26	71	1.25	1.48	1.27
27	70.5	1.1	1.32	1.13
28	70	0.98	1.17	0.99
29	69.5	0.88	1.03	0.88
30	69	0.79	0.91	0.8
31	68.5	0.72	0.81	0.73
32	68	0.66	0.73	0.67

33	67.5	0.61	0.66	0.62
34	67	0.57	0.61	0.58
35	66.5	0.54	0.57	0.55
36	66	0.51	0.53	0.52
37	65.5	0.48	0.5	0.48
38	65*	0.46	0.47	0.45
39	64.5	0.43	0.44	0.43
40	64	0.41	0.42	0.39

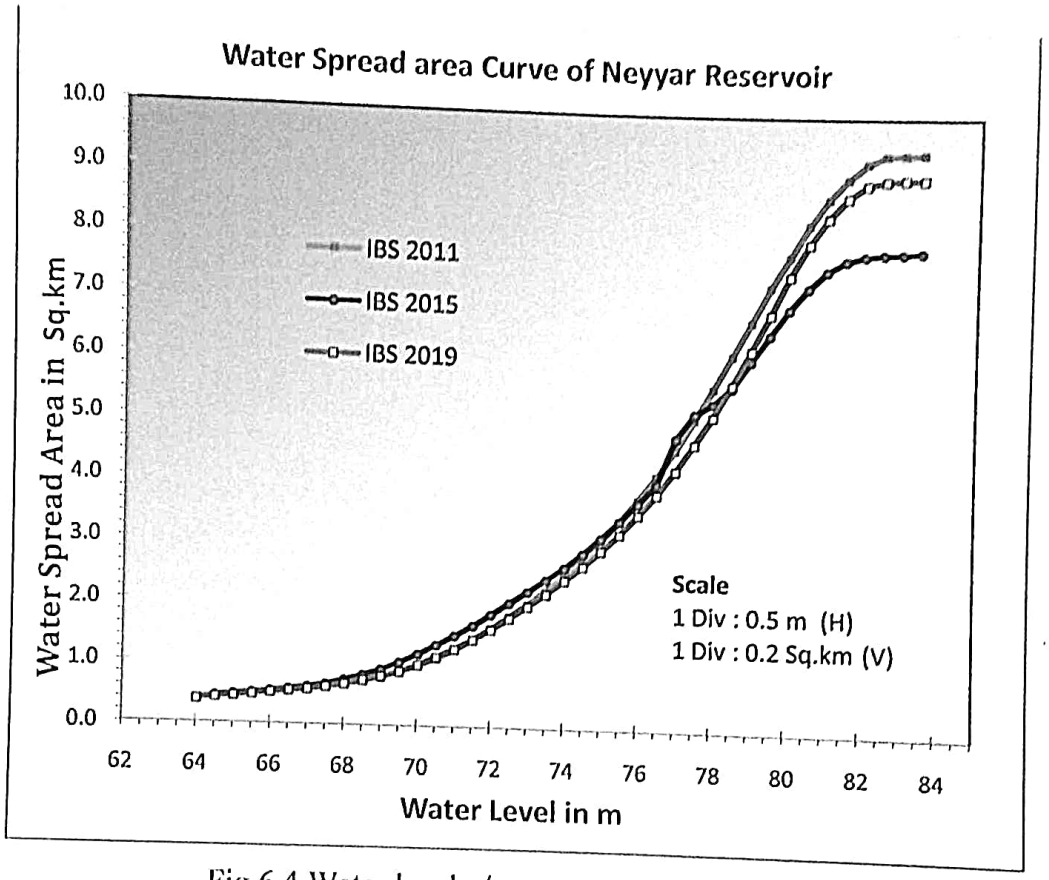


Fig.6.4 Water level v/s water spread area curve

7. CLASSIFICATION OF SOIL

7.0 SOIL SAMPLE COLLCETION

Disturbed soil samples were collected using grab type mud sampler (only surface soil) from 10 locations in the reservoir. The sample collection process is shown in Plate 8. Undisturbed samples cannot be collected using this type of sampler. These soil samples were analyzed in Soil Mechanics and foundation Division, KERI, Peechi.

