BEFORE THE HONOURABLE NATIONAL GREEN TRIBUNAL SOUTHERN ZONE AT CHENNAI

O.A.No.143 of 2021

BETWEEN

Tribunal on its own motion-SUO MOTU Based on the News item in Eenadu Newspaper Edition Dated: 12.06.2021, "Dredging along the embankments of Krishna River to be stopped".

... **APPLICANT**

-VS-

The Chief Secretary to Government of Andhra Pradesh
& 10 others

... **RESPONDENTS**

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It is certified that all the documents contained in the above annexure are true copies.

Date: 27.07.2021

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Krishna Delta System
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BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE BENCH AT CHENNAI

Original Application No.143 of 2021
(Under Section 18(1) read with Sections 14 & 15, of National Green Tribunal Act 2010)

IN THE MATTER OF:

Tribunal on its own motion-SUO MOTU Based on the News item in Eenadu Newspaper Edition Dated: 12.06.2021, "Dredging along the embankments of Krishna River to be stopped".

... **Applicant**

-VERSUS-

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COUNTER AFFIDAVIT FILED BY THE 11th RESPONDENT

I, C. Narayana Reddy, S/o. C. Chenna Krishna Reddy, Aged about 58 years, Occ: Chief Engineer, Krishna Delta System, Vijayawada, Krishna District, R/o. Vijayawada, Krishna District, do hereby solemnly affirm and sincerely state as follows:-

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1. I am the 11thRespondent in the above said matter and I am authorized to swear to this affidavit and I am conversant with the facts and circumstances of the said matter and also I am competent to swear this affidavit on behalf of 5thand 10th respondents also.

2. This respondent denies each and every averment made in the affidavit filed in support of the application as false and incorrect except those that are specifically admitted herein in this counter affidavit.

The Brief facts of the case are;-

3. The above matter has been taken as Suo Motu application registered by this Hon'ble Tribunal on the basis of newspaper report published in Eendau Edition, dated: 12/06/2021 under the caption "Dredging along the embankments of Krishna River to be stopped"

4. It is alleged in the newspaper report that on account of the unscientific dredging in the Krishna River and dumping of sand in agricultural lands weakens the embankment during heavy rains. The embankments may breach and flood the agricultural lands of the capital region, which can affect the river ecology, unless it is stopped at once. Necessary permission should have been obtained from Capital Region Development Authority (CRDA) before the dredging work is undertaken and the dredging work must also be done in a scientific manner without weakening the strength of the embankment.

5. This Hon'ble Tribunal in several matters of this nature, have given several directions as to how dredging etc., will have to be done and the procedure to be followed before undertaking dredging and also how the river ecology plays their role in

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protecting environment apart from providing shelter for aquatic life. It is highly necessary to protect the river ecology as part of protection of the environment.

6. So considering the circumstances, we feel that there arises a substantial question of environment which requires the interference of this Hon'ble Tribunal. So the matter is admitted.

7. It is submitted that the Prakasam Barrage was constructed during 1954-57 across River Krishna abutting the old Krishna Anicut for a maximum flood discharge of 12.00 Lakhs cusecs and serves an ayacut of 13.08 Lakh Acres.

Designed storage capacity of the barrage is 3.071 TMC at pond level (+) 57.05 Ft. The Barrage has 70 no's of Flood gates of size 40 ft X 12 ft each to dispose of Max flood discharge of 12 lakh cusecs. Besides this, there are 6 no's of scour sluices on left side and 8 no's of scour sluices on right side of the barrage to dispose of the sediment deposits accumulated in the foreshore of the barrage.

8. It is submitted that Original flood banks have been formed between the years 1882 and 1892. On verification of data on the maximum flood levels, it can be seen that there were high floods in the years 1882, 1896, 1903, 1916 and 1949. Prior to 1903, the flood banks were not sufficiently high and had no standards. Since, the flood of 1903 was the highest flood recorded till then, it was decided to raise the top of flood banks by 2ft. Subsequently high floods occurred again in 1914 and 1916. As a result of these floods, in 1917, a committee was appointed to enquire in to and report on the causes of the breaches and to indicate the nature of special improvements which may be necessary in order to minimize the danger in future. Based on the recommendations of the Committee, the flood banks have

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been raised to 3 ft over the highest recorded levels during the years 1903, 1914 and 1916. Subsequently another high flood occurred in 1949 and hence, these Flood banks were further raised to higher standards with respect to the observed high flood levels of 1949.

9. It is submitted that the flood Banks have been reformed after the Floods of 1949 to irrigation standards, keeping the top of flood bank at 0.91Mt (i.e., Free Board) above the maximum observed flood levels in 1949. The top width of the flood banks is 5.50 mts with carriage way of 3.75 Mts and with shoulders 0.875 on both sides. These Flood banks are formed with 1 ½ : 1 slope on the waterside and 2:1 slope on the landside. The Left Flood Bank above the Anicut extends from 0.00Km to 13.00Km to a point where it abuts on the Ibrahimpatnam Hills. The Right Flood Bank originally formed from Tadepalli Hill and extends up to Undavalli Hills for a distance of 1.32Km was later extended up to Vaikuntapuram Hill for a further distance of 22.60Km under flood protection program.

The Right side & Left side flood banks were formed away from the banks of the River course. The width of the margin land between the banks of the river to the flood banks (River Margins) varies from a minimum distance of 100 Mts to maximum distance of 500Mts at certain locations. The existing flood Banks on either side of the river on Upstream side of Prakasam Barrage are stable and no damage was occurred to flood banks even during heavy floods in river Krishna in the years 2009 and 2019, when the maximum flood discharge was recorded as 11.10 Lakh Cusecs and 8.05 Lakh Cusecs respectively. The margin land between Right Flood bank and River course are under the possession of Amravati Metropolitan Region Development Authorities (AMRDA) which was acquired by Land Pooling for Capital City.

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10. It is submitted that the sediment deposited on upstream side of the Barrage is to be flushed out by operating the scour sluices located on either side of the barrage in every flood season. But, due to the operational constraints for keeping a Pond level of +17.39m to facilitate the passage of water into the Vijayawada thermal power station cooling canal and to provide drinking water to Vijayawada and Guntur cites, these scour gates could not be operated regularly for almost 10 years. After 2009 floods, the discharge of flood decreased gradually but the accumulated silt gradually increased due to storing of water on Upstream of the Barrage for regular needs. Further, after operating the Pattiseema lift scheme, the flood water from River Godavari is lifted and taken through Polavaram Right Main Canal and merged in to River Krishna at Pavitra Sangam located at 12 Kms upstream side of Prakasam Barrage. The water received from Pattiseema Lift Scheme contains high silt content and it resulted in heavy deposition of sediments on upstream side of Prakasam Barrage from the year 2015-16 onwards and the capacity of the barrage reduced by approximately 25% of its live capacity i.e., about 0.767 TMC.

11. It is submitted that the Heavy siltation coupled with increase of water demand in the region and safety considerations of Barrage including river berms and flood banks necessitated de-siltation. Besides Irrigation needs, the Prakasam barrage also caters the drinking & Industrial water needs all along River Krishna below Nagarjuna Sagar Project, of four districts namely Krishna, West Godavari, and Guntur and Prakasam districts. It is the major source of drinking water for Vijayawada Corporation, Municipalities of Gudivada, Jaggaiahpeta, Machilipatnam, Nuzivid, Pedana, Guntur Corporation, Municipalities of Magalagiri, Tadepalle, Tenali and part of West Godavari district. After bifurcation of the State, majority of the

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offices of Government of Andhra Pradesh are functioning from Velagapudi area of Amaravati. The surrounding areas of Vijayawada, Mangalagiri, and Tadepalli became more convenient residential zone for employees working in these offices. Hence, the population is increasing day by day. Simultaneously Industrial and commercial zone is growing rapidly mainly in Vijayawada Corporation and Mangalagiri municipality which are located on either side of River Krishna adjacent to Prakasam Barrage. Hence, requirement of water is increased in both Vijayawada Corporation and Mangalagiri municipality. The only source to meet this additional requirement of drinking water is Prakasam Barrage. Prakasam Barrage has been receiving heavy sediment inflows from the catchment due to change in climatic conditions, deforestation and urbanization due to heavy floods. The sediment expulsion devices of the barrage could not be operated for the last 10 years due to the operational constraints, resulting in accumulation of the sediment/silt and shoal formation in the reservoir bed.

12. It is submitted that the heavy shoal formation has occurred in the barrage leading to the erosion of the islands and marginal lands, resulting in change of flow pattern, concentrated flows, cross currents, scouring near the structure and gradual shifting of Islands towards the Structure. The heavy shoal/deposit formation on upstream side of the Prakasam Barrage besides reducing the capacity of barrage also endangers the safety of Barrage & flood banks and damages the environment, infrastructure. The Indian Standard Code IS: 7349: 2012 for BARRAGES AND WEIRS – OPERATION AND MAINTANANCE Guide section 6.5 stated that ***"if a study of the survey data indicates that shoal formation has occurred on the upstream and /or downstream of the barrage in spite of judicious operation of gate, during normal and flushing operation of reservoir, the shoal should be removed by***

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dredging by using suitable dredgers to the extent possible so that satisfactory flowing conditions are established and also desired capacity is re-stored"(Annexure-I).

13. It is submitted that to safeguard the Barrage, river flood banks and river ecology, as a part of maintenance in accordance with the Indian Standard Recommendations (IS 7349:2012), de-siltation of the mounds and shoals were proposed to be taken upon upstream side of Prakasam Barrage by dredging process. The desilting works now proposed on upstream side of the Barrage is only for removal of the accumulated sediment deposits using dredging operation up to natural bed level of the river, and this cannot be classified as mining activity as there is no commercial intent. There is zero or negligible disturbance to the environment and ecology of river owing to the de siltation of Barrage now proposed.

14. It is submitted that in compliance with Hon'ble NGT directions in O.A.No 935/2018, Water Resources department has carried out bathymetric survey in upstream of Prakasam Barrage i.e., (From KM 0.00 to KM 13.50). Bathymetry is the study of underwater depth of river. *Bathymetric surveys* allow us to measure the depth of a river as well as map the underwater features of a river and it is also called as Hydro-graphic survey. It is a scientific study done by using Single Beam Echo Sounder(SBES), Positioning and Navigation systems from Prakasam Barrage to Ibrahimpatnam (About 13.50 km upstream of Barrage) in Krishna River in regular grid intervals of 10m (Both in X & Y Planes). The area of study is only on foreshore of water submerged area which will be considered as reservoir. The study was carried out by hiring the services of M/S BSP Hydro Dredging Works, Bhimavaram. M/S BSP Hydro Dredging Works, Bhimavaram had previous experience in conducting Hydrographic Surveys required for National Waterway-4 in

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Krishna River from Harischandrapuram to Chamarru and conducted Bathymetry surveys in Krishna River.

15. It is submitted that the capacity of Prakasam Barrage is 3.071 TMC at 12 ft (+17.39 Mts) Level i.e., F.R.L (Full Reservoir Level). After conducting the first Bathymetric survey during Dec-2019 & Jan-2020, it is found that the volume of silt deposits above original Bed Level to be removed is 1,24,77,704 Cum and the water storage capacity to be restored is 0.441 TMC. In Dec-2020 & Jan-2021 once again Water Resources department has carried out second bathymetric survey on upstream of Prakasam Barrage i.e., (From KM 0.00 to KM 13.50) and found that the volume of the silt deposits above original Bed Level to be removed is 1,30,26,531 Cum and the water storage capacity to be restored is 0.460 TMC(Annexure-II).

16. It is submitted that as part of maintenance activity to safeguard the Barrage and to maintain the storage capacity of the reservoir, it is proposed to remove the shoals and sediment deposits accumulated on the river bed on Upstream side of the Barrage. Out of total estimated deposited silt quantity of 130.26 Lakh Cums, it is now proposed to remove 61.83 lakh cums of deposited silt on upstream side of Prakasam Barrage from Km0.50 to Km13.50by dredging process. The de-siltation activities proposed to be carried out through dredging operations are located in both districts of Krishna & Guntur. In order to carry out the de-silting works on upstream side of Prakasam barrage to achieve the desired benefits as mentioned in above paras, a meeting was conducted between Mining department and Water resources department on 16.12.2020(Annexure-III).

17.It is submitted that as per the decisions taken in the above meeting, the Water Resources Department of Government of Andhra Pradesh, vide *G.O.RT.No:81 Water Resources (Projects. I)*

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Department Dated: 15-03-2021 accorded administrative approval for an amount of Rs.102.447 Crores to take up 12 nos of de-silting works on upstream side of Prakasam Barrage for extracting 61,83,000 Cum of de-silted material(Annexure-IV).

18. It is submitted that the tenders for 12 works were invited by Water Resources Department in e-procurement platform by Reverse Tendering system. After finalizing the qualified bidders, on Dt: 30/04/2021, the Letter of Acceptances were issued to the lowest bidders to execute these works. The details of the appointed agencies.

19. It is submitted that the de-siltation on upstream side of Prakasam Barrage is proposed to be taken by dredging process using scientific methods duly taking all precautions and following the procedures laid down in IS specifications. The Dredging/De-silting operations is not a mining/ quarrying activity and this activity will be done in foreshore area of irrigation reservoirs/streams/rivers, and it does not need mining plan and Environmental Clearance, as it is a restoration process as per clause 6.5 of ISI Code IS: 7349: 2012 to bring back the irrigation reservoirs/streams/rivers to its original storage capacity.

20. It is submitted that the de-silting operations on upstream side of Prakasam Barrage in the village limits of Thalayapalem, Lingayapalem in Guntur District and Ibrahimpatnam in Krishna District was executed during the years 2016 to 2018 by dredging process and a quantity of 9,94,752 Cum was dredged and the de-silted material was supplied to Government works. Apart from this, a quantity of 33,00,000 Cum was de-silted through mechanized boats on upstream side of Prakasam Barrage. As a whole, a total quantity 42,94,752 Cum of Silt was de-silted in Krishna River above Prakasam Barrage in Both Krishna and

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Guntur Districts. During this period, de-siltation was carried out under the supervision of both Water Resources Department and Mines & Geology Department of Government of AP and the de-siltation works are carried out smoothly without any objections from the local farmers. The de-siltation activity was done in a scientific way without any disturbance to the river ecology, exiting flood banks and also to the river margin lands.

21. It is submitted that the Dredging operation is completely a maintenance work which extracts the deposited silt under the water, and it is not a mining activity. No damage will be caused to the flood banks due to de-siltation. Due to de-siltation, the heavy shoals deposited in the river, which are obstructing the natural river course and flow pattern will be removed. The de-siltation now proposed will minimize the erosion of margin lands and lanka lands. It also protects banks and safeguard neighboring villages along the river course during floods. The existing Right side & Left side flood banks were formed away from the banks of the River course. The width of the margin between the banks of the river to the flood banks (River Margins) varies from a minimum distance of 100 Mts to maximum distance of 500Mts at certain locations.

22.Hence it is submitted that there are margin lands available in between river banks and flood banks. In dredging operations, the total dredged material in the form of slurry will be pumped and collected into a pond formed with four sides surrounding bunds of suitable strength with a facility to drain out the clear water. The floating/shore pipeline will connect one end to the dredger and other end will be placed into ponds created in the margin land on either side of the River nearer to the dredging area. Number of ponds are required for stacking dredged material and these ponds can be formed on vacant margin land adjacent to the proposed de-silted area. The respective ponds (for

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stacking dredged material) will be formed by leaving minimum safe margin of 50Mts from toe of the existing Flood Banks.

23. It is submitted that the margin lands on right side of River Krishna are in Guntur district which were acquired by the CRDA (AMRDA) through land pooling. Water Resources Department requested the Metropolitan Commissioner, AMRDA, Vijayawada to allot these adjacent margin lands to an extent of Ac.20.00 cts in Penumaka Village of Tadepalli Mandal and Venkatapalem, Mandadam Villages of Thullur Mandal to deposit the dredged materials on temporary basis as per AMRDA norms (Annexure-V). The de-siltation operation will be carried out after allotment of the above marginal lands from AMRDA and the operations will be carried out without any disturbance and damage to the existing flood banks along the River.

25. It is submitted that the maximum flood discharge received in 2019 is 8.05 Lakh Cusecs and in 2020 the maximum flood discharges received is 7.76 Lakh Cusecs as against the maximum designed flood discharge of Prakasam Barrage of 12.00 Lakh Cusecs. These heavy floods continued for number of days and no damages were observed for flood banks on either side of the Krishna River. Hence the contents mentioned in Newspaper Eenadu Edition dated 12-6-2021 ,"***that the de-silting on Upstream side of Prakasam Barrage by unscientific dredging process and dumping of sand in agriculture lands weakens the embankment and during heavy rains the embankments may breach and flood the agricultural lands of the capital region***" is not at all correct and baseless. In this regard, it is to submit that, if the heavy deposits of silt accumulated on upstream side of Prakasam barrage is not removed, this will obstruct the free flows in river Krishna and during floods, turbulence may occur resulting in damage to river margin, flood bank and the Islands situated in

river course. The turbulent flows during heavy floods are dangerous and may erode the river banks and in due course of time the width of the river margin will be reduced and the existing flood banks may breach. Hence to protect the river banks and existing flood banks during heavy floods, the silt deposits on upstream side of Prakasam Barrage are to be removed in a manner without causing any disturbance to the ecology of the river.

26. It is submitted that the Water Resources Dept proposed to de-silt on upstream side of Prakasam Barrage to safeguard the ecology of the river, existing Flood banks, river margins and agriculture lands on either side. Regarding permission from AMRDA, it is to submit that the proposed de-siltation works on upstream side of Prakasam barrage, will be executed under the supervision of Water Resources Department and APMDC Ltd and land required for dumping the dredged material is to be provided by AMRDA on temporary basis. No permissions are necessary from AMRDA to execute the de silting works.

27. It is submitted that the Original application No. 935/2018 was filed before the National Green Tribunal Principle bench, New Delhi on the de-siltation of Prakasam Barrage which was carried out by the Water Resources Dept and Mines & Geology Dept during the period from 2016 to 2018. The National Green Tribunal directed the respondents of these cases to clarify whether any Environment Impact Assessment (EIA) has been done in accordance with Environmental Clearance Regulations 2006 for execution of de-silting works on upstream side of Prakasam Barrage. It is also ordered a detailed study with regard to assess the extent of the damage to Avifauna, Aquatic flora and Fauna including benthic community is to be carried out by assigning to a reputed institution based on experience. It is also ordered the bathymetric survey of reservoir is to be carried out

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for the assessment of depth of mining and siltation of reservoir extent of the mining of the river bed.

28. It is submitted that in compliance of the above NGT directions, the Department of Mines GOAP approached the authorities of Acharya Nargarjuna University in the month of sep 2019 and requested to take up the necessary study on the effect of de-siltation in Krishna River upstream waters up to 13.50Km from Prakasam Barrage on flora and fauna as well as on socio economic conditions of dependent people. Consequently, the university authorities have assigned the work to four Departments namely Department of Zoology & Aquaculture, Department of Botany & Microbiology, Department of Environmental Sciences and Department of sociology and Social Work. The Expert Committee members 1) T.Mahima, Scientist 'D', Central Pollution control Board, (Ministry of Environment, Forest & C C, Government of India) Regional Directorate(South, Bengaluru) 2) Prof G. Rosaiah Department of Botany & Microbiology, Acharya Nagarjuna University A.P, 3) Dr.G.Simhachalam Department of Zoology & Aquaculture, Acharya Nagarjuna University A.P 4) Dr. V. Uma MaheswaraRao Department of Botany & Microbiology, Acharya Nagarjuna University A.P 5) Dr P.Brahmaji Rao Department of Environmental Sciences, Acharya Nagarjuna University A.P and

6) Dr.M.Trimurthirao Department of Sociology & Social work, Acharya Nagarjuna University A.P, made a detailed study in this regard and a detailed report was furnished(Annexure-VI). The Secretary to Government (Mines), Industries, Infrastructure, Investment and Commerce Department, Government of Andhra Pradesh submitted a Counter affidavit along with the above detailed report of Expert Committee Members furnished on Ecological Impact Assessment study on Flora & Fauna of River Krishna (Upstream of Prakasam barrage up to 13.50 Km) and

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Socio economic effects due to de-siltation as directed by the Hon'ble National Green Tribunal, New Delhi. The National Green Tribunal Principle Bench, New Delhi on dt:24/08/2020 issued following order on the above case O.A.No:935/2018(Annexure-VII).

1. Whether the activity termed as 'de-silting' by the State authorities is in fact 'illegal mining' in Krishna River in Andhra Pradesh, as alleged by the applicant, is the question for consideration.

2. Vide order dated 14.02.2020, the Tribunal referred to earlier proceedings and finding conflicting versions in the report, sought a report from an Expert Committee.

3. Accordingly, a report dated 20.07.2020 has been filed. Overall concluding remarks in the report are:-

"**Overall concluding remarks of the Committee Members**

I. Water Resource Department, Government of Andhra Pradesh has carried out bathymetric survey in conformity with the established and recommended practices. As per the Bathymetric survey carried out during December, 2019 to January, 2020 present storage capacity of Prakasam barrage is 2.982 TMC. There is loss in storage capacity of 0.089 TMC as compared to the design capacity of 3.071 TMC.

II. The report submitted by Water Resource Department, Govt. of Andhra Pradesh to Hon'ble NGT is satisfactory.

III. From the Ecological assessment report it can be inferred that the **cautious use of dredgers & mechanized boats and judicious de-silting activity may not have serious impacts on flora and fauna in Prakasam barrage**.

IV. Overall the Ecological assessment report is satisfactory excepting the section on Water quality."

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V. In view of above, no further order is necessary except that the operations be overseen by the same Expert Committee to ensure that no damage is caused to the environment.

A copy of this order be forwarded to the members of the Expert Committee by e-mail.
All pending applications do not survive and are disposed of.

29. It is submitted that Hon'ble N.G.T has thoroughly examined the report furnished by the Export Committee and satisfied on the ecological assessment report and inferred that the **cautious use of dredgers & mechanized boats and judicious de-silting activity may not have serious impacts on flora and fauna in Prakasam barrage** and the report is satisfactory except the section of water quality. The Hon'ble N.G.T also ordered that the de-silting activities are overseen by the same expert committee to ensure that no damages is caused to Environment.

30. It is humbly submitted that compliance of the orders issued by the Hon'ble National Green Tribunal in O.A.No.935 of 2018 on dated:24/08/2020, the Chief Engineer, Krishna Delta System, Vijayawada addressed a letter No. CE/KDS/VJA/OT-3/AE-10/F-De-salting/1107 Dt:09-06-2021 to the Senior Environmental Engineer, Central Pollution Control Board, Regional Directorate (South), Bengaluru, that the proposed dredging operations be overseen during execution by the Expert Committee to ensure that no damage is caused to the environment(Annexure-VIII). The dredging operations will be carried out under the strict supervision of Engineers of Water Resources Department of Government of Andhra Pradesh and also the experts on dredging operations nominated by the APMDC Ltd and these works will be overseen by the expert committee to ensure that no damage is caused to the

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environment and river ecology as directed by NGT in OA No:935/2018.

31. It is submitted that, the directions issued on 24-8-2020, by this Hon'ble Tribunal and the Principal Bench of National Green Tribunal on O.A.No:935/2018 which have been filed before Principle Bench of National Green Tribunal, New Delhi in respect of similar issue based on which the directions are also issued and the State of Andhra Pradesh proposed to undertake the de-silting works on upstream side of Prakasam Barrage strictly in compliance with these directions.

32. It is submitted that this respondent craves leave of this Hon'ble Tribunal to raise additional counter in the course of proceedings, if required.

It is therefore humbly prayed that this Hon'ble Tribunal may be pleased to pass appropriate orders as this Hon'ble Tribunal may deem fit and thus render justice

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Solemnly affirmed at Vijayawada
on this the 27thday of July, 2021
and signed his name in
my presence ADVOCATE

Before me

VERIFICATION

I, C. Narayana Reddy S/o. C. Krishna Reddy, Aged about 58 years, Occ: Chief Engineer, Krishna Delta System, Vijayawada, Krishna District, R/o. Vijayawada, Krishna District do hereby verify that the contents of Paras of Counter Affidavit are based on record and information are true to the best of my knowledge and belief.

Hence, it is verified on the 27th day of July at Vijayawada

Chief Engineer
Krishna Delta System
Vijayawada-2

BEFORE THE HONOURABLE NATIONAL GREEN TRIBUNAL SOUTHERN ZONE AT CHENNAI

O.A.No.143 of 2021

BETWEEN

Tribunal on its own motion-SUO MOTU Based on the News item in Eenadu Newspaper Edition Dated: 12.06.2021, "Dredging along the embankments of Krishna River to be stopped".

... **APPLICANT**

-VS-

The Chief Secretary to Government of Andhra Pradesh
& 10 others ... **RESPONDENTS**

COUNTER AFFIDAVIT FILED BY THE 11TH RESPONDENT

Date:-27.07.2021

M/S MADHURI DONTI REDDY
ADVOCATE
STANDING COUNCIL FOR GOVERNMENT OF ANDHRA PRADESH
A.P. POLLUTION CONTROL BOARD
T.T.D. SUPREME COURT OF INDIA
#S2, Royal Castle, 26, Gill Nagar Extension, Choolaimedu,
Chennai – 600 094. Mobile: 98407 98460 / 6383121322
COUNSEL FOR 11th Respondent

इंटरनेट मानक

Disclosure to Promote the Right To Information

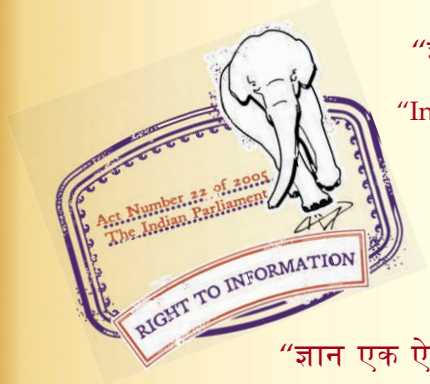
Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

"जानने का अधिकार, जीने का अधिकार"
Mazdoor Kisan Shakti Sangathan
"The Right to Information, The Right to Live"

"पुराने को छोड नये के तरफ"
Jawaharlal Nehru
"Step Out From the Old to the New"

IS 7349 (2012): Barrages and weirs - Operation and maintenance - Guidelines [WRD 22: River Training and Diversion Works]

"ज्ञान से एक नये भारत का निर्माण"
Satyanarayan Gangaram Pitroda
"Invent a New India Using Knowledge"



"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 7349 : 2012

भारतीय मानक

बैरज और वियर — प्रचालन और रख-रखाव — मार्गदर्शी

(दूसरा पुनरीक्षण)

Indian Standard

BARRAGES AND WEIRS — OPERATION AND MAINTENANCE — GUIDELINES

(Second Revision)

ICS 93.160

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 2012 **Price Group 6**

River Training and Diversion Works Sectional Committee, WRD 22

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the River Training and Diversion Works Sectional Committee had been approved by the Water Resources Division Council.

Proper maintenance and operation of barrages and weirs are the prime factors to govern the life and efficacy of the structure. Experience shows that improper operation and maintenance have considerably diminished the life as much as the efficacy of the structure. It is necessary for the engineer in-charge, to be well conversant with the final drawings (both civil and manufacturer's drawings of hydro-mechanical equipments) and manual, etc. His prime duty should include the documentation of the data, design computations, modifications in the designs and final drawings, etcs, as well as inspection of the structure from time-to-time.

This standard was first published in 1974 and revised in 1989. The first revision was made in view of the experience gained during the use of this standard. In the first revision requirements of operation and regulation had been fully revised, providing detailed clarifications/guidelines on many of the issues faced by the site engineers. The history of headworks had also been revised with the addition of data on gate/shutter operation adopted from time-to-time.

With the experience gained from the prototype behaviour of many barrages and weirs and the corresponding remedial measures suggested/adopted for addressing the difficulties, faced in actual operation and maintenance, it is considered necessary to revise the standard to incorporate many of the measures currently in vogue based on the latest technical advancements.

The composition of the Committee responsible for the formulation of this standard is given at Annex B.

Indian Standard

BARRAGES AND WEIRS — OPERATION AND MAINTENANCE — GUIDELINES

(Second Revision)

1 SCOPE

This standard lays down guidelines for the operation and maintenance of hydro-mechanical installations and civil structures connected with the barrages and weirs.

2 REFERENCES

The standards listed in Annex A contain provisions, which through references in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibilities of applying the most recent edition of the standards indicated in Annex A.

3 GENERAL

Generally, the river discharges are widely fluctuating and operations/regulation of the gates have to be modified from time-to-time on the basis of river behaviour, morphological changes, etc. Barrages are not storage structures and the waterway is designed according to design flood without any moderation. As such, during the life of barrage, it is seldom that all the gates are required to be opened fully. Gate operations, particularly during low floods is a key factor for flushing of sediments and prevention or alteration of shoal formation on the upstream and downstream of the barrage.

4 OPERATION AND MAINTENANCE OF HYDRO-MECHANICAL INSTALLATIONS

4.1 It should be ensured that a thorough inspection of hydro-mechanical installations/equipment is done atleast once in a year to check corrosion, loss of metal and other defects. All machinery at the works should be kept clean, tidy and in proper working order and care should be taken to ensure that it is properly handled in conformity with the manufacturer's instructions. The main hydro-mechanical items are generally the gates, hoist equipment, control system, etc. IS 7718 may also be referred for inspection, testing and maintenance of gates.

In case of remote controlled operation of gates, it has to be ensured that the operating system (hardware and software) are fully functional in addition to mechanical controls.

4.2 Operation of Gates and Falling Shutters

4.2.1 All lift gates should be operated at suitable intervals, preferably once in fortnight to clear the gate grooves/slots, flood passage and ensure free movement of moving parts of gate. In low supplies when openings are not desirable, raising of gates by 150 mm for a few minutes should suffice. If the gates have not been moved for a sufficiently long time, they should not be forcibly raised all at once but should be lifted by about 30 mm or so and left at that position for about 10 to 15 min till the silt deposited against the gates gets softened and water begins to ooze out. This is essential to avoid heavy strain on the machinery.

4.2.2 The speed of operation of the gates should be limited to the maximum speed indicated by the manufacturer.

4.2.3 The head regulator gates should be opened equally unless otherwise indicated in the model studies report.

4.2.4 The operation of under sluice gates should be based on approved gate operation schedule besides model studies, if conducted, for optimum silt exclusion, hydraulic efficiency and structural safety.

4.2.5 Sequence of operation of barrages gates/weir shutters should be decided by the engineer-in-charge depending on the prevailing factors, such as river behaviour, shoal formation, scour, etc, both on the upstream and the downstream. However, while deciding the same, recommendations/ observations of the model studies, if any, should also be kept in view.

4.2.6 Where the considerations given in **4.2.5** are not governing, it should generally be desirable to subject barrage gates to wedge operation commencing to open from the centre and moving on either side till all the gates have been opened equally. The gates should be opened in installments not exceeding 300 mm at a time. However, suitable passage may be provided to flush out the boulders/ debris, as required.

4.2.7 The operation should be carried out in such a manner that the safety of the structure is not jeopardized at any time. It should be ensured that the permissible difference in static head on either side of the divide walls is not exceeded beyond the safe limit, which should be clearly specified.

4.2.8 The gates provided for silt/shingle excluding devices should be closed very slowly to avoid water hammer action, and other detrimental effects.

4.2.9 Stop-logs are multiple elements placed one above the other upstream of main gate for facilitating inspection and maintenance of main gates. They are generally operated by a gantry crane or a monorail hoist under balanced head condition. Stoplogs shall not be operated under flowing water or unbalanced condition unless these and the operating machinery is designed for such conditions.

4.3 Maintenance of Gates

4.3.1 All cavities and angles in the gates/shutters should be kept clear of debris, driftwood, moss and silt accumulations. All drainage holes in the webs of horizontal structural members should be kept clear to drain off any accumulated water. Green stains should not be allowed to form on the steel members at the back of the gates/shutters. The gates and counter balanced boxes should hang perfectly in level and plumb. This should be checked occasionally and adjustment made as needed. In case of shutters, the chains/anchors holding them should be kept free from rust. IS 10096 (Part 1/Sec 1) and IS 7718 may also be referred for the inspection/ maintenance of the gates considering the type of gates provided on the barrages/weirs.

4.3.2 No painting is required for machined surfaces and surfaces of stainless steel, brass or bronze. These surfaces should be protected by a coating of gasoline-soluble rust preventive non-corrosive compound.

4.3.3 Painting shall be restored by the same type/ quality of paint as originally provided if it has proved satisfactory. Otherwise a suitable painting system can be evolved considering local conditions. The method of application for the paint and surface preparation shall be as per IS 14177 or any standard practices being followed by project owner with the approval of concerned competent authority.

4.4 Gate Grooves and Seals

Grooves and particularly their machined faces should be kept clean and lubricated well and all sticky deposits should be scraped off before application of lubricant.

4.4.1 *Seals*

Efficiency of rubber seals should be tested initially after construction and at the time of closures or isolation of different portions for repairs. The horizontality and verticality of the seal seat and wall plates should be checked with spirit level and seal faces of the rubber seal should be tested to press uniformly both by light test and by use of paper strip inserts. Seals of the gate should be checked for wear and tear as well as deterioration. These should be adjusted/replaced, as necessary. Few sets of spare seals should be kept in stock and stored for emergency in such a way that these seals do not get damaged during storage with the passage of time.

4.4.2 *Staunching Pipes*

Staunching pipes, where provided, should be checked for their sealing efficiency. Repairs/ replacements should be carried out, if necessary.

4.5 Steel Wire Ropes

All steel wire ropes must be cleaned to remove all dust accumulation and lubricated with suitable grease at least once a year.

4.5.1 The clamping devices should be de-clamped and re-clamped at least once in three years. The inspection and maintenance of wire ropes, wire clamps and other clamping devices should be in accordance with the provisions contained in IS 3973 and IS 10096 (Part 3).

4.6 Roller Trains and Fixed Rollers

The roller trains should be examined at least once a year. Partially jammed rollers should be cleaned, freed and greased but totally jammed rollers should be replaced. The bolts of roller guard should be checked and tightened. The sliding/fixed rollers should be extracted at the time of closure (unless necessitated otherwise due to some defects which may need immediate repairs), and cleaned and greased properly. Spare rollers should be kept in stores for ready replacement. IS 7718 may also be referred for inspection, testing and maintenance of gates.

4.7 Winches/Hoist

4.7.1 All winches and lifting drums should be examined at least once a year to see, if all the gears and axles are clean and properly lubricated. All grease-fed bearings should be cleaned, old grease removed with kerosene oil and fresh grease applied. The alignment of shafts should be checked and coupling bolts tightened.

4.7.2 All grease cups must be kept full of lubricants and covers tightened periodically to ensure lubricant

moving and causing an effective seal against dust getting into the bearings. For winches with ratios of 60 : 1 to 100 : 1, four men should be able to operate the hoist easily. If the working of any winch becomes hard and it requires more men to operate, it should be examined and the defect removed before it is used. Winch gear covers should have felt or rubber washers to check the entry of dust. The winches should be operated in correct direction and to ensure this, direction or operation should be correctly marked and the limits of operation indicated.

4.7.3 In case of electrically-operated hoists, all precautions necessary to ensure safety and fault free operation of electric motors and switching devices such as checking up of insulation of all electrical wirings, motor armature windings, etc, should be taken. Mechanical upkeep of motor bearings and reducing gears should be ensured through proper inspection and lubrication. The arrangement for operation of hoists manually in addition to the operation of hoists by electric means should also be provided besides provision for isolating the one from the other. The latest technique of automatic gate lifting may also be provided, if the project is equipped for such operation.

4.8 Wooden planking wherever provided in the decking of hoist bridge, should be checked to tighten up the loose holding down nuts and bolts and worn out planks shall be replaced. The wooden planking should receive at least two coats of creosote oil application once in two years.

4.9 The engineer-in-charge should test all lift gates, chain and clips of falling shutters and submit a certificate to the competent authority before the advent of the monsoon to the effect that all gates/ falling shutters are in good operational condition.

4.10 All flood lighting and barrage illumination should be checked daily during flood season and once in a week during slack season.

4.11 The road bridge bearings should be inspected, cleaned and attended for any defects once a year after the monsoon.

4.12 Any part of the gate leaves, grooves, lifting mechanisms, etc, that may get deteriorated or damaged due to negligence or accident, should be thoroughly repaired or replaced as soon as the damages are noticed.

4.13 The cleaning and painting of superstructures should be done once in two years.

4.14 IS 10096 (Part 3) may also be referred for inspection/maintenance of hoists considering the type of hoist provided on the barrages/weirs before the onset of monsoon and after the flood season.

5 INSPECTION, MAINTENANCE AND INSTRUMENTATION OF CIVIL WORKS

5.1 Inspection of barrages and weirs is necessary to repair all damages and to obviate the possibility of extension of damage. Such inspection should usually be carried out annually for all underwater works after monsoon by means of under water lamps and sounding rods. In addition, detailed inspection in stages should be carried out using underwater videography at suitable intervals depending upon extent of damage. Repairs can be undertaken by either depleting the pond or by isolating the damaged portion by construction of ring bunds. The requisite suitable measures for upstream floor and other floors shall be suitably planned and designed.

5.2 The repairs as necessary as a result of inspection should be carried out well before the onset of the next monsoon. Serious defects noticed should be reported to appropriate authorities for taking remedial measures in time.

5.3 The inspection and maintenance for the following works may be carried out:

a) *Aprons*:
   1) Upstream apron and area immediately upstream of it; and
   2) Downstream apron and area immediately downstream of it;

b) *Impervious floors*:
   1) Upstream of the gates/falling shutters; and
   2) Downstream of the gates/falling shutters;

c) Piers/Abutments;
d) Road/Rail bridges;
e) Sediment excluding devices;
f) Canal head regulator;
g) Instrumentation and performance; and
h) River training works.

5.3.1 *Aprons*

The sounding and probing in the area should be undertaken every year immediately after the monsoon in order to assess the scours and launching of aprons in the vicinity of structures. The non-launching portion should be carefully examined, particularly on downstream, to ensure the effectiveness of inverted filter.

5.3.2 *Impervious Floors*

A thorough inspection of upstream and downstream floors should be undertaken after the monsoon. The upstream floor should be inspected every year early in the fair weather season by probing and the use of

underwater lamps. A careful inspection of joints of the stone-sets should be done where such structures exists. Minor repairs can be done underwater whereas major repairs may be undertaken by isolating the area.

5.3.2.1 The downstream basin should also be carefully inspected and the repairs carried out well in time before the onset of monsoon. In case of deep cisterns requiring expensive cleaning and dewatering, inspection of sandy reaches can be carried out by probing but in boulder reaches where this may not be possible, dewatering, cleaning and repairs may be carried out by rotation once in three years. The condition of boulder-set or granite block in the case of boulder stage river should be carefully examined, and repairs and replacements made, as found necessary. While dewatering deep downstream basins, care should be taken to ensure that the design uplift for such condition is not exceeded. This should be clearly specified in the regulation order.

5.3.3 *Sediment Excluding Devices*

A thorough inspection of roofs, ducts and mouth of the sediment excluders should be carried out every year in the fair weather with the help of divers and underwater lamps. Minor repairs may be carried out underwater and major repairs by local isolation.

5.3.4 *Canal Head Regulator*

The works should be carefully examined every year in the fair weather. The upstream floor should be examined by probing and downstream floor under dry conditions during closure or isolating the area where closure may not be possible. Visual inspection of upstream floor should also be carried out once in three to five years by isolating the area. All necessary repairs should be carried out in time.

5.3.5 *Instrumentation and Performance*

It is essential that every year a performance report be prepared on the basis of instrument observations. The observations can be broadly classified under the following sub-heads:

a) Uplift pressure;
b) Suspended sediment;
c) Settlement;
d) Retrogression;
e) Aggradation upstream; and
f) Discharge distribution and cross flow.