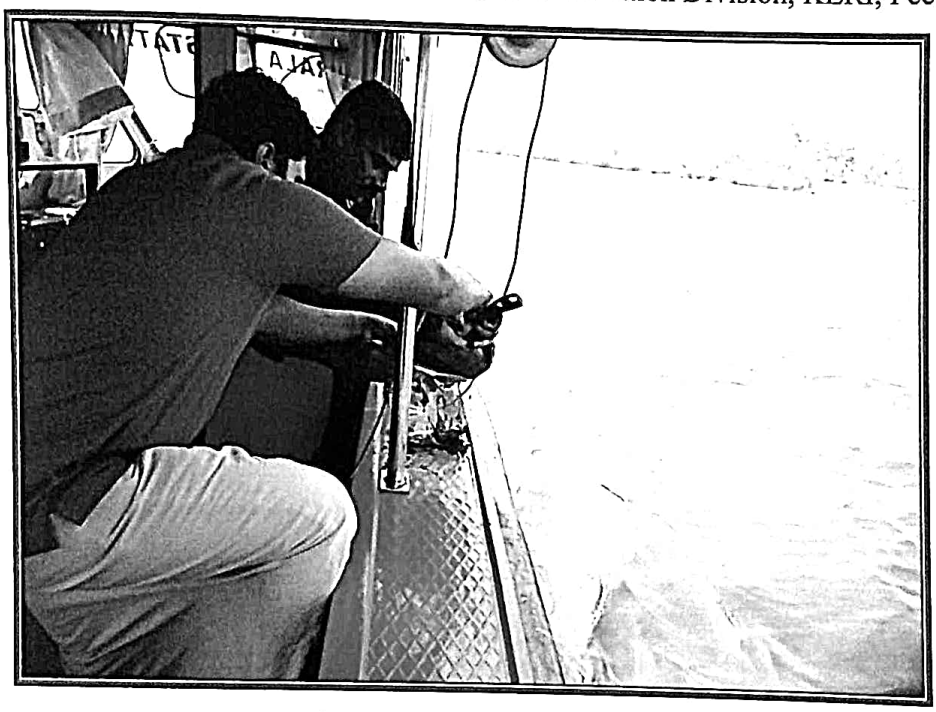


Plate. 8 Soil sample collection

7.1 ANALYSIS OF SOIL SAMPLE

The soil samples were analyzed and the result is shown in table 7.1 In the present study 10 Nos of soil samples are analyzed. The soil sample locations are shown in Fig7.1 Soil sample analysis was done in previous survey conducted in 2011. The average percentage of clay, silt, sand and gravel of the analyzed samples in the two consecutive studies are graphically represented in Fig 7.2. By comparing the results of

the studies, it is observed that there is not much variation in the percentage of various soil components by comparing with the previous result.

Since we are analyzing the grab samples, the percentages of soil particles are only indicative and not accurate. For accurate assessment of contents in the soil, core sample analysis must be done.