5.3.5.1 *Uplift pressure*

The uplift pressure observation pipes (*see* IS 6532) are embedded in the weir or barrage structure, generally in piers and flank walls in such a manner as to give representative uplift, pressure along and immediately beneath the horizontal floor and at different points along the vertical cut-off. Additional pressure pipes may be installed, if required, to determine uplift pressure at critical points in case of stratified foundations. The pipes should be numbered and a permanent record of observations should be maintained. The observed uplift pressure should be compared with the design uplift pressures with the help of a graphical plot and any needed remedial measures taken. Frequency of observation will depend upon local conditions. It may generally be enough to take observations once a month during monsoon period and more frequently during the non-monsoon period. It should be ensured that,

a) the mouths of all pipes are kept closed by caps to obviate the chances of foreign matter findings its way into the pipes and clogging them;
b) each pressure observation point is given a distinct number; and
c) each pipe is frequently tested to ensure that its strainer is not choked. This can be best done with the help of an ordinary hand pump, by working it till water comes out freely.

5.3.5.2 *Pressure release (drainage) pipes*

The effluent/discharge coming out of pressure release/drainage pipes, where provided in the downstream floor, should be observed for its quantity as well as quality of sediment contents. Such observations may be possible only during dry season when all the gates of the compartments are closed. This is necessary to check the efficient working of the drainage system. A correlation between head of water and discharge should be established and any large variations immediately taken notice of and suitable action taken. As presence of sediment in the effluent could lead to undermining of the foundations, immediate remedial measures should be undertaken. In extreme case, it may become necessary even to completely block the sediment discharging pipe.

5.3.5.3 *Hydraulic jump profile*

Strip gauges should be painted every 10 m on the wing walls and the long divide walls to observe the hydraulic jump profile in the prototype under different hydraulic conditions. The following observations should be taken:

a) Upstream water level;
b) Downstream water level;
c) Shade temperature — maximum and minimum;
d) Temperature of the river water at a depth from the surface below which it remains approximately constant;

e) Temperature of the sub-soil water in a few selected observation pipes;

f) Water level in all pipes may be observed by using a bell sounder or by other suitable means;

g) Discharge from drainage pipes; and

h) Depth of sediment on upstream and downstream floors.

5.3.5.4 *Suspended sediment*

During the monsoon season, water sample should be taken in accordance with IS 4890 simultaneously upstream and downstream of the under-sluices and in the canal below the head regulator to assess the suspended sediment therein. Such observations should be taken at least once a week (closer intervals in case of high sediment concentration) to asses the efficiency of sediment exclusion device and to decide if any change in the mode of regulation and/or other remedial measures are required.

5.3.5.5 *Settlement*

Where appreciable foundation settlements are anticipated, particularly when the structure is founded partially or wholly on clay or other soft soil, surface settlement of relatively heavily loaded parts of the structure should be observed early in the fair weather every year and remedial measures undertaken, if necessary. This can be done by establishing permanent observation points of steel on the structure and doing precise levelling from permanent bench marks established sufficiently away from the influence of any structure.

5.3.5.6 *Retrogression*

Retrogression of the river bed can be expected downstream of the weir/barrage. In order that the lowering of water level at any discharge condition does not exceed that provided for in the design, it is necessary to establish gauges on both banks, one immediately downstream of the work and two more, 1 000 m and 2 000 m downstream of the first and to observe them simultaneously at least once a day. Remedial measures should be undertaken as and when required to ensure the safety of the structure.

5.3.5.7 *Aggradation upstream*

The river bed upstream of the barrage or weir is likely to aggradate resulting in increased afflux and reduction in freeboard provided in design. To determine the increase in the afflux, if any, gauges should be established on the upstream, one immediately upstream of the work and one each at 1 000 m and 2 000 m upstream of the first, and observed regularly. The afflux bunds may have to be raised, if found necessary, to restore the designed freeboard.

5.3.5.8 *Discharge distribution and cross-flow*

Observations should be taken to find the discharge distribution through different bays of the barrage. If there is significant cross-flow and/or difference in discharge intensities through different bays, remedial measures should be taken to check this tendency by adopting modified gate regulations, removal of shoals, etc.

5.3.5.9 *Pond capacity*

Where balancing storage is also provided in the barrage, soundings in the entire pond area may be made at suitable intervals for periodic review of storage capacity.

5.3.6 *River Training Works*

5.3.6.1 A detailed river survey covering the barrage/weir and river training works upstream and downstream should be carried out every year. The survey should preferably extend about one metre above the design flood level on both the banks on upstream side. Similarly, the survey on downstream side should extend to a length up to which river bed changes occur. Sufficient number of permanent reference marks should be established on both banks to facilitate superimposition of old and new survey. The changes in the river course should be examined and remedial measures taken.

5.3.6.2 The afflux bunds, guide bunds and spurs should be examined in the fair weather and necessary repairs to the bunds, pitching and aprons carried out and completed well before the onset of monsoon. An adequate stock of boulder/stones should be maintained close to the protection works for use in emergency.

6 OPERATION AND REGULATION

6.1 Adequate regulation staff should be provided and their duties should be clearly specified. Adequate stock of stores, tools and plants required to meet emergencies should be maintained on all barrages and weirs. These should be listed in detail in the regulation orders and their availability checked periodically by the engineer-in-charge. The gauge sites (*see* **6.3.2.1**) should be linked with the headworks by a reliable communication arrangement such as telephone, wireless, telegraph, etc. As a precautionary measure, the engineer-in-charge will maintain a dossier of personnel who could be deployed at project site in emergency. These personnel should be available at very short notice and capable of performing assigned tasks.

6.2 In general, operation of the barrage gates should ensure the following features:

a) Required pond level is maintained both during the non-monsoon flows and the falling flood periods.

b) Non-monsoon flows remain near the under-sluice bays so that feeding of the canal(s) through the head regulator(s) is not affected.

c) A fair uniform distribution of discharge along the width of the barrage is obtained, as far as practicable.

d) Flow parallel to barrage axis both on the upstream and the downstream of the barrage is avoided at all times, as far as practicable.

e) Risk of deep scour and shoal formations in the vicinity of the barrage both on the upstream and the downstream is minimized, as far as possible.

f) If shoal formation has taken place, the gates in front of the shoal should be opened more to accentuate flushing of sediment with the forward flow wherever sufficient discharge is available. Alternatively, method of sudden and simultaneous opening of required number of gates in front of the shoal could be tried.

g) To evolve the operation of gates to exclude maximum silt/debris deposits on the upstream side and also to minimize the entry of same in canals/channels.

h) Hydraulic jump should not be allowed to form beyond the toe of the downstream glacis in any case.

j) A relatively high intensity of flow is avoided in the deep scour zones, if formed.

k) If a shoal has formed on either upstream, or downstream, or both sides of the barrage, it is washed out and kept away from the barrage, as far as practicable.

m) Gate operation schedule should also consider constraints regarding rates of lowering/raising of ponds. It should also consider the safe rate of filling of the canals.

n) Constant and regular supply in canals/ channels even during fluctuations in discharges from power houses located on the upstream side.

p) Approach channel should be trained so that the tendency of the river to meander near the barrage or outflanking the barrage can be arrested.

6.3 The operation and regulation can be divided into three distinct periods as given below:

a) Pre-monsoon;
b) During monsoon; and
c) Post-monsoon.

6.3.1 *Pre-monsoon Operation*

It is a low flow period and normally no wastage of water should be permitted during this period. The barrage gates/falling shutters should be regulated in such a way that all the available supplies are conserved and pond level is maintained. Any excess flow over and above the requirements through the head regulator(s) should be released through under-sluice bays and silt excluder tunnels, wherever provided. The release through the head regulator of the canal should be based on the discharge tables. The discharge tables should be occasionally checked for accuracy by actual measurements in the canal.

For any flashy flood, the canal may have to be closed temporarily, if the concentration of suspended silt is in excess of the safe limit prescribed.

6.3.2 *Monsoon Operation*

6.3.2.1 Gauges to indicate flood stage should be installed sufficiently (not less than 1 000 m) upstream of the barrage at suitable locations so as to ensure adequate margin of time for operation of gates at the weir/barrage site.

6.3.2.2 During low floods, the gauges should be signalled and recorded every 3 h while in medium and high floods, these should be recorded every hour. The signaller at the headworks, on receiving the flood warning should communicate the same to the official/officer-in-charge of the headwork and other regulation points downstream and to the district officers of the neighbouring districts.

6.3.2.3 The advisability of installation of wireless transmitting stations on headworks located on major rivers for speedy transmission of flood warning should be considered.

6.3.2.4 In order to create most favourable conditions for sediment exclusion from the canal, still-pond regulation should be resorted to, as far as possible. However, in locations where canals cannot be closed for flushing, semi-still pond/regulation may be adopted (as in the case of power channels) as given below:

a) *Still pond operation* — In still pond operation, all the gates of the under-sluice bays are to be kept closed so as to limit the discharge flowing into the under-sluice pocket to be equal to the canal supply. The specified or required discharge only should be drawn in the canal and the surplus river discharge should be passed through the

spillway bays or river sluice bays, if provided. As the under-sluice bays are kept closed, the flow velocity in the pocket cause the sediment to settle down and relatively clear water enters the canal. However, the pocket gets silted up in this process after some time.

At that time, the canal head regulator gates should be closed and deposited silt should be flushed out by opening the gates of the under-sluice bays. The canal supply may be stopped during this scouring operation which may take about 24 h. After the silt deposits are flushed out sufficiently, the head regulator gates should be opened and under-sluice closed. This operation is desirable where the crest of the head regulator is at a sufficiently higher level than that of the upstream floor of the under-sluice bays. This still pond operation should be continued till the river stage reaches the pond level after which the under-sluice gates should be opened to avoid overtopping.

b) *Semi-still pond operation* — In the semi-still pond operation, the gates of the canal head regulator are not closed for flushing of silt deposit in the pocket. The gates of the under-sluice bays should be kept partially open to the minimum necessary so that the bed material in the pocket could be passed downstream. The discharge in excess of the canal requirement should be passed through the under-sluice bays and silt excluder tunnels also, wherever provided.

6.3.2.5 Excluders, where provided, should be kept open and while doing so, the limitations imposed by the safety of the structure should be kept in view. The required intensity of discharge q, which may be sufficient to flush the deposited silt in the pocket can be calculated from the Lacey/Blench's scour equation:

$$R = 1.35\left[\frac{q^2}{f}\right]^{0.33}$$

where

R = scour depth that is, between the water level and the level of the pocket floor in this case, in m;

q = intensity of discharge, in $m^3/s/$ m width; and

f = silt factor corresponding to the deposited material in the pocket.

The required intensity of discharge thus calculated may be generated by suitable gate openings when sufficient head is available in the pond. Under no circumstances should the under-sluice gates be allowed to be overtopped. Silt ejectors in the canal should be operated as much as possible so that the chances of heavy siltation in the canal posing a problem of flushing due to its compaction are minimized.

6.3.2.6 During monsoon month, it is important to keep a constant watch over the sediment entering the headworks, the portion thereof ejected by the extractor if any, and the sediment deposition taking place in the canal and to ensure that sediment deposition only to the extent that can be washed out early in the fair weather before the full demand develops, is allowed. For this, the following actions should be taken:

a) Sediment charge observations (both suspended sediment and bed load) should be made at least once a day in low floods immediately below the head regulator, below the silt ejector, if any, and at any other sensitive point lower down the canal. The frequency of observations may be increased in medium and high floods as required;

b) Cross-section of the canal should be taken daily at a few sensitive points to watch the extent of sediment deposition in the canal;

c) Water surface slopes in the sensitive head reach of the canal should be kept under observation daily with the help of gauges;

d) The ponding upstream of power stations, if any, in the canal should be restricted to the requisite extent so as to avoid harmful sediment deposition; and

e) The canal should be closed from the headworks,

1) beyond a specified sediment charge during medium/high flood and re-opened when the sediment charge drops below the specified limit. Since the silt carrying capacity of the canal would govern this specified limit, it would vary from project to project and should be estimated based on actual data/ experience. In so far as the power channels are concerned, this would depend on the size of the particle carried down.

2) when sediment deposition at the sensitive points has reached the maximum permissible bed level. This limit along with the sediment charge in excess of which the canal is to be kept closed, may have to be fixed for different months during the monsoon period in order to be able to meet the irrigation and power demand.

6.3.2.7 Since cross flows and vortex formations dangerously cause deep scours both on the upstream and downstream of the barrage leading to washing away or sinking of cement concrete blocks and loose stone aprons, and damages to the nose and shanks of guide bunds, visual observations of the direction of current and vortex formation during low and medium floods should be made. After critically observing the effects of different patterns of gate operation on the same, the engineer-in-charge should judiciously select the correct pattern which would cause only minimum scour or minimum shoaling.

6.3.2.8 The engineer-in-charge should be conversant with the shoal formations, changing network of spill channels, etc, which cause unequal distribution of flows through different bays, cross flow near the barrage floor ends, vortex formations, etc. Gate operation of barrage structure should be attempted in such a manner that the shoal formation in the vicinity of barrage structure both upstream and downstream is avoided.

6.3.2.9 The pond level should be kept minimum required to feed the canal with the required discharge by suitably opening the gates. It should be ensured that in a high flood, all falling shutters of weirs are lowered and all gates raised clear of the water level with adequate freeboard to clear floating debris.

6.3.2.10 The operation of barrage gates/weirs shutters should preferably be based on model studies at various flood intensities, that is, low, medium and high, as modified by observed river behaviour at site. In this connection, for major barrages it would be desirable to constitute a gate regulation committee for each barrage comprising senior engineers of the project design office and research station and engineer-in-charge of the headworks division. The Committee should hold meetings at least once during pre-monsoon, monsoon (preferably twice) and after monsoon and should review the gate operation pattern and modify, wherever necessary on the basis of the observed river cross-section on the upstream and downstream of the structure. After some years when satisfactory flow conditions are established, all the recommendations of the Committee from time-to-time should be compiled in the form of a manual so that guidance could be obtained by the gate operating personnel for future use in the project. Generally with the rise in the flood discharge, step-by step gate operation with gradual increase of opening from ends towards the centre is sometimes recommended.

6.3.2.11 In order to keep a close watch on the river behaviour and bed configuration both upstream and downstream of the barrage, river surveys should be conducted regularly, once before the floods and another after the floods. For major structures, powerful launches fitted with echo-sounders or any other state of art instrument is desirable to take cross-sections even during medium flood stage. The survey should be conducted over a stretch of the river close to the barrage at least up to the end of guide bank both on upstream and downstream. The bed levels should be determined at close intervals of at least 10 m. Depending upon the bed configuration, the pattern of gate regulation should be modified suitably to ensure safety and better hydraulic performance of the barrage. Canals having hydro-electric power stations should be provided with trashracks at the head regulator to check entry of floating debris. The trashracks should be kept clean, preferably by a mechanical or electrical operation device. Instances of collapse of trash racks due to lack of cleaning and excessive pressure built up have been on record. Where floating debris try to enter the irrigation canal head regulators, trash booms may be erected just upstream of the head regulators.

6.3.2.12 The cranes for lifting weir shutters should be housed safely in the crane house when not in use.

6.3.3 *Post-monsoon Operation*

6.3.3.1 Sediment charge observations and cross-section at sensitive points on the canal should be continued at less frequent intervals till satisfactory conditions have been established.

6.3.3.2 Still/semi-still pond operation, with sediment excluders operating, depending on the surplus water availability should be continued till water becomes reasonably clear.

6.4 When a canal is first opened, a low supply should be run for a few hours at least and the depth should gradually be increased according to the requirements. The rate of falling and lowering of the canal should be prescribed and these should not be transgressed. Silt ejector hoppers and outlet pipes may be cleaned by pressure flow or back-jetting before the canal is started for operation.

6.5 If a study of the survey data indicates that shoal formation has occurred on the upstream and/or downstream of the barrage inspite of judicious operation of the gates, during normal and flushing operation of reservoir, the shoal should be removed by dredging by the use of suitable dredgers to the extent possible so that satisfactory flow conditions are established and also desired capacity is restored.

6.6 Satellite imageries obtainable from the National Remote Sensing Agency may be helpful in the identifying the variations of the bank lines, flow

patterns, formation of submerged shoals, etc, in the upstream pond from year to year. Studies with satellite imageries may be made and remedial measures for improving the river behaviour and flow pattern may be taken up.

6.7 In addition, physical/morphological model study will be useful for understanding,

a) morphological behaviour of the river;
b) its aggradation, degradation and meandering tendency; and
c) sediment transport with varying level, etc.

Attempt should be made to prove/improve these models on the basis of prototype observations of barrages.

7 HISTORY OF HEADWORKS

A continuous history of river behaviour and the overall performance of the barrage/weir, head regulators and river training works should be maintained on all major headworks. The history should also contain the details of maintenance, damage and repair carried out from time-to-time, prescribed schedule of gate operation and in case of deviation of prescribed schedule, the actual gate operation with reasons thereof, etc. Necessary drawings should be appended in the record. Pre-monsoon and post-monsoon river bed contours may be plotted, reduced in size and properly filed in serial order for comparison to understand the pattern of shoals, scours, oblique flow, etc.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
3973 : 1984	Code of practice for the selection, installation and maintenance of wire ropes (*first revision*)
4890 : 1968	Methods for measurement of suspended sediment in open channels
6532 : 1972	Code of practice for design, installation, observation and maintenance of uplift pressure pipes for hydraulic structures on permeable foundations
7718 : 1991	Recommendations for inspection, testing and maintenance of fixed wheel and slide gates (*first revision*)
10096	Recommendations for inspection, testing and maintenance of radial gates and rope drum hoists:
(Part 1/Sec 1) : 1983	Inspection, testing and assembly at the manufacturing stage, Section 1 Gates
(Part 3) : 2002	After erection (*first revision*)
14177 : 1994	Guidelines for painting system for hydraulic gates and hoists

ANNEX B
(*Foreword*)

COMMITTEE COMPOSITION

River Training and Diversion Works Sectional Committee, WRD 22

Organization	*Representative(s)*
Central Water Commission, New Delhi	Shri G. S. Purba (***Chairman***)
Bhakra Beas Management Board, Nangal Township	Superintending Engineer Senior Design Engineer (B&B) (*Alternate*)
Border Roads Organization, New Delhi	Shri A. K. Dikshit Shri D. K. Purwar (*Alternate*)
Brahamputra Board, Guwahati	General Manager Chief Engineer (P&D) (*Alternate*)
Central Water & Power Research Station, Pune	Shri D. N. Deshmukh Shri M. N. Singh (*Alternate*)
Central Water Commission, New Delhi	Director (FM I) Director (BCD) E&NE (*Alternate*)
Consulting Engineering Services, New Delhi	Shri P. K. Chatterjee Dr Om Prakash (*Alternate*)
Delhi College of Engineering, New Delhi	Head (Civil Enginerring Department)
Flood Control Department, Government of Assam, Guwahati	Chief Engineer (Quality Control) Additional Chief Engineer (*Alternate*)
Gammon India Limited, Mumbai	Shri M. S. Bisaria Shri V. N. Heggade (*Alternate*)
Ganga Flood Control Commission, Patna	Director (Master Planning 2) Director (Planning) (*Alternate*)
ICT Pvt Ltd, New Delhi	Shri P. L. Diwan Prof S. K. Mazumder (*Alternate*)
IIT, Roorkee	Dr Nayan Sharma
Indian Institute of Technology, New Delhi	Head (Civil Engineering Department)
Irrigation & Waterways Directorate, Govt of West Bengal, Kolkata	Director (CDO) Dr Abhijit Saha (*Alternate*)
Irrigation Department, Government of Andhra Pradesh, Hyderabad	Superintending Engineer (B&C) Superintending Engineer (Dams) (*Alternate*)
Irrigation Department, Government of Haryana, Chandigarh	Chief Engineer (Drainage) Director (Central Design) (*Alternate*)
Irrigation Department, Government of Jammu, Jammu	Shri Bodh Raj Dogra Shri Natha Ram (*Alternate*)
Irrigation Department, Government of Punjab, Chandigarh	Chief Engineer (Drainage) Joint Director (Central Designs) (*Alternate*)
Irrigation Department, Government of Uttarakhand, Roorkee	Director (IRI) Research Officer (IRI) (*Alternate*)
Irrigation Department, Government of Maharashtra, Nasik	Superintending Engineer (Gates) Shri R. V. Jaltare (*Alternate*)
Kolkata Port Trust, Calcutta	Shri Bikas Chaudhuri Shri M.N Ray (*Alternate*)

Organization	*Representative(s)*
Ministry of Railways (RDSO), Lucknow	Director (B&F)/Inp. Assistant Design Engineer (B&F) (*Alternate*)
NHPC Ltd, Faridabad	Shri A. K. Jain Shri Mahesh Kumar (*Alternate*)
Public Works Department, Chennai	EIC, WRO & CE (GI) Supertending Engineer (DC) (*Alternate*)
RITES, New Delhi	Shri G. Sethuraman Shri Mukesh Kumar (*Alternate*)
Sardar Sarovar Narmada Nigam Limited, Gandhi Nagar	Shri Vivek P. Kapadia Shri Mukesh B. Joshi (*Alternate*)
Tehri Hydro Development Corporation Limited, Rishikesh	Shri G. M. Prasad
Water Resources Department, Patna	Shri S. Janki Raman Prasad Sinha
Water Resources Development Organization (WRDO), Bangalore	Shri C. V. Patil Shri Basavaraja Koti (*Alternate*)
BIS Directorate General	Shri J. C. Arora, Scientist 'F' and Head (WRD) [Representing Director General (*Ex-officio*)]

Member Secretary

Shri R. R. Dash
Scientist 'B' (WRD), BIS

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Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

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TOTAL VOLUME OF SILT TO BE REMOVED ABOVE ORIGINAL BED LEVEL FROM KM 0.000 TO KM 13.500 AS PER 1ST BATHYMETRIC SURVEY (DEC-2019 & JAN - 2020).		
Sl. No.	**Mileage**	**Silt volume to be removed above original bed level (in Cum)**
1	From Km 0.000 to Km 2.000	2021790
2	From Km 2.000 to Km 3.000	1627318
3	From Km 3.000 to Km 4.000	2346845
4	From Km 4.000 to Km 5.000	2148367
5	From Km 5.000 to Km 6.000	1079361
6	From Km 6.000 to Km 7.000	357011
7	From Km 7.000 to Km 8.000	392878
8	From Km 8.000 to Km 9.000	1310469
9	From Km 9.000 to Km 10.000	508263
10	From Km 10.000 to Km 11.000	184515
11	From Km 11.000 to Km 12.000	278960
12	From Km 12.000 to Km 13.000	215358
13	From Km 13.000 to Km 13.500	6570
TOTAL		**12477705**

TOTAL VOLUME OF SILT TO BE REMOVED ABOVE ORIGINAL BED LEVEL FROM KM 0.000 TO KM 13.500 AS PER 2ND BATHYMETRIC SURVEY (DEC-2020 & JAN - 2021).		
Sl. No.	**Mileage**	**Silt volume to be removed above original bed level (in Cum)**
1	From Km 0.000 to Km 2.000	2025763
2	From Km 2.000 to Km 3.000	1777497
3	From Km 3.000 to Km 4.000	2346899
4	From Km 4.000 to Km 5.000	2148451
5	From Km 5.000 to Km 6.000	1081597
6	From Km 6.000 to Km 7.000	377436
7	From Km 7.000 to Km 8.000	644004
8	From Km 8.000 to Km 9.000	1334469
9	From Km 9.000 to Km 10.000	535235
10	From Km 10.000 to Km 11.000	187104
11	From Km 11.000 to Km 12.000	281017
12	From Km 12.000 to Km 13.000	217278
13	From Km 13.000 to Km 13.500	69783
TOTAL		**13026531**

Minutes of meeting held between Mining Department and Water Resources Department for De-Siltation of Prakasam Barrage, Krishna River at 2:30 PM on 16.12.2020 in Conference Hall, O/o Commissionerate, PR&RD, Tadepalli

A meeting is conducted under the Chairmanship of Spl. Chief Secretary to Govt. (Irrigation Dept.) between officials of Water Resources Department (WRD), Department of Mines & Geology and M/s APMDC Ltd. to finalize the action plan for de-siltation of Prakasam barrage duly considering the judgment of Hon'ble NGT in O.A.No. 935 of 2018 from 2:30 PM on 16.12.2020. The following officials attended the meeting:

1. Sri. Aditya Nath Das, IAS,
   Spl. Chief Secretary to Govt. (Water Resources Dept.)
2. Sri. Gopal Krishna Dwivedi, IAS,
   Prl. Secretary, Ind. & Comm. (Mines) Dept. (FAC)
3. Sri. Hari Narayanan M. IAS,
   VC & MD, M/s APMDC Ltd
4. Sri. K. Narasimha Murthy, S.E., Water Resources Dept.
5. Sri. V. Koteswara Raju, JDMG, O/o DMG
6. Sri. D. Srinivas Rao, JDMG, O/o APMDC Ltd.
7. Sri. A. Raja Swaroop Kumar, E.E. K.C Division, R.C (Krishna)
8. Sri. R. Umamaheswar Reddy, ADMG (FAC), O/o DMG
9. Sri K. Narendra, A.E.E., R.C (Section Officer)
10. As per the orders of Hon'ble National Green Tribunal on 24.08.2020 in O.A.No. 935 of 2018, Hon'ble NGT has disposed of the case stating that no further order is necessary except that the operations be overseen by the same Expert Committee to ensure that no damage is caused to environment.
11. Based on the discussions at length, it is decided as follows:

i. Desiltation operations shall be undertaken by the Water Resources Department (WRD), to restore the storage capacity of the barrage which has been silted over the years.

ii. The tender for appointing competent agency will be floated by SE,

WRD., Prakasam Barrage to undertake Desilting operations in the Prakasam Barrage, duly considering the following aspects:

a. The appointed agency shall be required to comply with the orders issued by Hon'ble NGT in O.A.No. 935 of 2018.
b. WRD shall demarcate the area proposed for De-siltation and estimate the volume of silt to be extracted by the agency.
c. The quantity proposed to be desilted shall be arrived duly considering the silt required to be removed to restore the design storage capacity of the barrage.
d. Targets shall be specified for the Agency to ensure minimum fifty (50) lakh tonnes of desilted sand in the next six (6) months.
e. Finalize any other Technical guidelines to be complied by the appointed agency for undertaking desiltation in the reservoir.
f. Specify the permissible levels of clay in the extracted silt which will be permitted, for the purpose of making payments to the agency. The same shall be incorporated in the tender.
g. WRD shall specify the location of the stockyard for the silt extracted from the reservoir.
h. Lowest rate per Cubic meter of silt of suitable quality quoted by the Agency shall be selected as the Successful Bidder.
i. Technically qualified agency, which quotes the lowest bid (i.e. per tonne/per Cubic meter basis) for de-siltation and depositing the silt in the specified location, shall be selected as the Successful Bidder.
j. The appointed agency shall be required to undertake de-siltation operations duly adhering to all guidelines and rules and procedures prescribed by the WRD.

iii. The sand obtained through De-siltation process shall be handed over to M/s APMDC Ltd (or any other Agency as appointed by the State Government) for subsequent disposal.

iv. The eligible cost incurred by the WRD towards the de-siltation operations shall be borne by M/s APMDC Ltd (or any other Agency as appointed by the State Government).

v. WRD shall charge, M/s APMDC Ltd (or any other Agency as appointed by the State Government) a Supervisory fee of 1.5% on the Cost of De-siltation quantity towards administrative and supervision charges.

vi. Tender document shall be prepared within one (1) week and the NIT shall be issued by Irrigation Dept. within two (2) weeks

4. Meeting is ended with the above mentioned instructions.

Prl. Secretary to Government (Mines)

Spl. Chief Secretary to Govt. (Water Resources Dept.)

GOVERNMENT OF ANDHRA PRADESH
ABSTRACT

Water Resources Department – Krishna Delta System - Administrative approval accorded for an amount of Rs. for Rs.102.447 crores for the work of "De-silting of silt from the foreshore of Prakasam Barrage in Krishna River" - Orders – Issued.

WATER RESOURCES (PROJECTS.II)DEPARTMENT

G.O.RT.No. 81 **Dated: 15-03-2021**
Read the following:-

1. From the Chief Engineer, Krishna Delta System, Vijayawada, Letter No.CE/KDS/VJA/OT-3/AE-10/F-De-silting/2220 dated 30.11.2020.
2. Govt. Memo. No.MJIR/599/Projects.II/2020-1 dated 17.12.2020. & 27.12.2020.
3. From the Chief Engineer, Krishna Delta System, Vijayawada, Letter No.CE/KDS/VJA/OT-3/AE-10/F.De-silting/45 dated 07.01.2021.
4. From the Chief Engineer, Krishna Delta System, Vijayawada Letter No. CE/KDs/VJA/OT-3/AE-10/F.De-slting/233 dated 29.01.2021.

O R D E R:-

In the references 1st 3rd and 4th read above, the Chief Engineer, Krishna Delta System, Vijayawada while explaining the circumstances and submitting the following (12) nos estimates for de-silting works on upstream side of Prakasam Barrage, has requested the Government to accord Administrative Approval for an amount of Rs. 109.65 crores, under the Head of Account "MH 4700-COL on Major Irrigation– (01)MI – (136) KDS – GH(11) NSP – SH (27) – 530 Major Works – 531 Major Works" and also ratify the action, taken in according to Technical Sanction and calling tenders by the Superintending Engineer, Irrigation Circle, Vijayawada prior to the Administrative Approval.

Sl. No.	Name of the work	Estimate Amount (Rs. in Lakhs)
1	De-silting of silt from the foreshore of Prakasam Barrage from Km 0.50 to Km 1.00 in Krishna River	764.00
2	De-silting of silt from the foreshore of Prakasam Barrage from Km 1.40 to Km 2.00 in Krishna River	940.00
3	De-silting of silt from the foreshore of Prakasam Barrage from Km 2.25 to Km 2.50 in Krishna River	904.50
4	De-silting of silt from the foreshore of Prakasam Barrage from Km 2.90 to Km 3.20 in Krishna River	957.00
5	De-silting of silt from the foreshore of Prakasam Barrage from Km 3.50 to Km 3.70 in Krishna River	957.00
6	De-silting of silt from the foreshore of Prakasam Barrage from Km 3.90 to Km 4.10 in Krishna River	887.00
7	De-silting of silt from the foreshore of Prakasam Barrage from Km 4.30 to Km 4.50 in Krishna River	869.50
8	De-silting of silt from the foreshore of Prakasam Barrage from Km 4.80 to Km 5.20 in Krishna River	905.00
9	De-silting of silt from the foreshore of Prakasam Barrage from Km 5.70 to Km 6.50 in Krishna River	957.00
10	De-silting of silt from the foreshore of Prakasam Barrage from Km 7.50 to Km 8.40 in Krishna River	997.50
11	De-silting of silt from the foreshore of Prakasam Barrage from Km 8.80 to Km 9.30 in Krishna River	939.50
12	De-silting of silt from the foreshore of Prakasam Barrage from Km 11.00 to Km 13.50 in Krishna River	887.00
Total		10965.00

(P.T.O)

2. Government after careful examination hereby accord administrative approval for an amount of Rs. **102.447 (Rupees one hundred two crores, forty four lakhs and seventy thousand only)** as detailed below for taking up de-silting works on upstream side of Prakasam Barrage for extracting 50 Lakhs tones of de-silted material for use in priority works of the Government, subject to the following conditions, and also ratified the action, taken in according to Technical Sanction and calling tenders by the Superintending Engineer, Irrigation Circle, Vijayawada prior to the Administrative Approval.

1. The W.R. Department & M/s APMDC Limited shall obtain certification from the competent technical authority that the de-silted material is suitable for the purpose of the proposed works & satisfy themselves about the same.
2. The de-silting operations are taken up in strict conformity with the directions of the Hon'ble NGT in O.A.No 935/2018.
3. The entire cost of de-silting operations shall be met by M/s APMDC Limited.
4. The value derived from sale of the de-silted material shall exceed the cost of the end-to-end operation i.e., survey, excavation, transportation, sale, etc., and result in net profit to APMDC Limited/ Government.

Sl. No.	Name of the work	Estimate Amount (Rs. in Lakhs)	After Scrutiny (Rs. in Lakhs)
1	De-silting of silt from the foreshore of Prakasam Barrage from Km 0.50 to Km 1.00 in Krishna River	764.00	714.00
2	De-silting of silt from the foreshore of Prakasam Barrage from Km 1.40 to Km 2.00 in Krishna River	940.00	878.5
3	De-silting of silt from the foreshore of Prakasam Barrage from Km 2.25 to Km 2.50 in Krishna River	904.50	845.70
4	De-silting of silt from the foreshore of Prakasam Barrage from Km 2.90 to Km 3.20 in Krishna River	957.00	895.00
5	De-silting of silt from the foreshore of Prakasam Barrage from Km 3.50 to Km 3.70 in Krishna River	957.00	895.00
6	De-silting of silt from the foreshore of Prakasam Barrage from Km 3.90 to Km 4.10 in Krishna River	887.00	828.00
7	De-silting of silt from the foreshore of Prakasam Barrage from Km 4.30 to Km 4.50 in Krishna River	869.50	812.00
8	De-silting of silt from the foreshore of Prakasam Barrage from Km 4.80 to Km 5.20 in Krishna River	905.00	845.00
9	De-silting of silt from the foreshore of Prakasam Barrage from Km 5.70 to Km 6.50 in Krishna River	957.00	894.00
10	De-silting of silt from the foreshore of Prakasam Barrage from Km 7.50 to Km 8.40 in Krishna River	997.50	932.00
11	De-silting of silt from the foreshore of Prakasam Barrage from Km 8.80 to Km 9.30 in Krishna River	939.50	877.50
12	De-silting of silt from the foreshore of Prakasam Barrage from Km 11.00 to Km 13.50 in Krishna River	887.00	828.00
	Total	**10965.00**	**10244.70**

(continue…3)

3. The Chief Engineer, Krishna Delta System, Vijayawada, shall take necessary action in the matter.

4. This order issues with the concurrence of Finance Department vide their U.O.No. FIN01-FMU0MRAS(WR2)/13/2021-FMU-WR-II Computer No:1340494 16/02/2021.

(BY ORDER AND IN THE NAME OF THE GOVERNOR OF ANDHRA PRADESH)

J.SYAMALA RAO
SECRETARY TO GOVERNMENT

To
The Chief Engineer, Krishna Delta System, Vijayawada.
Copy to:
The P.S to Hon'ble Minister for Water Resources Department
The P.S to Secretary to Government (WRD).
The Finance (FMU- WR.II) Dept.,
The Accountant General, A.P., Vijayawada.
The Director of Works and Accounts, Ibrahimpatnam, Vijayawada.
Sf/Sc.

// FORWARDED :: BY ORDER //

SECTION OFFICER

(206)

R No:- 195
28-5-2021

GOVERNMENT OF ANDHRA PRADESH
WATER RESOURCES DEPARMENT

(1)

From:
Sri A.Raja Swaroop Kumar, M.Tech.,
Executive Engineer,
Krishna Central Division,
Vijayawada.

To,
The Commissioner,
AMRDA,
Vijayawada.

Letter No: EE/KCD/DB/JTO1/ 494M Date: 19 - 05-2021

SE	
Dy. SE	
N.T.P.A.	

Sir

Sub: - Water Resources Department – "De-silting of silt from the foreshore of Prakasam Barrage in Krishna River" – 12 No:of Works – Requesting for Providing of Government Land in 2 Reaches – Report Submitted – Reg.

Ref: 1 Water Resources (Projects.II) Department G.O Rt.No:81 Dated:15/03/2021.
2)Letter of Acceptance of Reach Dredging Limited Lr No: SE/IC/VJA/DB/ATO / 434M Dated:30/04/2021.
3)Letter of Acceptance of Reach Dredging Limited Lr No:SE/IC/VJA/DB/ATO/ 435M Dated:30/04/2021.
4)Reach Dredging Limited Letter Ref:RDL/2021-21/APWRD/004 Dated:10/05/2021.
5)DEE/HQ Sub Division, Vijayawada Lr No: 169E Dated:15/05/2021.

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In the reference 1st cited the GoAP, Water Resources Department accorded administrative approval for an amount of Rs.102.447 Crores for taking up 12 no of de-silting works on upstream side of Prakasam Barrage for extracting 50 Lakhs tones of de-silted material for use in priority works of the Government and restore to the original capacity of the Barrage.

In continuation the tenders have been invited for the 12 no. of works in Reverse Tendering system. After finalizing the qualified bibbers, the work orders were issued by the Superintending Engineer, Irrigation Circle, Vijayawada to the lowest bidder on 30/04/2021 and the works are going to start duly obtaining the men and machinery and land for stacking the dredged material.

A.J.D
31/5/21

With reference to the above 2nd & 3rd cited, the 7 works was awarded to the Reach Dredging Ltd as shown below.

S.No	Reach No	Dredging Chainage	Latitude	Longitude
1	1	From KM.0.500 to KM.1.000	16°30'3.02"N	80°35'54.70"E
			16°30'7.47"N	80°35'38.51"E
2	2	From KM.1.400 to KM.2.000	16°30'12.41"N	80°35'26.06"E
			16°30'21.10"N	80°35'7.94"E
3	5	From KM.3.500 to KM.3.700	16°30'27.00"N	80°34'18.09"E
			16°30'27.08"N	80°34'11.38"E

4	6	From KM.3.900 to KM.4.100	16°30'29.14"N	80°34'4.97"E
			16°30'32.43"N	80°33'59.13"E
5	7	From KM.4.300 to KM.4.500	16°30'37.31"N	80°33'54.68"E
			16°30'42.36"N	80°33'50.44"E
6	9	From KM.5.700 to KM.6.500	16°31'10.04"N	80°33'21.86"E
			16°31'26.57"N	80°33'0.99"E
7	10	From KM.7.500 to KM.8.400	16°31'51.71"N	80°32'39.63"E
			16°32'16.67"N	80°32'23.85"E

With reference to the 4th cited, the Reach Dredging Limited is going to start the reaches 9th and 10th in first instant and requiring Government land nearby for dumping the dredging material and mentioned that the lands is available with CRDA in survey numbers 83,84,87,98,99,101,102 in venkatapalem village and 3,4,5,6,7,8,9,10,11,12,13,14,15,16, 17,32,165,166,205,206 in Mandadam village.

In view of the above, it is requested to allot the adjacent lands at least an extent of 20 Acres in between the coordinates mentioned above in Penumka Village of Tadepalli Mandal and Venkatapalem, Mandadam Villages of Thullur Mandal to the agency on temporary basis with your department norms as per the procedure in vogue.

This is submitted for information and further taking necessary action.

Yours Faithfully
Sd/- A. Raja Swaroop Kumar
Executive Engineer,
Krishna Central Division,
Vijayawada.

- Copy submitted to the Chairman & Managing Director/ADCL for Favour of Information and necessary action.
- Copy submitted to the Superintending Engineer, Irrigation Circle, Vijayawada for Favour of Information and necessary action.
- Copy to the Deputy Engineer, Head Quarters Sub Division, and Vijayawada for favour of Information and to pursue the matter immediately.

Executive Engineer,
Krishna Central Division,
Vijayawada.

ECOLOGICAL IMPACT ASSESSMENT STUDY ON FLORA AND FAUNA OF RIVER KRISHNA (UPSTREAM OF PRAKASAM BARRAGE, UP TO 13.5 KM) AND SOCIO-ECONOMIC EFFECTS DUE TO DESILTATION

I BACKGROUND

Department of Mines, Govt. of Andhra Pradesh has approached the authorities of Acharya Nagarjuna University in the month of September, 2019 and besought to takeup an assessment study on the effect of desiltation in river Krishna upstream waters upto 13.5 kms from Prakasam barrage on flora and fauna as well as on Socio-economic condition of dependant people. Consequently, the University authorities has directed and assigned the work to four departments namely Dept. of Zoology & Aquaculture, Dept. of Botany & Microbiology, Dept. of Environmental Sciences and Dept. of Sociology & Social Work. In obdience to that, Prof. G. Rosaih and Dr. V. UmaMaheswara Rao of Dept. of Botany & Microbiology, Dr. G. Simhachalam of Dept. of Zoology & Aquaculture, Dr. P. Brahmaji Rao of Dept. of Environmental Sciences and Dr. M. Trimurthi of Dept. of Sociology & Social Work, along with the Research scholars as assistant personnel, have taken up the task of studying different aspects of the proposed work pertained to the areas of the departments.