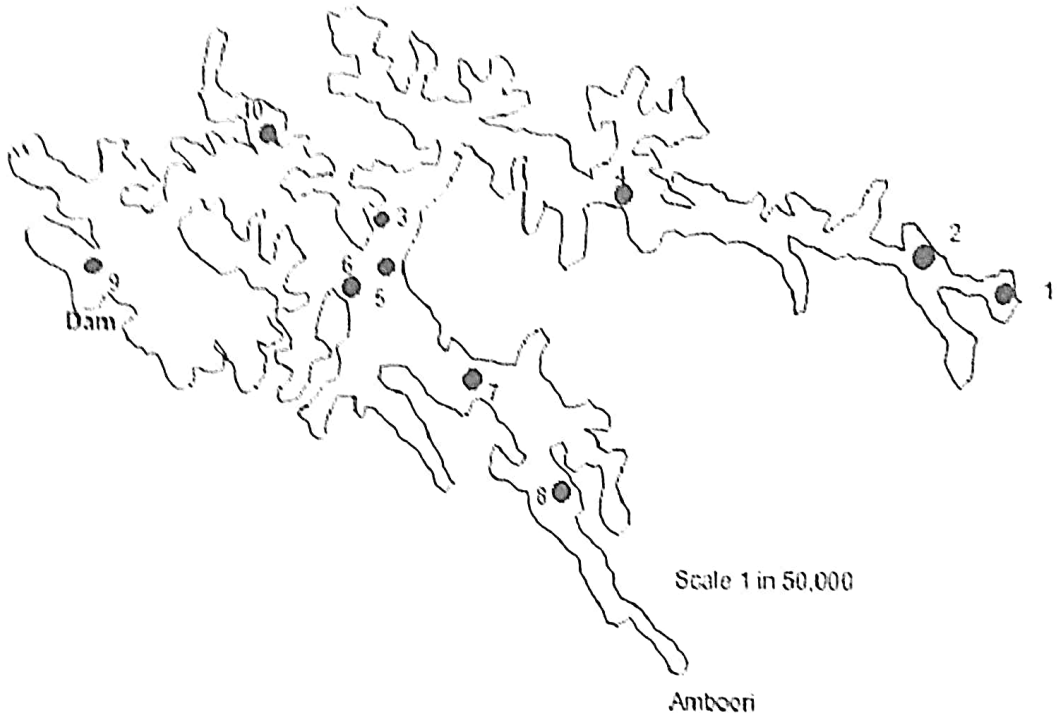


Fig.7.1 Location of Soil sample

Table 7.1 Soil Sample Analysis Result

Sl. No.	Sample Position	Depth of Sample taken in m	Nature of sample	Soil texture	Colour	Specific gravity	% of Various size of Soil Particle			
							Clay	Silt	Sand	Gravel
1.	N- 0944236 E- 745360	2.1	Disturbed	Silty sand	Ash grey	2.21	5	7	SS	0
2.	N-0943739 E- 744893	2.4	Disturbed	Silty sand	Ash grey	2.17	7	14	76	3

3.	N-0946482 E-738889	7.4	Distur bed	Clayey sand	Lead grey	1.83	17	32	51	0
4.	N-0945253 E-741410	10.4	Distur bed	Silty sand	Lead grey	2.11	4	12	84	0
5.	N-0944471 E-739167	12.4	Distur bed	Clayey silt	Slate grey	1.99	34	61	5	0
6.	N-0943402 E-738674	12.2	Distur bed	Clayey silt	Slate grey	2.08	29	69	2	0
7.	N-0943585 E-739992	14.4	Distur bed	Clayey silt	Slate grey	1.83	38	61	1	0
8.	N-0942598 E-740767	10.9	Distur bed	Clayey silt	Slate grey	2.04	27	70	3	0
9.	N-0944462 E-736267	10.8	Distur bed	Silty sand	Slate grey	2.08	12	16	67	5
10.	N-0945754 E-737863	15.2	Distur bed	Silty sand	Slate grey	2.14	13	30	57	0