II. INTRODUCTION

The river Krishna is one of the major sources of irrigation and drinking water. An embankment across the river Prakasam Barrage (16°30'23.0"N, 80°36'17.2"E) at Vijayawada, near Amaravathi for conserving water. Bhavani Island situated in the midst of the Krishna River at the upstream of Prakasam barrage is a tourist spot and also small

Islandare unique to the river. The river water supporting to the native flora, fauna, and they form different communities.

Krishna river water quality criteria is one of the more prominent of rivers in India. The physico-chemical and biological parameters of Krishna river water represent more potability. Good water quality in the river favorably enrich the habitat for aquatic flora, fauna and benthic organisms. The optimum trophic levels in the riverine system enhance the primary productivity, consumers and decomposers, thereby ecological balance is maintained in the riverine ecosystem.

Phytoplankton are the microscopic organisms that live in fresh or salty water environments. The most common kinds of phytoplankton are Blue green algae, Green algae, Diatoms and Dinoflagellates. Several factors viz., temperature, salinity, depth, CO_2 and nutrients of water habitats, sunlight and grazing by predators influence the growth rate of phytoplankton. However, the life span of any individual phytoplankton species is rarely more than a few days. Phytoplankton contribute to about 90% of total primary production in aquatic habitats. Phytoplankton is a key food item for rotifers, molluscs etc., being the foundation of aquatic food web. Phytoplankton play a central role in nutrient cycling in aquatic habitats. They also serve as indicators of water quality as they respond quickly to environmental changes. However, dense blooms of phytoplankton blocks sunlight from reaching the bottom in shallow areas of estuaries and may cause massive decline in the submerged aquatic vegetation.

A riparian zone or area is the interface between land and a river or stream. Plant habitats and communities along the river margins and banks are called Riparian vegetation. Many kinds of plants including grasses, shrubs, herbs, vines, trees and hydrophilic plants grow in the riparian region. The healthy riparian vegetation helps to reduce stream bank erosion, to maintain stable stream, and to maintain high water quality in streams, rivers and lakes by functioning as a buffer, filtering out sediments and debris. Riparian vegetation slows down and dissipates flood waters and thereby prevents erosion that damage fish spawning areas and aquatic insect habitats.

Zooplankton are a type of heterotrophic plankton that range from microscopic organisms to large species, non motile perform weak swimming. Water currents help them for movement. Zooplankton lead partially plankton mode of life (larval forms of aquatic

organisms), remain as plankton for their entire lifecycle (Rotifera, Cladocera, Copepoda). Composition and distribution vary with the locations of the water body. Seasonal Changes in the abiotic factors, rainfall and nutrients could lead to zooplankton succession. Zooplankton is the major primary and secondary links in the food chain. Zooplankton community serves as basic indicators.

Benthos are organisms in the community that live in or on the river bottom. Benthic zone is the region at the bottom of the river including sediment surface and subsurface layers. Depth of water, temperature and type of substrate effect the distribution quality of benthos. Bivalves are dominant at hard substrates sand bottoms. Polychaetes populate at soft muddy bottoms. Algae serve as food for a variety small worms, insects, crustaceans and other benthic invertebrates.

The freshwater fishes are an integral component of aquatic ecosystem. In addition of being a desired resource for users of the aquatic habitat, they play important role in energy flow, cycling of nutrient and maintaining community balance in the river. It is an important element in the dependent community as well as economy of our nation and many people utilize as a diet. Freshwater fishes are direct indicators of the healthy river system.

Avian fauna is generally observed in riverine system and wetlands particularly for the feeding activity on molluscs, fishes and insects. Some avian species are resident to particular habitats for hatching and breeding. Birds are so important for the ecosystem, as their nutrient-valued faecal matter droppings leads to the improvement of ecosystem.

Social effects are evolved from the environmental, social and economic factors; however, it should be emphasized the quantifying socio-economic effects is a difficult task. An assessment and a study on socio-economic effects of desiltation in river Krishna would be helpful in wise decision making in river management. Though some sub-components of desiltation may improve the social conditions i.e. income generation, local revenue, livelihood, employment etc.

III. ABOUT ACHARYA NAGARJUNA UNIVERSITY

Acharya Nagarjuna University, a state university established in 1976, has been constantly striving towards achieving progress and expansion during its existence for over four decades, in terms of introducing new courses in the University Colleges, affiliated colleges

and professional colleges. Spread over 300 acres of land on the National High Way (NH-5) between Vijayawada and Guntur of Andhra Pradesh, the University is one of the front ranking and fastest expanding Universities in the state of Andhra Pradesh. The University was inaugurated on 11th September, 1976 by the then President of India, Sri Fakruddin Ali Ahmed and celebrated its Silver Jubilee in 2001. The National Assessment and Accreditation Council (NAAC) awarded 'A' grade to Acharya Nagarjuna University in the year 2016.

It is named after Acharya Nagarjuna- one of the most brilliant preceptors and philosophers, whose depth of thought, clarity of perception and spiritual insight were such that even after centuries, he is a source of inspiration to a vast number of people in many countries. The University is fortunate to be situated on the very soil where he was born and lived, a soil made more sacred by the aspiration for light and a state of wholesomeness by generations of students.

With campus student strength of over 5000, the University offers instruction for higher learning in 50 PG programs and guidance for the award of M. Phil and PhD in 48 disciplines spread over six campus colleges and one PG Campus at Ongole. It also offers 153 UG programs in 412 affiliated colleges in the regions of Guntur and Prakasam Districts. It has a Centre for Distance Education offering 87 UG & PG programs. Characterized by its heterogeneous students and faculty hailing from different parts of the state and the country, the University provides most hospitable environment for pursuing Higher Learning and Research. Its aim is to remain connected academically at the forefront of all higher educational institutions.

The University provides an excellent infrastructure and on-Campus facilities such as University Library with over one lakh books & 350 journals; Smart Classrooms, Computer Centre; University Scientific Instrumentation Centre; Central Research Laboratory with Ultramodern Equipment; Well-equipped Departmental Laboratories; Career Guidance and Placement Cell; Health Centre; Sports facilities with Indoor & Outdoor Stadia and Multipurpose Gym; Sports Hostel; well facilitated separate hostels for Boys, Girls, Research Scholars and International Students; Pariksha Bhavan (Examinations Building); Computers to all faculty members; WiFi connectivity to all Departments; Canteen, Student Centre & Fast-food Centre; Faculty Club; Dr. H.H. Deichman & Dr. S.John David Auditorium cum Seminar Hall; Post Office; Telecom

Centre; State Bank of India; Andhra Bank; Energy Park; Silver Jubilee Park; Fish ponds; Water harvesting structures. The salient features of the university and technical capabilities of the professors is enclosed as Annexure-I.

IV. OBJECTIVES OF THE STUDY

IV.a. Study aspects

The present investigation (October to December 2019) was taken up by four departments; Botany and Microbiology, Zoology and Aquaculture, Environmental Sciences and Sociology and Social Work, ANU, to study the ecological impact of desiltationin River Krishna upstream from Prakasam barrage, Vijayawada, with the following objectives assigned by Dept. of Mines, Govt. of A.P.

1. Studies on suspended solids, turbidity in river Krishna
2. Studies on plankton (Phyto and Zoo plankton) in river Krishna
3. Diversity and community composition of fishes in river Krishna
4. Studies on Benthic fauna of river Krishna
5. Studies on riparian vegetation in river Krishna
6. Studies on Avian fauna in river Krishna
7. Ecological impact study due to desiltation activity
8. Socio-Economic condition of dependents / fisher men of river Krishna

   Accordingly,the study was distributed among four departments of the University concerned to their fields.

IV.b. Study areas

The following sites of river Krishna upstream of Prakasm barrage both on Guntur and Krishna districts side of desiltation locations are taken into consideration for the present study:

1. **Undavalli** (reference site) is located (16° 30' 26.7" N, 80° 34' 23.0" E) in Tadepalli Municipality, Guntur District and south side of Prakasam Barrage from 2.0 km to 3.2 km of KRF Bank. Undavalli is the non-desiltation area which is taken as reference site for the study.There was no baseline data available, hence a site with similar geological characteristics where no dredging activity has taken place is chosen as reference site to compare the impacts.

2. **Penumaka** is located (16° 30' 41.5" N, 80° 33' 54.9" E)in Tadepalli Municipality, Guntur District nearby Undavalli from 3.2 km to 4.4 km of KRF Bank.
3. **Venkatapalem** is located (16° 31' 24.2" N, 80° 33' 38.7" E)in Mandadam Mandal, Guntur District, the desilting area is from 5.0 km to 6.4 km of KRF Bank.
4. **Uddandrayunipalem** is located (16°33'49.0" N, 80°31' 27.4"E) in Mandadam Mandal, Guntur District, the desilting area is from 9.0 km to 10.8 km of KRF Bank.
5. **Lingayapalem**is located (16° 33' 44.7" N, 80° 30' 15.2" E)in Thulluru Mandal, Guntur District, the desilting area is from 10.8 km to 12.0 km of KRF Bank.
6. **Rayapudi** is located (16° 34' 09.3" N, 80° 28' 27.9" E)in Thulluru Mandal, Guntur District, the desilting area is from 12.0 km to 13.5 km of KRF Bank.
7. **Surayapalem** is the (16° 32' 36.4" N, 80° 33' 14.4" E) Panchayat nearby Gollapudi, Krishna District the desilting area is from 6.0 km to 7.0 km of KLF Bank.
8. **Guntupalli**is the (16° 33' 00.3" N, 80° 32' 40.1" E)Panchayat nearby, Krishna District, the de-silting area is from 7.0 km to 9.0 km of KLF Bank.
9. **Ibrahimpatnam**is the (16° 34' 28.9" N, 80° 29' 44.9" E)Mandal in Krishna District, the distance from Prakasam Barrage is 10.0 km to 13.5 km of KLF Bank.

* The desiltation activity was stopped from 01.04.2019 onwards at the sites namely Penumaka, Venkatapalem, Uddandarayunipalem, Lingayapalem and Rayapudi of Guntur district side as per the Govt. Order dated 31.03.2019. On the Krishna district side, the desiltation was stopped at Surayapalem, Guntupally and Ibrahimpatnam from 05.04.2019 as per the Govt. Order dated 05.04.2019.

V. METHODOLOGY

In the present study suitable methodology appropriate to the proposed studies was followed.

V.a. Water quality analysis

The water samples were collected in plastic container of 2 liters capacity from nine different geographic locations along the river during sampling period. Water samples were collected from nine different study sites. From each site six samples from different depths at different times were collected. The total suspended solids (TSS) and turbidity were estimated using Gravimetric method and nephelometric (in termes Nephelo Turbidity

Units), respectively. The water quality in the riverine system was studied w.r.t TSS and turbidity since desilting is likely to increase the TSS and associated turbidity. Grab samples were collected from each location at varying depths of1.5 and 2.0 mts. for6rounds with a gap of 15days between samplings during the 3-month study period from October to December, 2019. Totally, 12samples were collected from each location.

V.b. Plankton and Benthic fauna collection

Plankton (Phyto and zoo plankton) sampling was done by towing the plankton net on the surface (phyto plankton), different depths (zooplankton) of waters until sufficient quantity was collected in the net. The collected samples were transferred to aseptic plastic sampling bottles and added 1% formaldehyde for preservation of Phyto plankton, 5% formaldehyde for preservation of zooplankton. The collected samples were brought to the laboratory for analysis. For screening of phytoplankton and zooplankton concentrated samples of water was placed on clean glass slide and the genera and species were identified through Lica Stereo Zoom Trinacular Microscopic observation and based on the reference slides to the genus level and a consolidated list was prepared.

The qualitative study on zooplankton was carried out by observing the prepared slides under Lica Stereo Zoom Trinacular Microscope. Zooplankton were identified to the genus and species level using previous literature.

For collection of benthic fauna, small core sub samples were taken from superficial sand layer and transferred into the plastic tubs and stirred thoroughly, sieved with different mesh size. Large forms associated with bottom surface collected by hand picking. For benthic fauna associated with vegetation scums and filamentous algae, small amounts of these materials washed into enamel tray containing salt solution and stirred thoroughly. The benthic organisms floated on to the surface were collected and preserved in 10% formaldehyde. Micro benthic fauna were observed under Stereo Zoom Trinocular Microscope and identified to the genus and species level.

V.c. Riparian vegetation collection

For the riparian vegetation study, the plants of riparian vegetation at the study sites were observed, collected, photographed and identified based on the standard books and the representative plant species are given as a consolidated list.

V.d. Fish collection

Fish fauna were collected with the help of artisanal fishermen using different types of gears (Cast nets, Gill nets, dragnets, scoop nets) and craft. Fishes were also collected from catches of local fisher folks at the sites, and from fish market of Polkampadu fishermen cooperative society at Sitanagaram, near Kondaveetivagu head regulatory, where fishes sold only catches of fish folks of river Krishna. As formalin decolorizes the colour of the fish on long preservation, photographs were taken at the collection spot itself and preserved specimens. Fishes were identified to the genus and species level.

V.e. Avian fauna survey

For avian fauna, extensive survey was conducted at 9 different sites of Krishna River basin from October to December, 2019. The observations of bird species were made from early morning to late evening. Point count method was used for observation and identification of bird species. The birds were sighted using an Olympus Binocular (10 x 40, field 7.8), and photographed, wherever it was possible. Birds were identified by using the field guides.

VI. RESULTS OF QUALITATIVE ANALYSIS

VI.a. Water quality

Table 1. Upstream of river Krishna (13.5 km) water quality in the selected stations

S .No	Sampling Location	TSS (mg/l)		Turbidity (NTU)	
		Min	Max	Min	Max
1	Undavalli	125	145	4.5	5.5
2	Penumaka	165	195	5.5	6.1
3	Venkatapalem	110	135	4.1	4.9
4	Uddandrayunipalem	135	165	4.8	5.2
5	Lingayapalem	120	145	4.4	5.4
6	Rayapudi	160	190	5.3	5.9
7	Surayapalem	130	155	4.8	5.1
8	Guntupalli	110	140	5.5	6.1
9	Ibrahimpatnam	95	125	4.5	5.6

The estimated TSS and turbidity values of water samples collected from Undavalli area, non-desilatation sampling site, found in the ranges of 125-145 mg/l and 4.5- 5.5 NTU, respectively. The minimum and maximum values of the estimated TSS in the water

samples collected from the desiltation sites were found to be in the range of 95 – 165 mg/L (minimum) and 125 – 195 mg/L (maximum). On the other hand, the range of turbidity values of the water samples of desiltation sites were observed to be in the minimum and maximum ranges of 4.1 – 5.5 NTU and 4.9 – 6.5 NTU, respectively.

As per BIS drinking water standards, the permissible TSS and turbidity are300 to 600 mg/L and 1.0 to 5.0 NTU, respectively.The TSS and turbidity in reference site and desilting locations are almost in the same range, which implies that the desiltation has not impacted thewater quality w.r.t TSS and turbidity, since desiltation is stopped since more than 6 months.

Figure showing collection of the water sample at Penumakasite

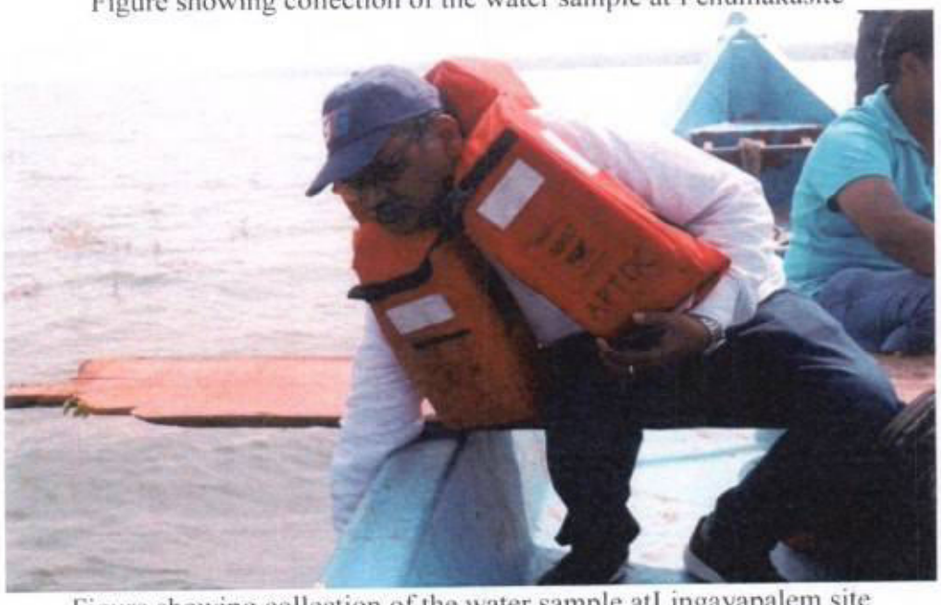

Figure showing collection of the water sample atLingayapalem site

VI.b. Plankton, Benthos and Riparian vegetation

VI.b.i. Undavalli (Reference Site)

Table 2. Consolidated list of flora and fauna of six samplings observed at Undavalli site (Non desilting and reference area) during the study period (Oct – Dec, 2019)

S. No.	Particulars	Observed Species
1	Phytoplankton	Green algae: *Actinastrum* sps.,*Ankistrodesmus* sps., *Coelastrum* sps., *Pandorina* sps., *Pediastrum* sps., *Spirogyra* sps., *Ulothrix* sps. Blue green algae: *Anabaena* sps., *Aphanizomenon* sps., *Arthrospira* sps., *Microcystis* sps., *Nostoc* sps., *Oscillatoria* sps., *Phormidium* sps., *Spirulina* sps., Diatoms: *Pinnularia sps.*
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus dichotomus, Brachionus diversicornis, Brachionus falcatus, Brachionus forficula, Brachionus quadridentatus, Brachionus rubens, Keratella trophica, Asplanchna sp.* (Asplanchnidae), *Cephalodella sp.* (Notommatidae), *Filinia longiseta* (Trochosphaeridae), *Hexthra sp.* (Hexarthridae), *Habrotrocha rosa* (Habrotrochidae), *Habrotrocha zanette, Macrothrix sp.*(Macrothricidae),*Lecane sp.* (Lecanidae) Cladocerans: *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma excisum* (Sididae), *Moina micrura* (Moinidae), *Moina macrocopa, Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Pseudochydorus sp., Alona sp., Biapertura sp., Indialona sp., Chydorus sp., Bosmina sp.* (Bosminidae), *Bosminopsis deitersi* Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Sinodiaptomus (Rhinediaptomus) indicus, Halicyclops spinifer* (Cyclopidae), *Microcyclops varicans, Mesocyclops leuckarti, Mesocyclops sp., Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Paracyclops sp., Calanoid nauplii* (Cyclopidae),*Parastenocaris sp.* (Parastenocarididae) Protozoa: *Vorticella sp.* (Vorticellidae)
3	Benthos	Crustaceans

		Ostracoda: *Cypris condona* (Cyprididae), *Cypris obensa, Cypris subglobosa, Cypris sp., Strandesia indica, Hemicypris falcatus, Cypretta sp., Herpetocypris sp., Parastenocypris major, Stenocypris sp., Parastenocypris biswasi, Parastenocypris sp., Physocypria minutus* (Cyclocyprididae), *Candona sp.* (Candonidae) Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic insects Bugs: *Lethocerus* sp. (Belostomatidae), *Lacotrephes* sp. (Nepidae), *Gerris* sp. (Gerridae), *Micronecta* sp. (Corixidae), *Enithares sp.* (Notonectidae) Beetles: *Dineutus sp.* (Gyrinidae), *Noteridae sp.* (Noteridae), *Sandracottus sp.* (Dytiscidae), *Hydaticus sp., Laccophilus sp.* Insect larvae: *Glossosoma sp.* (Glossosomatidae), *Stenopsyche sp.* (Stenopsychidae), *Hydropsyche sp.* (Hydropsychidae), *Chironomous* (Chironomidae), *Chaoborus* (Chaoboridae), *Thalerosphyrus* (Heptageniidae), *Manayunkia speciosa* (Fabriciidae) Crab: *Paratelphusa jacquemontii* (Gelechiidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Leech: *Hirudinea sp.* (Hirudinidae) Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Gabbia sp.* (Bithyniidae), *Digoniostoma sp., Thiara lineate* (Thiaridae), *Thiara scabra, Thiara tuberculata, Melania scabra, Melanoides tuberculatus, Lymnaea acuminate* (Lymnaeidae), *Lymnaea luteola, Indoplanorbis sp.* (Planorbidae), *Gyraulus convexiusculus, Cryprozona sp.* (Ariophantidae), *Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia sp., Parreysia sp., Corbicula straitella* (Cyrenidae), *Corbicula sp., Macrochlamys sp.*
4	Riparian vegetation plants	*Acacia nilotica, Alternanthera sessilis, Calotropis procera, Cyperus sps., Eichhornia crassipes, Ipomoea aquatica, Phyllanthus amarus, Pithecellobium dulce, Polygonum glabrum, Saccharum spontaneum, Sida longifolia, Ziziphus jujuba.*

At Undavallireference site, a total of 16 different genera of phytoplankton belonging to three main groups viz., Green algae (7 genera), Blue-green algae (8 genera) and Diatoms (1 genus) were observed during the study period. Of the green algae group,

species of *Actinastrum*, *Pediastrum*, *Spirogyra* and *Ulothrix* were found more abundantly in the samples. Species of *Microcystis*, *Oscillatoria*, *Phormidium* and *Spirulina* were abundant among the blue-green algae group and only one genus of diatoms namely *Pinnularia* was observed at Undavalli site.

At Undavalli, the reference site without any desiltation activity in the present study, twelve plant species have been identified belonging to different plant categories. Mainly, *Acacia nilotica* and *Pithecellobium dulce* of tree category; *Calotropis procera*, *Polygonum glabrum* and *Ziziphus jujuba* of shrubs category; *Sida longifolia* and *Phyllanthus amarus* of herbs category, *Eichhornia crassipes* and *Ipomoea aquatica* of hydrophytes category, and *Saccharum spontaneum* of grass category were found predominant at the site area as riparian vegetation on the side of river bank.

Zooplankton of River Krishna at Undavalli reference site comprised three main groups (Table 2) viz; Rotifers, Cladocerans and Copepods. Rotifera were represented by 19 species of 9 genera and Cladocera by 14 species of 13 genera. The species abundance of genus *Brachionus* was higher than rotifers recorded from reference site. The species diversity was more in Cladocera. All the other genera of rotifer and cladocera recorded with single species, except the genus *Moina* represented by two species. Copepoda were represented by Calanoid and Cyclopoid copepods in a good number (11 species) belongs to 12 genera.

Benthos, mainly represented by *Lamellidens, a* bivalve molluscan, *Pila, Thiara, Gyraulus* of molluscs. The *Lamellidens* was observed at higher densities in sub-littoral limnitic region where water velocity is less. The other benthic organism, viz., Ostracods (14 species), clamp shrimp, five species of aquatic bugs and beetles, insect larvae (seven species) Annelida of one species and freshwater crab, *Pseudodiaptomus binghami* were recorded during the study period at reference site. The presence or absence of fauna mainly depend on quality and type of bottom. Since the bottom of the river Krishna upstream water covered / made with sand may reflects the absence of some bethic fauna. The diversity of zooplankton, benthos community of river Krishna at Undavalli /reference site was higher and it can be attributed to the physico-chemical conditions and available nutrients supporting for development, survival and distribution.

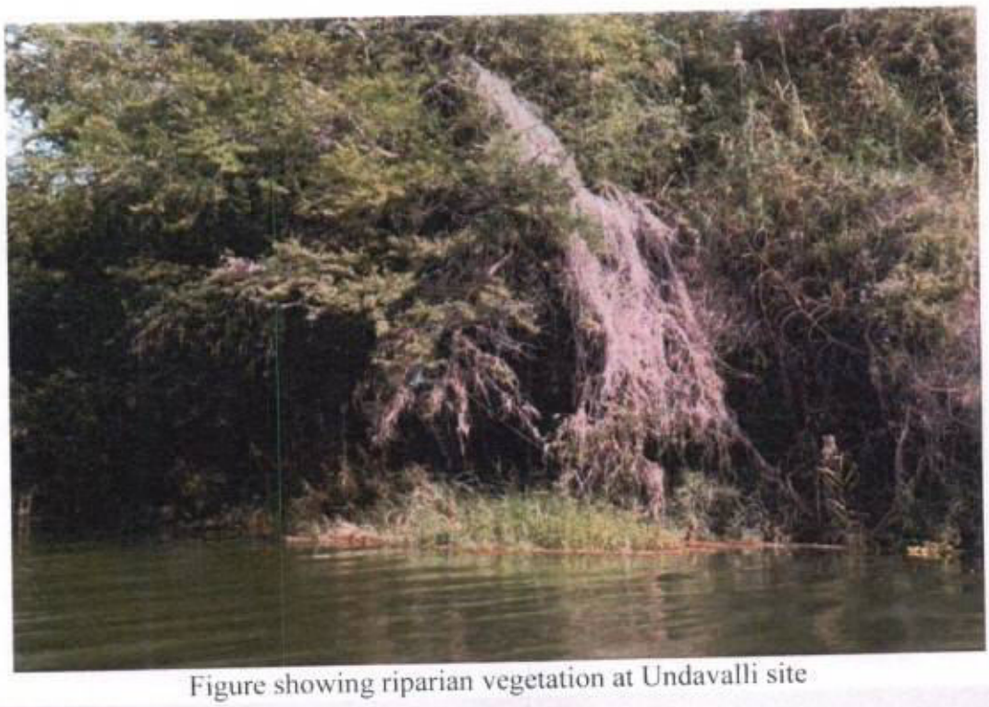

Figure showing riparian vegetation at Undavalli site

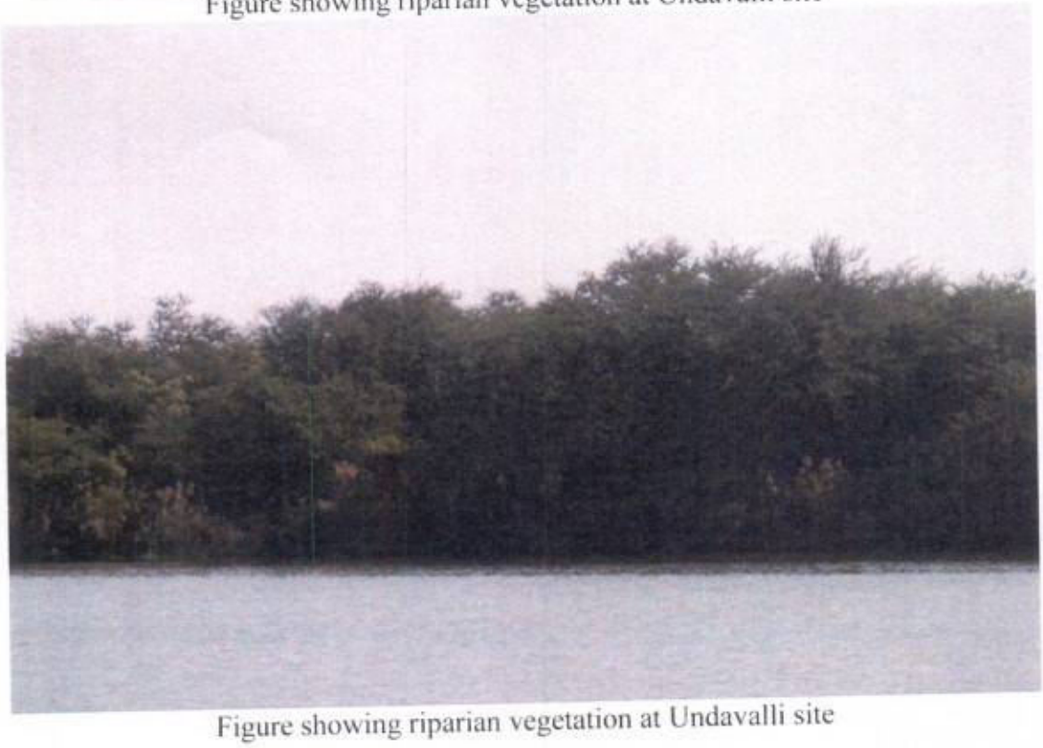

Figure showing riparian vegetation at Undavalli site

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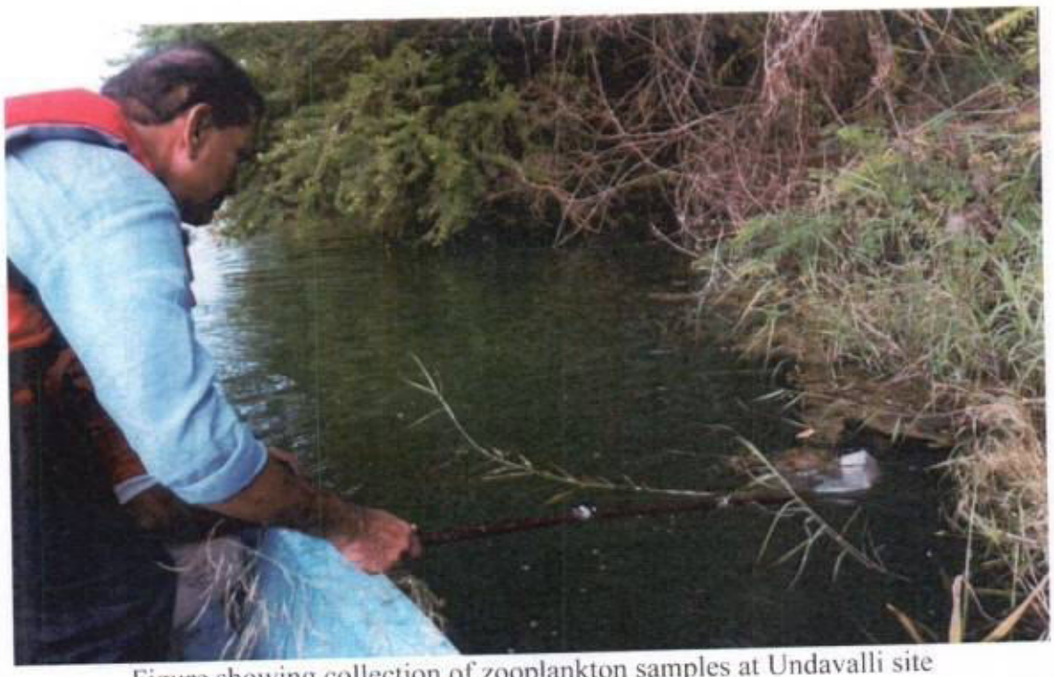

Figure showing collection of zooplankton samples at Undavalli site

VI.b.2. Penumaka (Desiltation Area)

Table 3. Consolidated list of flora and fauna of six samplings observed at Penumaka site (Desiltation area) during the study period (Oct – Dec, 2019).

S. No.	Particulars	Observed Species
1	Phytoplankton	Green algae: *Coelastrum* sps., *Eudorina* sps., *Monoraphidium* sps., *Pandorina* sps., *Pediastrum* sps., *Spirogyra* sps., *Ulothrix* sps. Blue green algae: *Microcystis* sps., *Nostoc* sps., *Oscillatoria* sps., *Phormidium* sps., *Spirulina* sps., Diatoms: *Asterionellopsis* sps., *Pinnularia* sps.
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus dichotomus, Brachionus diversicornis, Brachionus falcatus, Brachionus forficula, Brachionus rubens, Keratella trophica, Asplanchna sp.* (Asplanchnidae), *Cephalodella sp.* (Notommatidae), *Hexthra sp.* (Hexarthridae), *Habrotrocha rosa* (Habrotrochidae), *Macrothrix sp.* **(Macrothricidae).** Cladocerans: *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma excisum* (Sididae), *Moina micrura* (Moinidae), *Moina macrocopa, Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Pseudochydorus sp., Alona sp., Biapertura sp., Indialona sp.,*

		Chydorus sp., Bosmina sp. (Bosminidae), *Bosminopsis deitersi* Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Sinodiaptomus (Rhinediaptomus) indicus, Halicyclops spinifer, Mesocyclops leuckarti, Mesocyclops sp., Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Paracyclops sp., Calanoid nauplii, Parastenocaris sp.* (Parastenocarididae) Protozoa: *Vorticella sp.* (Vorticellidae)
3	Benthos	Crustaceans Ostracoda: *Cypris condona* (Cypprididae), *Cypris obensa, Cypris subglobosa, Cypris sp., Strandesia indica, Hemicypris falcatus, Cypretta sp., Candonocypris dentatus, Herpetocypris sp., Parastenocypris major, Stenocypris sp., Parastenocypris biswasi, Parastenocypris sp., Physocypria minutus* (Cyclocyprididae), *Candona sp.* (Candonidae) Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic Insects Bugs: *Lethocerus* sp. (Belostomatidae), *Lacotrephes* sp. (Nepidae), *Ranatra sp., Gerris* sp. (Gerridae), *Micronecta* sp. (Corixidae), *Enithares sp.* (Notonectidae) Beetles: *Dineutus sp.* (Gyrinidae), *Noteridae sp.* (Noteridae), *Sandracottus sp.* (Dytiscidae), *Hydaticus sp., Laccophilus sp.* Insect larvae: *Glossosoma sp.* (Glossosomatidae), *Stenopsyche sp.* (Stenopsychidae), *Hydropsyche sp.* (Hydropsychidae) *Chironomous* (Chironomidae), *Chaoborus* (Chaoboridae), *Thalerosphyrus* (Heptageniidae), *Manayunkia speciosa* (Fabriciidae) Crab: *Paratelphusa jacquemontii* (Gelechiidae) Leech: *Hirudinea sp.* (Hirudinidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Gabbia sp.* (Bithyniidae), *Digoniostoma sp., Thiara lineate* (Thiaridae), *Thiara scabra, Thiara tuberculata, Melania scabra, Melanoides tuberculatus, Lymnaea acuminate* (Lymnaeidae), *Lymnaea luteola, Amnicola sp.* (Hydrobiidae), *Indoplanorbis sp.* (Planorbidae), *Gyraulus convexiusculus, Gyraulus sp.,Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia favidens, Parreysia sp., Corbicula straitella* (Cyrenidae), *Corbicula peninsularis, Corbicula sp.,*

		Macrochlamys sp.
4	Riparian vegetation plants	*Alternanthera sessilis, Borreria hispida, Chloris montana, Cleome viscosa, Corchorus aestevans, Crotalaria procera, Cyanodon dactylan, Cyperus sps., Dactyloctenium aegyptium, Echinochloa colona, Eclipta alba, Eichhornia crassipes, Fimbristylis miliacea, Ipomoea aquatica, Phyllanthus amarus, Pithecellobium dulce, Polygonum sps.,Prosopis juliflora,Saccharum spontaneum, Sida acuta, Sida cordifolia.*

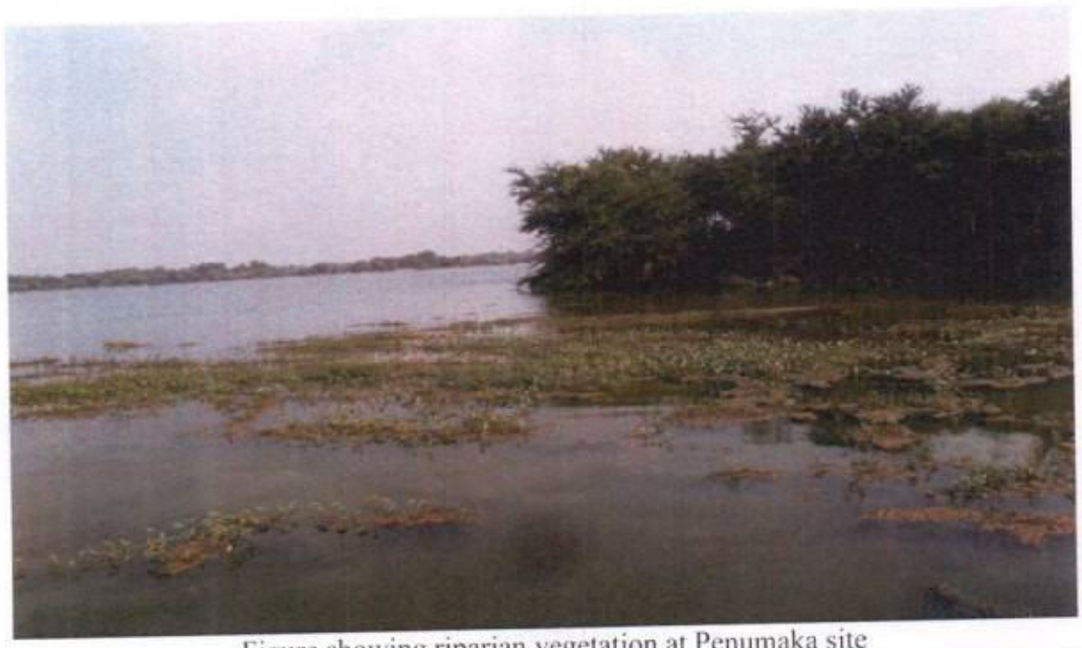

Figure showing riparian vegetation at Penumaka site

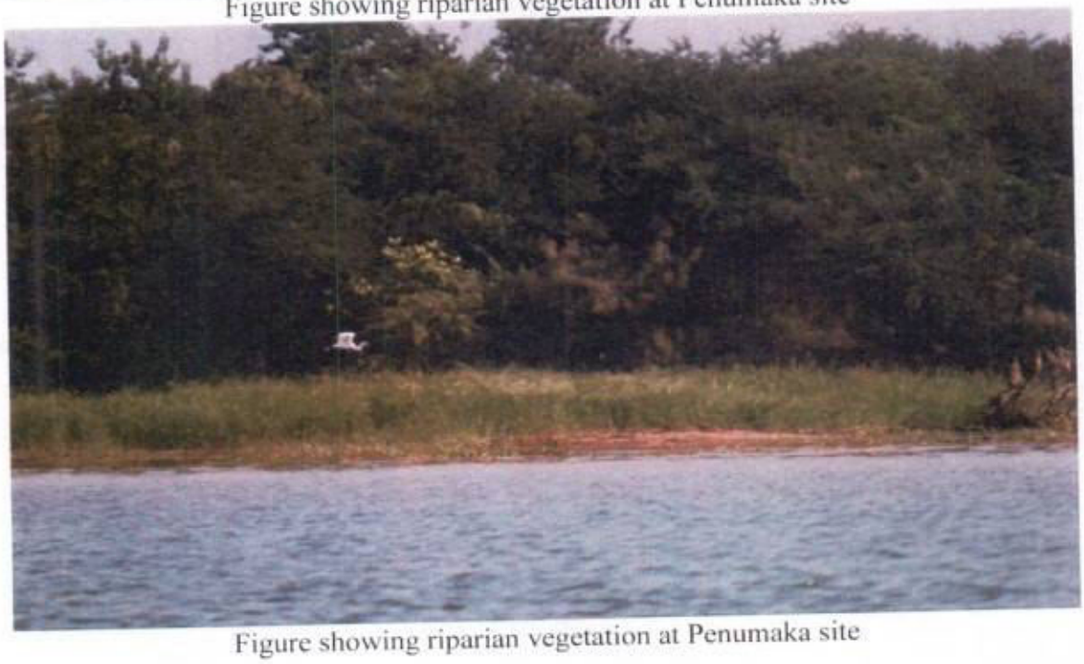

Figure showing riparian vegetation at Penumaka site

Figure showing plankton sample collection at Penumaka site

Figure showing collection of zooplankton samples at Penumaka site

Figure showing benthic fauna sample collection at Penumaka site

VI.b.3. Venkatapalem

Table 4. Consolidated list of flora and fauna observed at Venkatapalem site (Desiltation area) during six samplings during the study period (Oct – Dec, 2019).