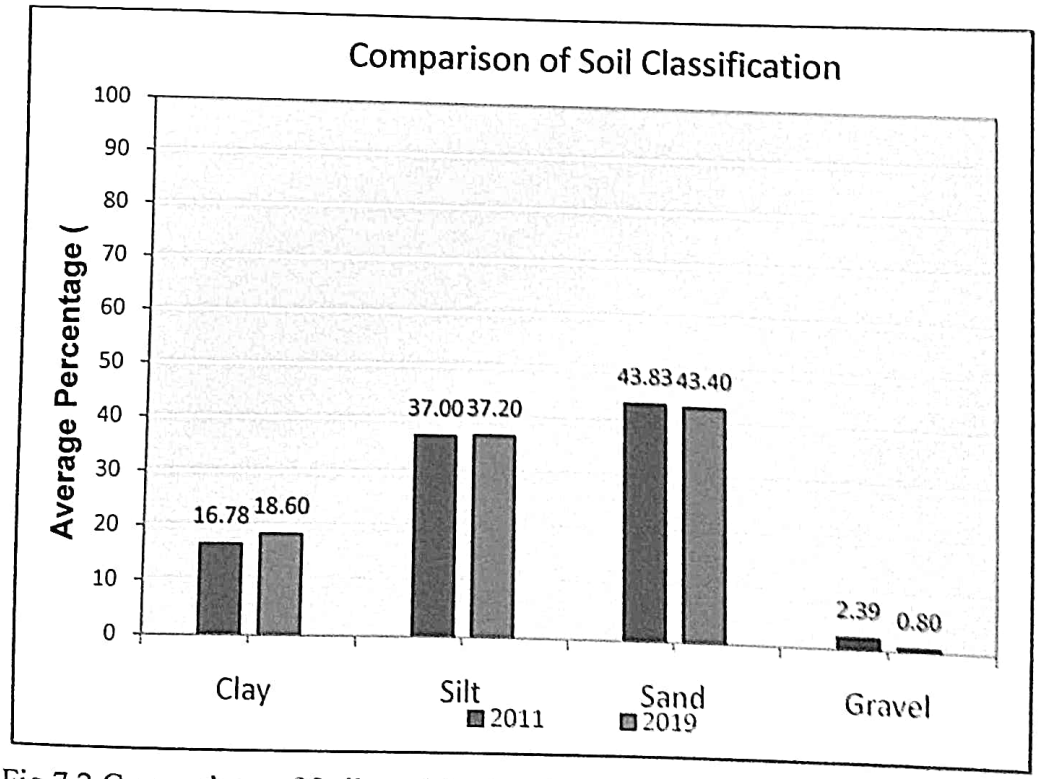


Fig.7.2 Comparison of Soil particle distribution as per two consecutive studies

8. RESULT AND DISCUSSION

The original Capacity of Neyyar Reservoir at 83.5m level is 95.157 Mm^3. The present capacity is 83.016 Mm^3. The capacity reduction of the reservoir is 12.141Mm^3in 55 years 12.75% of the original capacity.

- The IBS **Surveys in 2011** and **2015** were conducted at WL83.6m and WL84.75m respectively and corresponding reservoir capacity was 88.66 Mm^3 and 97.345 Mm^3 against the original capacity of 96.034$Mm^3$and 106.188 Mm^3respectively. As per the 2011 study, the capacity reduction rate is0.16 Mm^3/per year within 47 years. In basis of 2015 study, the reduction rate is 0.173Mm^3/per year within 51 years.
- The original volume at dead storage level (65 m) was 10.524Mm^3, volume reduced to 2.27 Mm^3within 51 years. Reduction percentage is 78.43 %.

- The **present study is conducted at WL 83.5m**, the reservoir capacity is 83.016$Mm^3$and the capacity is reduced by 12.141 Mm^3 in 55 years @ 0.221 Mm^3/per year ie 0.23% of the original capacity per year.
- Volume at dead storage level is 1.968 Mm^3, Percentage reduction in dead storage is 81.3 % in 55 years. Within the last 4 years after the second study the dead storage capacity is reduced by 2.87 %.
- In the previous studies conducted in 2011 and 2015, the reservoir capacity corresponding to the WL 83.5m was 87.408 Mm^3 & 86.253 Mm^3 respectively. For the last four years the rate of capacity reduction is 0.809 Mm^3/year ie 0.85% of the original capacity per year.
- Sediment layer profile of the reservoir area at an interval of 100m is obtained from the Sub Bottom profiler.

Based on the first study conducted in 2011, the capacity reduction rate corresponding to WL 83.5m was ***0.17 %***per year during the first 47 years of the dam

life. From the next study in 2015, the capacity reduction rate was estimated as *0.30%* per year for the last 4 years after the first study. From the present study conducted in 2019, the capacity reduction rate is *0.85%* for the last 4 years after the second study. ie ***There is a huge increase in rate of sedimentation and this is the outcome of the unusual heavy flood occurred in 2018 and 2019.***

After the heavy flood in 2018, sedimentation studies of some reservoirs all over Kerala have been conducted. It is observed that some reservoirs show an increase in capacity based on the previous study results. But in the case of Neyyar reservoir there is a huge reduction in the capacity after the heavy flood. In case of Kanjirapuzha reservoir also shows a huge reduction in capacity. By enquiry with the dam officials, it is known landslides were occurred in the catchment area during the floods in 2018 & 2019. The huge capacity reduction is the outcome of this landslides occurred.