S. No.	Particulars	Observed Species
1	Phytoplankton	Green algae: *Actinastrum* sps., *Monoraphidium* sps., *Pediastrum* sps., *Spirogyra* sps., Blue green algae: *Anabaena sps., Aphanizomenon* sps., *Microcystis* sps., *Nostoc* sps., *Phormidium* sps., *Spirulina* sps., Diatoms: *Pinnularia* sps.
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus dichotomus, Brachionus diversicornis, Brachionus falcatus, Brachionus forficula, Brachionus quadridentatus, Brachionus rubens, Keratella trophica, Asplanchna sp.* (Asplanchnidae), *Cephalodella sp.* (Notommatidae), *Filinia sp.*, (Trochosphaeridae), *Hexthra sp.* (Hexarthridae), *Habrotrocha rosa* (Habrotrochidae), *Habrotrocha zanette, Macrothrix sp.*(Macrothricidae),*Lecane sp.* (Lecanidae),

		Cladocerans: *Daphnia carinata* (Daphniidae), *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma excisum* (Sididae), *Diaphanosoma Senegal, Moina micrura* (Moinidae), *Moina macrocopa, Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Pseudochydorus sp., Alona sp., Biapertura sp., Chydorus sp., Bosmina sp.* (Bosminidae), *Bosminopsis deitersi* Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Sinodiaptomus (Rhinediaptomus) indicus,Halicyclops spinifer* (Cyclopidae), *Microcyclops varicans, Mesocyclops leuckarti, Mesocyclops sp., Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Paracyclops sp., Calanoid nauplii* (Calanidae), *Parastenocaris sp.* (Parastenocarididae) Protozoa: *Vorticella sp.* (Vorticellidae)
3	Benthos	Crustaceans Ostracoda: *Cypris condona* (Cypridídae), *Cypris obensa, Cypris subglobosa, Cypris sp., Strandesia indica, Hemicypris falcatus, Cypretta sp., Candonocypris dentatus, Herpetocypris sp., Parastenocypris major, Stenocypris sp., Parastenocypris biswasi, Parastenocypris sp., Physocypria minutus* (Cyclocyprididae), *Candona sp.* (Candonidae) Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic insects Bugs: *Lethocerus* sp. (Belostomatidae), *Lacotrephes* sp. (Nepidae), *Ranatra sp., Gerris* sp. (Gerridae), *Micronecta* sp. (Corixidae), *Enithares sp.* (Notonectidae) Beetles: *Dineutus sp.* (Gyrinidae), *Noteridae sp.* (Noteridae), *Sandracottus sp.* (Dytiscidae), *Hydaticus sp., Laccophilus sp.* Insect larvae Aquatic larvae: *Glossosoma sp.* (Glossosomatidae), *Stenopsyche sp.* (Stenopsychidae), *Hydropsyche sp.* (Hydropsychidae), *Chironomous* (Chironomidae), *Chaoborus* (Chaoboridae), *Manayunkia speciosa* (Fabriciidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Leech: *Hirudinea sp.* (Hirudinidae) Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Gabbia sp.* (Bithyniidae), *Digoniostoma sp., Thiara lineate* (Thiaridae), *Thiara scabra, Thiara tuberculata, Melania scabra, Melanoides tuberculatus, Lymnaea acuminate* (Lymnaeidae), *Lymnaea luteola, Amnicola sp.* (Hydrobiidae),

		Indoplanorbis sp. (Planorbidae), *Gyraulus convexiusculus, Gyraulus sp., Cryprozona sp.* (Ariophantidae), *Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia favidens, Corbicula straitella* (Cyrenidae), *Corbicula sp., Corbicula sp.*
4	Riparian vegetation plants	*Azadirachta indica, Borreria hispida, Calotropis procera, Cleome viscosa, Coccinia indica, Cyperus sps., Eichhornia crassipes, Hibiscus vitifolius, Ipomoea aquatica, Oldenlandia sps., Pergularia daemia, Pithecellobium dulce, Prosopis juliflora, Saccharum spontaneum, Sida acuta, Sida cordifolia.*

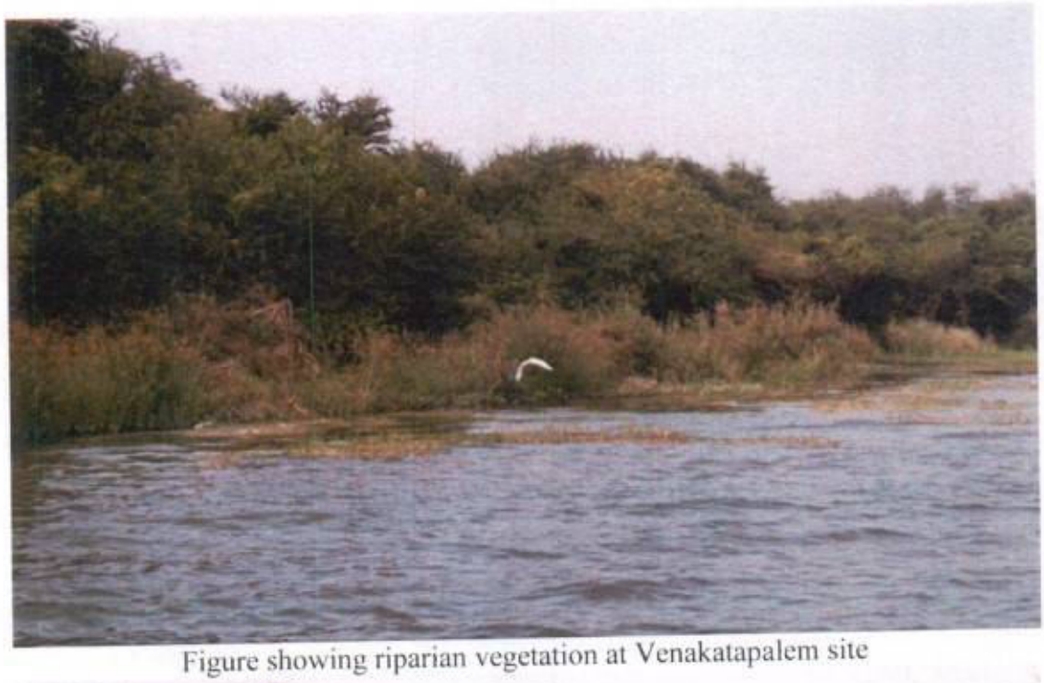

Figure showing riparian vegetation at Venakatapalem site

Figure showing riparian vegetation at Venakatapalem site

Figure showing riparian vegetation collection at venkatapalem site

Figure showing riparian vegetation at Venakatapalem site

Figure showing zooplankton samples collection at Venkatapalem site

Figure showing benthic fauna collection at Venkatapalem site

IV.b. 4.Uddandrayunipalem

Table 5. Consolidated list of flora and fauna observed at Uddandrayunipalem site (Desiltation area) during six samplings during the study period (Oct – Dec, 2019).

S. No	Particulars	Observed Species
1	Phytoplankton	Green algae: *Pediastrum* sps., *Spirogyra* sps., *Ulothrix* sps.

		Blue green algae: *Anabaena sps., Aphanizomenon* sps., *Microcystis* sps., *Oscillatoria* sps., *Phormidium* sps., *Spirulina* sps. Diatoms: *Asterionellopsis* sps.,*Pinnularia sps.*
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus diversicornis, Brachionus falcatus, Brachionus forficula, Brachionus quadridentatus, Brachionus rubens, Keratella trophica, Cephalodella sp.* (Notommatidae), *Filinia longiseta* (Trochosphaeridae), *Hexthra sp.* (Hexarthridae), *Habrotrocha rosa* (Habrotrochidae), *Habrotrocha zanette, Macrothrix sp.***(Macrothricidae).** Cladocerans: *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma excisum* (Sididae), *Diaphanosoma Senegal, Moina micrura* (Moinidae), *Moina macrocopa, Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Pseudochydorus sp., Alona sp., Biapertura sp., Chydorus sp., Bosmina sp.* (Bosminidae), *Bosminopsis deitersi* Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Sinodiaptomus (Rhinediaptomus) indicus, Microcyclops varicans* (Cyclopidae), *Mesocyclops leuckarti, Mesocyclops sp., Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Paracyclops sp., Calanoid nauplii* (Calanidae), *Parastenocaris sp.* (Parastenocarididae) Protozoa: *Vorticella sp.* (Vorticellidae)
3	Benthos	Crustaceans Ostracoda: *Cypris condona* (Cypridídae), *Cypris obensa, Cypris subglobosa, Cypris sp., Strandesia indica, Hemicypris falcatus, Cypretta sp., Candonocypris dentatus, Herpetocypris sp., Parastenocypris major, Stenocypris sp., Parastenocypris biswasi, Candona sp.* (Candonidae) Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic Insects Bugs: *Lethocerus* sp. (Belostomatidae), *Lacotrephes* sp. (Nepidae), *Ranatra sp., Gerris* sp. (Gerridae), *Enithares sp.* (Notonectidae) Beetles: *Dineutus sp.* (Gyrinidae), *Noteridae sp.* (Noteridae),

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		Sandracottus sp. (Dytiscidae), *Hydaticus sp., Laccophilus sp.* Insect larvae: *Glossosoma sp.* (Glossosomatidae), *Stenopsyche sp.* (Stenopsychidae), *Hydropsyche sp.* (Hydropsychidae), *Chironomous* (Chironomidae), *Chaoborus* (Chaoboridae), *Thalerosphyrus* (Heptageniidae) Crab: *Paratelphusa jacquemontii* (Gelechiidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Leech: *Hirudinea sp.* (Hirudinidae) Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Gabbia sp.* (Bithyniidae), *Digoniostoma sp., Thiara lineate* (Thiaridae), *Thiara scabra, Thiara sp., Thiara tuberculata, Melania scabra, Melanoides tuberculatus, Lymnaea acuminate* (Lymnaeidae), *Lymnaea luteola, Amnicola sp.* (Hydrobiidae), *Indoplanorbis sp.* (Planorbidae), *Gyraulus convexiusculus, Gyraulus sp., Cryprozona sp.* (Ariophantidae), *Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia favidens, Parreysia caerulea, Parreysia sp., Corbicula straitella* (Cyrenidae), *Corbicula sp., Macrochlamys sp.*
4	Riparian vegetation plants	*Acacia nilotica, Achyranthus aspera, Aerva lanata, Alternanthera sessilis, Alysicarpus sps., Ammania baccifera, Blumea mollis, Cleome viscosa, Commelina benghalensis, Corchorus aestivans, Cyperus sps., Ergastris tenella, Hydrilla verticillata, Ipomoea aquatica, Ipomoea biloba, Ipomoea eriocarpa, Merrimia emarginata, Phyllanthus simplex, Pithecellobium dulce,Prosopis juliflora, Saccharum spontaneum, Ziziphus mauritiana, Vernonia cinera.*

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Figure showing riparian vegetation at Uddandrayunipalem site

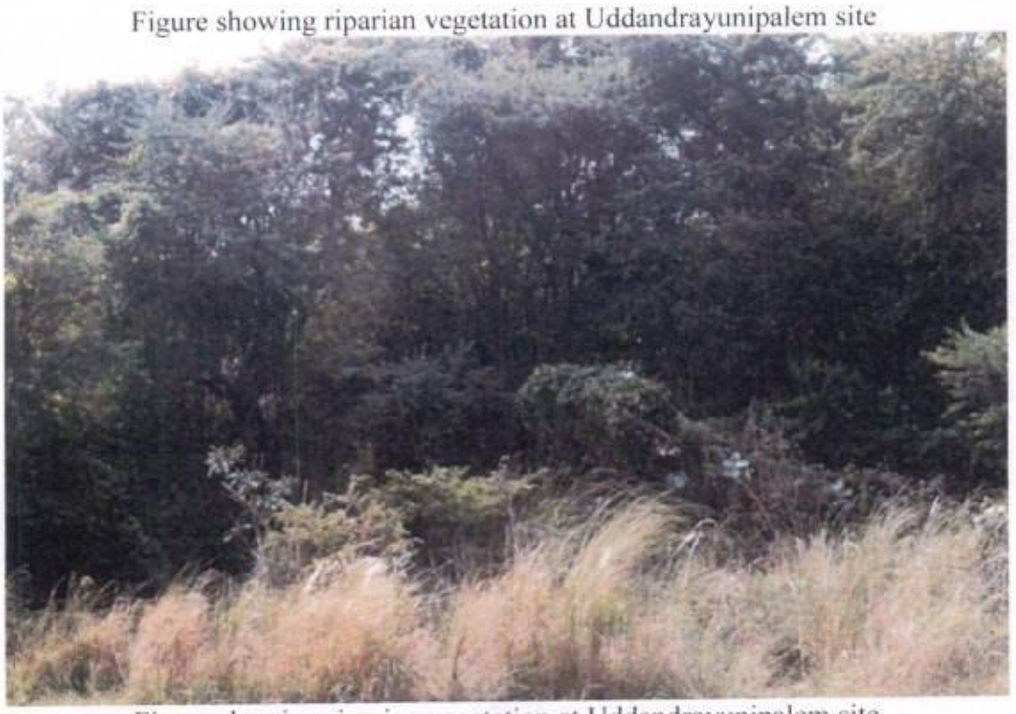

Figure showing riparian vegetation at Uddandrayunipalem site

Figure showing riparian vegetation collection at Uddandrayunipalem site

Figure showing riparian vegetation at Uddandrayunipalem site

Figure showing benthic fauna collection at Uddandrayunipalem site

Figure showing benthic fauna collection at Uddandrayunipalem site

VI.c.5. Lingayapalem

Table 6. Consolidated list of flora and fauna observed at Lingayapalem site (Desiltation area) during six samplings during the study period (Oct – Dec, 2019).

S. No.	Particulars	Observed Species
1	Phytoplankton	Green algae: *Actinastrum* sps., *Pediastrum* sps., *Spirogyra* sps., *Ulothrix* sps. Blue green algae: *Aphanizomenon* sps., *Arthrospira* sps., *Microcystis* sps., *Nostoc* sps., *Oscillatoria* sps., *Phormidium* sps., *Spirulina* sps. Diatoms: *Pinnularia sps.*
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus diversicornis, Brachionus falcatus, Brachionus forficula, Brachionus quadridentatus, Brachionus rubens, Keratella trophica, Asplanchna sp.* (Asplanchnidae), *Cephalodella sp.* (Notommatidae), *Hexthra sp.* (Hexarthridae), *Habrotrocha rosa* (Habrotrochidae), *Habrotrocha Sp., Macrothrix sp.*(**Macrothricidae**),*Lecane sp.* (Lecanidae) Cladocerans: *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma excisum* (Sididae), *Diaphanosoma Senegal, Moina micrura* (Moinidae), *Moina macrocopa, Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Pseudochydorus sp., Indialona sp., Chydorus sp., Bosminopsis deitersi* (Bosminidae) Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Sinodiaptomus (Rhinediaptomus) indicus,Halicyclops spinifer* (Cyclopidae), *Microcyclops varicans, Mesocyclops hyalinus, Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Paracyclops sp., Calanoid nauplii* (Calanidae) Protozoa: *Vorticella sp.* (Vorticellidae)
	Benthos	Crustaceans Ostracoda: *Cypris condona* (Cypridídae), *Cypris obensa, Cypris subglobosa, Cypris sp., Cypretta sp., Candonocypris dentatus, Herpetocypris sp., Parastenocypris major, Stenocypris sp., Parastenocypris biswasi, Parastenocypris sp., Candona sp.* (Candonidae) Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic Insects

		Bugs: *Lethocerus* sp. (Belostomatidae), *Lacotrephes* sp. (Nepidae), *Ranatra sp., Gerris* sp. (Gerridae), *Micronecta* sp. (Corixidae), *Enithares sp.* (Notonectidae) Beetles: *Dineutus sp.* (Gyrinidae), *Noteridae sp.* (Noteridae), *Sandracottus sp.* (Dytiscidae), *Hydaticus sp., Laccophilus sp.* Insect larvae: *Glossosoma sp.* (Glossosomatidae), *Stenopsyche sp.* (Stenopsychidae), *Hydropsyche sp.* (Hydropsychidae), *Chironomous* (Chironomidae), *Chaoborus* (Chaoboridae), *Thalerosphyrus* (Heptageniidae), *Manayunkia speciosa* (Fabriciidae) Crab: *Paratelphusa jacquemontii* (Gelechiidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Leech: *Hirudinea sp.* (Hirudinidae) Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Digoniostoma sp., Thiara lineate* (Thiaridae), *Thiara scabra, Thiara sp., Thiara tuberculata, Melania scabra, Melanoides tuberculatus, Lymnaea acuminate* (Lymnaeidae), *Lymnaea luteola, Amnicola sp.* (Hydrobiidae), *Indoplanorbis sp.* (Planorbidae), *Gyraulus convexiusculus, Gyraulus sp., Cryprozona sp.* (Ariophantidae), *Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia favidens, Parreysia caerulea, Parreysia sp., Corbicula sp.* (Cyrenidae)
4	Riparian vegetation plants	*Acacia leucophoea, Acacia nilotica, Ammania baccifera, Borassus flabellifer, Calotropis procera, Cyperus sps., Eclipta alba, Imperata cylindrica, Pithecellobium dulce, Polygonum glabrum, Polygonum sps.,Prosopis juliflora,Saccharum spontaneum.*