The capacity reduction rate corresponding to WL83.5m is graphically represented in Fig.8.1

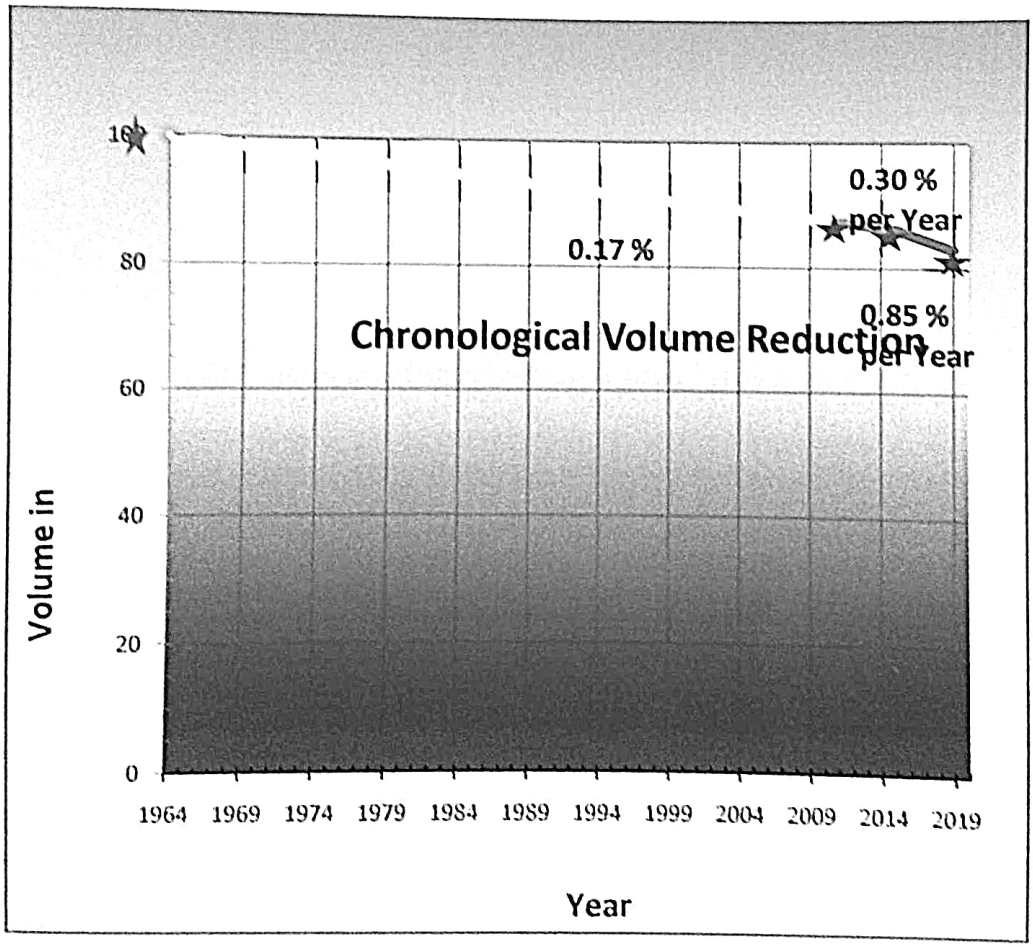


Fig 8.1 Chronological Volume Reduction

LIMITATIONS

- The IBS survey does not directly measure the silt in the reservoir. It helps to calculate the present storage capacity only which is compared with the original capacity and the reduction in capacity over a period of time is attributed to silt deposition.
- The accuracy in the silt estimation by this method is fully dependent on the accuracy of the original capacity table. The comparison of results of two or more surveys will give correct sedimentation pattern and rate of siltation. Hence it is recommended that sedimentation survey of all reservoirs may be conducted at an interval of five years
- In Sub Bottom profiler, the sediment layer thickness is calculated from the reflection of ultrasound waves. Presence of an object or hard thin layer above the sediment deposit may lead to error in sediment depth calculation.

9. CONCLUSION

The Bathymetric survey of Neyyar Reservoir is conducted from 21st October 2019 to 23rdNovember 2019. Previously the survey had been conducted in 2011 using IBS and in 2015using IBS and Sub Bottom Profiler and the results were published. Now the survey is carried out using IBS and Sub Bottom profiler and the results are reported herein. Soil sample analysis is done and the results are also published.

REFERENCE

1.Elcome Marine Services- Users guide to QINSY –

2. Elcome Marine Services- Users guide for Contouring and 3D surface mapping for scientists and Engineers 1999

3. Sub Bottom Profiler Users Guide – SES 2000

4. Technical Report No: 17-KERI/SEDIMENTATION/3/2011

5. Technical Report No: 24- KERI / Sedimentation / 09 / 2015