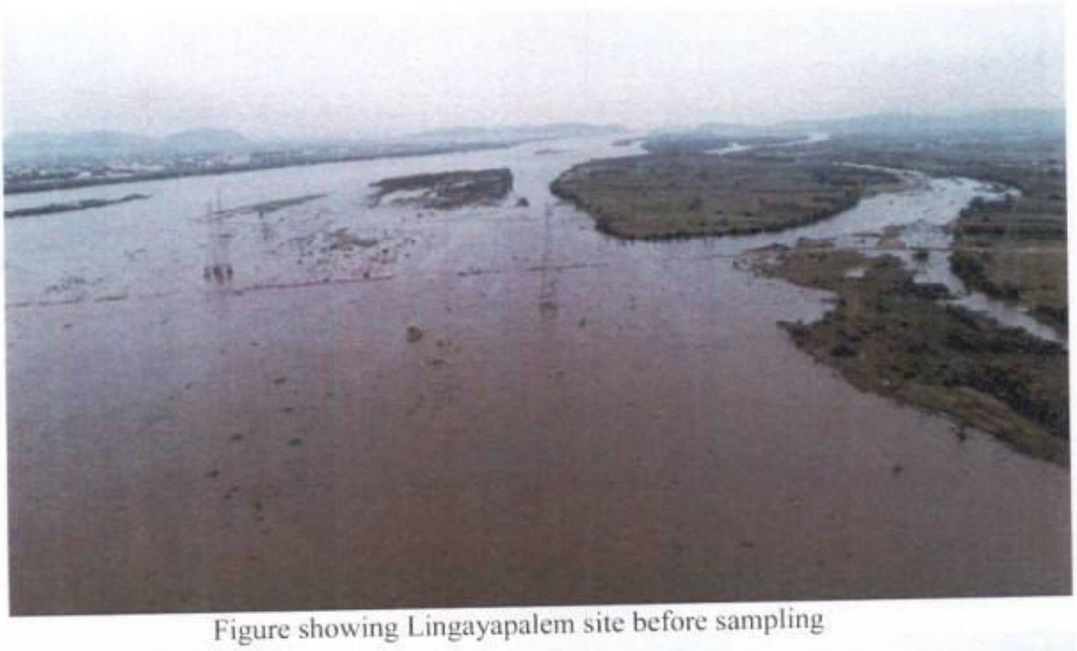

Figure showing Lingayapalem site before sampling

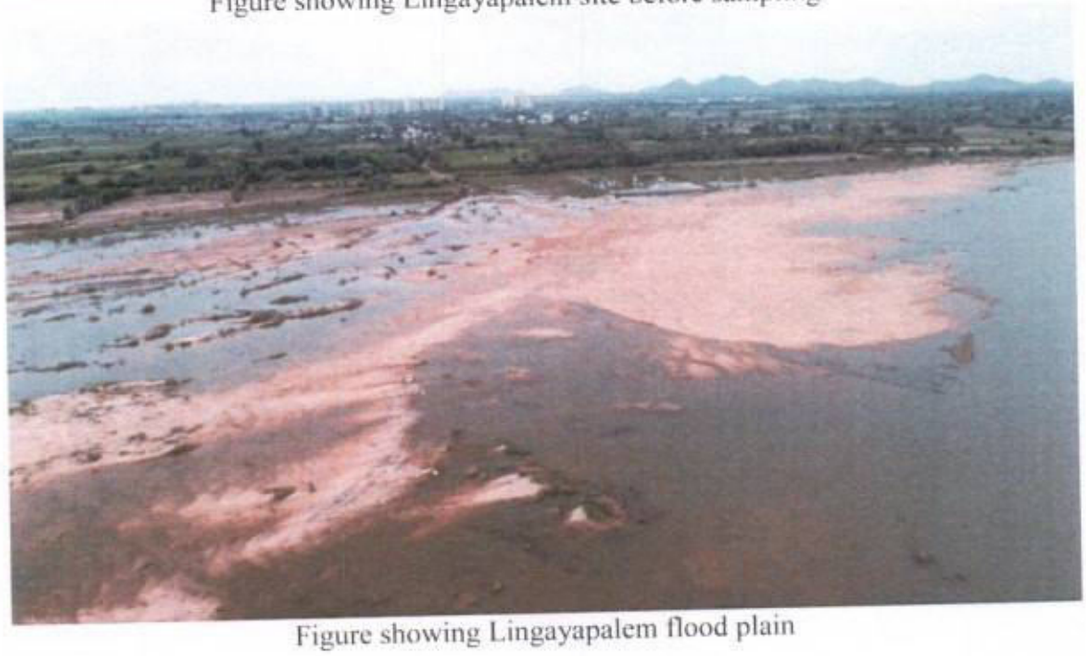

Figure showing Lingayapalem flood plain

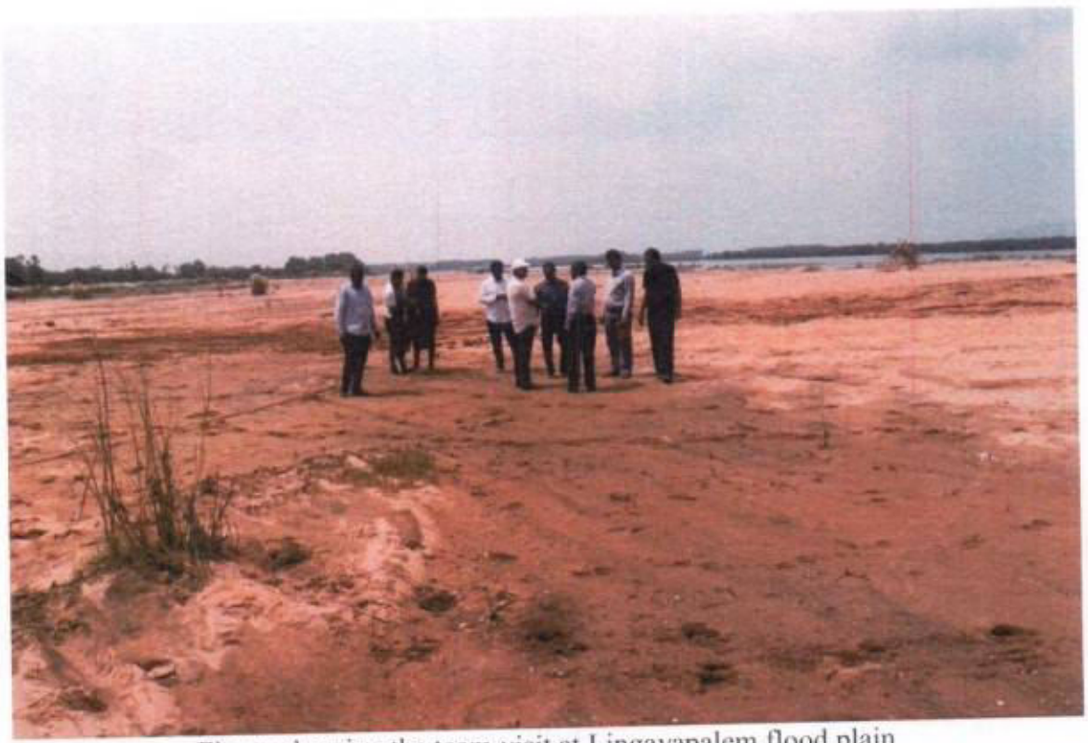

Figure showing the team visit at Lingayapalem flood plain

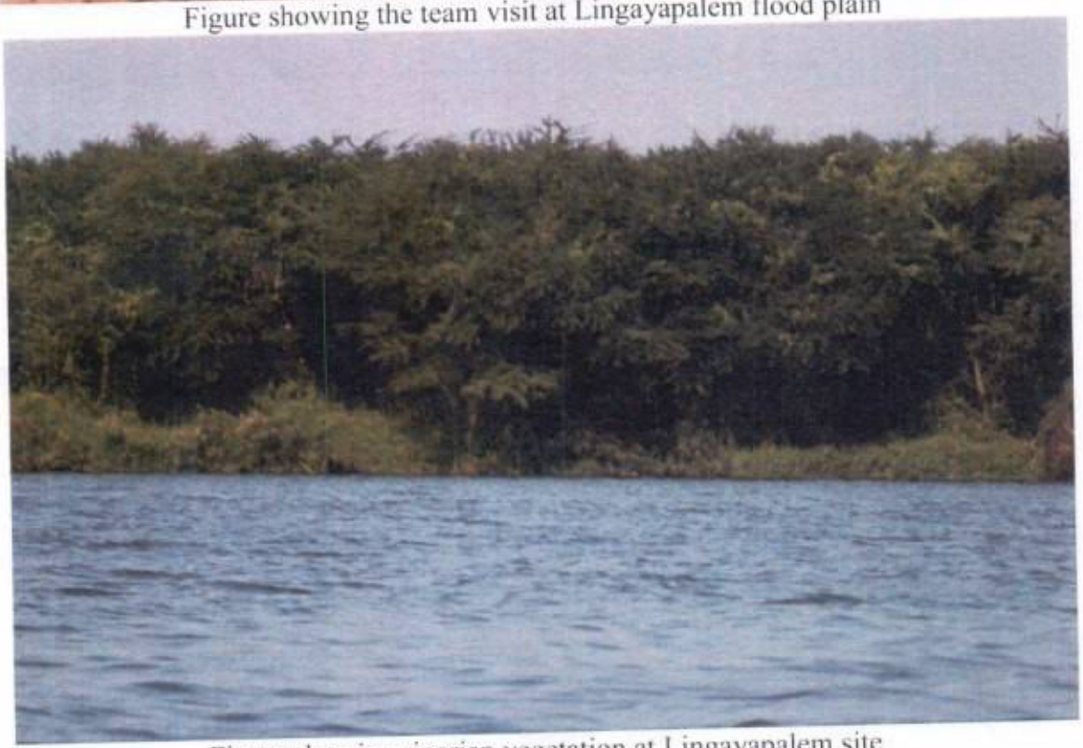

Figure showing riparian vegetation at Lingayapalem site

Figure showing riparian vegetation at Lingayapalem site

Figure showing plankton collection at Lingayapalem site

Figure showing plankton collection at Lingayapalem site

VI. b.6. *Rayapudi*

Table 7. Consolidated list of flora and fauna observed at Rayapudi site (Desiltation area) during six samplings during the study period (Oct – Dec, 2019).

S. No	Particulars	Observed Species
1	Phytoplankton	Green algae: *Actinastrum* sps., *Coelastrum* sps., *Monoraphidium* sps., *Pediastrum* sps., *Spirogyra* sps., *Ulothrix* sps., Blue green algae: *Aphanizomenon* sps., *Lyngbya* sps., *Microcystis* sps., *Nostoc* sps., *Oscillatoria* sps.,
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus dichotomus, Brachionus diversicornis, Brachionus falcatus, Brachionus forficula, Brachionus quadridentatus, Keratella trophica, Cephalodella sp.* (Notommatidae), *Habrotrocha rosa* (Habrotrochidae), *Habrotrocha zanette, Macrothrix sp.* **(Macrothricidae),** *Ptygura pilula* (Flosculariidae) Cladocerans: *Daphnia carinata* (Daphniidae), *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma Senegal* (Sididae), *Moina micrura* (Moinidae), *Moina macrocopa, Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Pseudochydorus sp., Alona sp., Indialona sp., Chydorus sp., Bosminopsis deitersi* (Bosminidae)

		Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Sinodiaptomus (Rhinediaptomus) indicus, Halicyclops spinifer* (Cyclopidae), *Microcyclops varicans, Mesocyclops Sp., Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Calanoid nauplii* (Calanidae),*Parastenocaris sp.* (Parastenocarididae)
3	Benthos	Crustacens Ostracoda: *Cypris condona* (Cypridídae), *Cypris obensa, Cypris subglobosa, Cypris sp., Strandesia indica, Hemicypris falcatus, Cypretta sp., Candonocypris dentatus, Stenocypris sp., Parastenocypris biswasi, Parastenocypris sp., Physocypria minutus* (Cyclocypridídae), *Candona sp.* (Candonidae) Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic insects Bugs: *Lethocerus* sp. (Belostomatidae), *Lacotrephes* sp. (Nepidae), *Ranatra sp., Gerris* sp. (Gerridae), *Micronecta* sp. (Corixidae), *Enithares sp.* (Notonectidae) Beetles: *Dineutus sp.* (Gyrinidae), *Noteridae sp.* (Noteridae), *Sandracottus sp.* (Dytiscidae), *Hydaticus sp., Laccophilus sp.* Insect larvae: *Glossosoma sp.* (Glossosomatidae), *Stenopsyche sp.* (Stenopsychidae), *Hydropsyche sp.* (Hydropsychidae), *Chironomous* (Chironomidae), *Chaoborus* (Chaoboridae), *Thalerosphyrus* (Heptageniidae), Crab: *Paratelphusa jacquemontii* (Gelechiidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Gabbia sp.* (Bithyniidae), *Digoniostoma sp., Thiara lineate* (Thiaridae), *Thiara scabra, Thiara sp., Thiara tuberculata, Melanoides tuberculatus, Lymnaea acuminate* (Lymnaeidae), *Lymnaea luteola, Amnicola sp.* (Hydrobiidae), *Indoplanorbis sp.* (Planorbidae), *Gyraulus convexiusculus, Cryprozona sp.* (Ariophantidae), *Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia favidens, Parreysia caerulea, Parreysia sp., Corbicula straitella* (Cyrenidae), *Corbicula peninsularis*
4	Riparian vegetation plants	*Acacia nilotica, Amaranthus viridis, Blumea mollis, Borassus flabellifer, Ceratophyllum sps., Cleome viscosa, Crotalaria retusa, Cyperus sps., Eclipta alba, Merremia emarginata, Phyllanthus maderaspatensis, Pithecellobium dulce,*

		Portulaca quadrifida, Prosopis juliflora,Saccharum spontaneum, Ziziphus mauritiana, Ziziphus jujuba.

Figure showing Rayapudi site before sampling

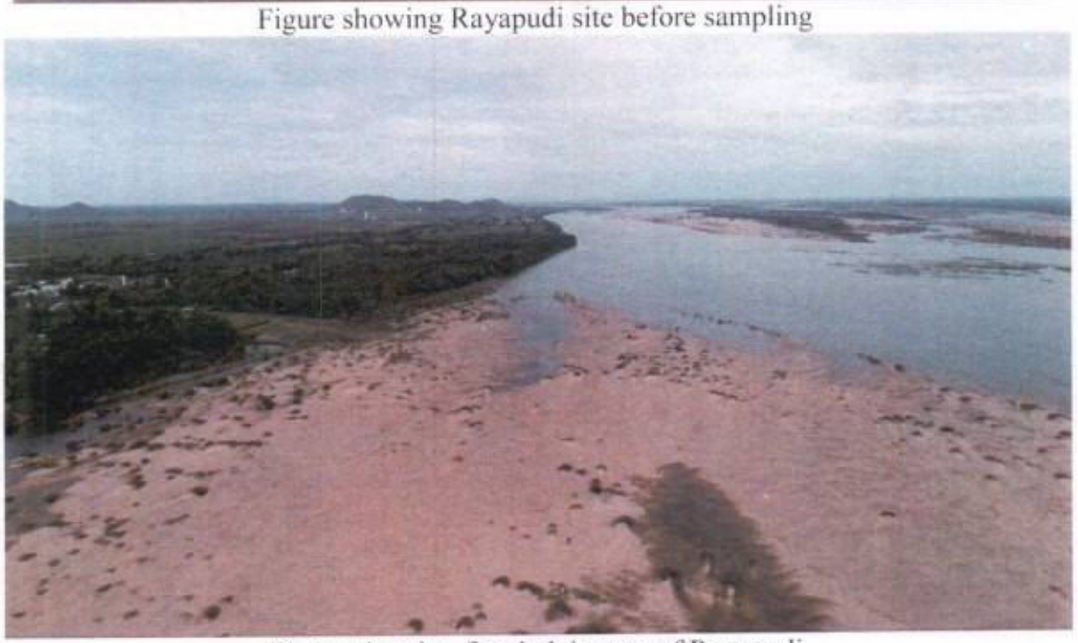

Figure showing flood plain area of Rayapudi

Figure showing riparian vegetation at Rayapudi

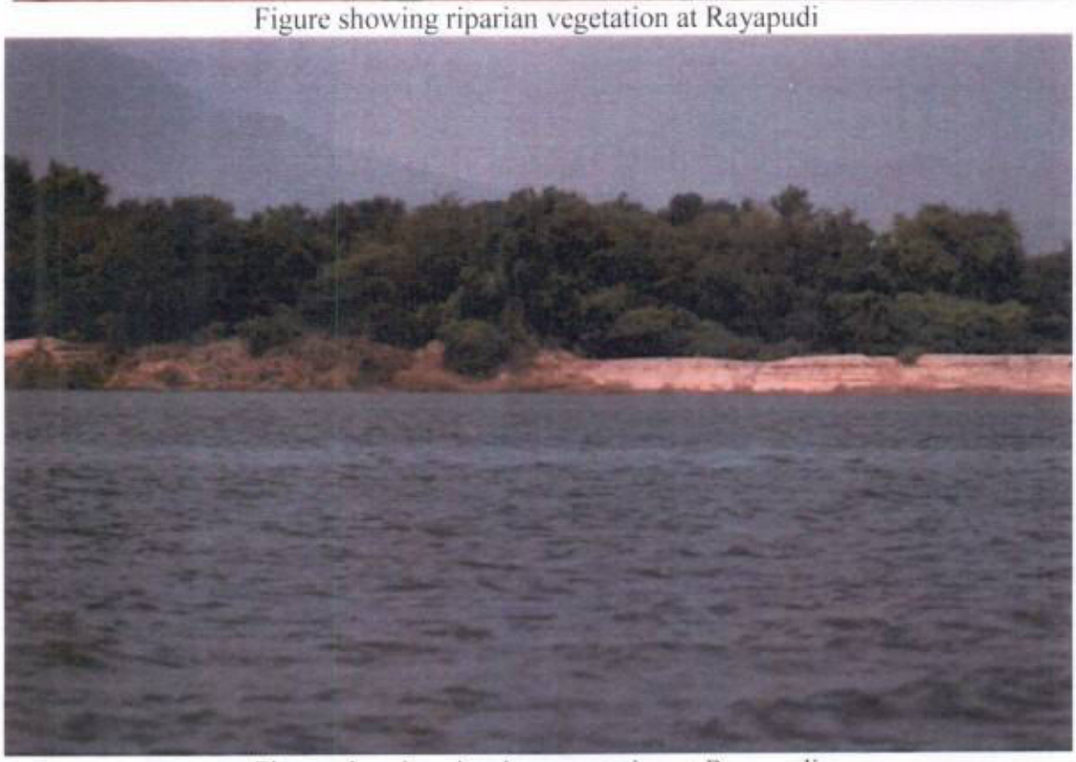

Figure showing riparian vegetation at Rayapudi

Figure showing benthic fauna collection at Lingayapalem site

Figure showing the team interaction with fishermen at Rayapudi

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VI. b. 7. SurayaPalem

Table 8. Consolidated list of flora and fauna observed at Surayapalem site (Desiltation area) during six samplings during the study period (Oct – Dec, 2019).

S.No.	Particulars	Observed Species
1	Phytoplankton	Green algae: *Monoraphidium* sps., *Pandorina* sps., *Pediastrum* sps., *Spirogyra* sps., *Ulothrix* sps., Blue green algae: *Aphanizomenon* sps., *Arthrospira* sps., *Lyngbya* sps., *Microcystis* sps., *Nostoc* sps., *Oscillatoria* sps., *Phormidium* sps., *Spirulina* sps., Diatoms: *Asterionellopsis* sps., *Pinnularia* sps.
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus dichotomus, Brachionus falcatus, Brachionus forficula, Brachionus quadridentatus, Brachionus rubens, Keratella trophica, Asplanchna sp.* (Asplanchnidae), *Cephalodella sp.* (Notommatidae), *Filinia longiseta* (Trochosphaeridae), *Hexthra sp.* (Hexarthridae), *Habrotrocha rosa* (Habrotrochidae), *Macrothrix sp.* **(Macrothricidae),** *Ptygura pilula* (Flosculariidae) Cladocerans: *Daphnia carinata* (Daphniidae), *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma excisum* (Sididae), *Diaphanosoma Senegal, Moina micrura* (Moinidae), *Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Pseudochydorus sp., Alona sp., Biapertura sp., Indialona sp., Bosmina sp.* (Bosminidae) Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Sinodiaptomus (Rhinediaptomus) indicus, Halicyclops spinifer* (Cyclopidae), *Microcyclops varicans, Mesocyclops leuckarti, Mesocyclops hyalinus, Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Paracyclops sp., Calanoid nauplii* (Calanidae), *Pseudodiaptomus binghami* (Pseudodiaptomidae) Protozoa: *Vorticella sp.* (Vorticellidae)
3	Benthos	Crustacens Ostracoda: *Cypris condona* (Cypridídae), *Cypris obensa, Cypris subglobosa, Cypris sp., Strandesia indica, Hemicypris falcatus, Cypretta sp., Candonocypris dentatus, Herpetocypris sp., Parastenocypris major, Stenocypris sp., Parastenocypris biswasi, Parastenocypris sp.,* Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic Insects

		Bugs: *Lethocerus* sp. (Belostomatidae), *Lacotrephes* sp. (Nepidae), *Ranatra sp., Gerris* sp. (Gerridae), *Micronecta* sp. (Corixidae), *Enithares sp.* (Notonectidae) Beetles: *Dineutus sp.* (Gyrinidae), *Noteridae sp.* (Noteridae), *Sandracottus sp.* (Dytiscidae), *Laccophilus sp.* Insect larvae: *Glossosoma sp.* (Glossosomatidae), *Stenopsyche sp.* (Stenopsychidae), *Chironomous* (Chironomidae), *Chaoborus* (Chaoboridae), *Thalerosphyrus* (Heptageniidae), *Manayunkia speciosa* (Fabriciidae) Crab: *Paratelphusa jacquemontii* (Gelechiidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Gabbia sp.* (Bithyniidae), *Thiara lineate* (Thiaridae), *Thiara scabra, Thiara sp., Thiara tuberculata, Melania scabra, Melanoides tuberculatus, Lymnaea acuminate* (Lymnaeidae), *Lymnaea luteola, Indoplanorbis sp.* (Planorbidae), *Gyraulus convexiusculus, Gyraulus sp., Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia favidens, Parreysia caerulea, Parreysia sp., Corbicula straitella* (Cyrenidae), *Corbicula peninsularis.*
4	Riparian vegetation plants	*Acacia leucophoea, Acacia nilotica, Coccinia indica, corchorus capsularis, Cyanatis axillaris, Cyperus sps.,Dactyloctenium aegyptium, Ipomoea aquatica, Ipomoea sps., Oxystelma chinensis, Phyllanthus maderaspatensis, Pithecellobium dulce, Prosopis juliflora,Saccharum spontaneum, Ziziphus jujuba.*

Figure showing riparian vegetation at Surayapalemsite

Figureshowing riparian plants, plankton and benthic fauna collection at riverbank side of Lingayapalem site

VI. b.8. Guntupalli

Table 9. Consolidated list of flora and fauna observed at Guntupalli site (Desiltation area) during six samplings during the study period (Oct – Dec, 2019).

S. No.	Particulars	Observed Species

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1	Phytoplankton	Green algae: *Monoraphidium* sps., *Pediastrum* sps., *Spirogyra* sps., *Ulothrix* sps. Blue green algae: *Arthrospira* sps., *Lyngbya* sps., *Microcystis* sps., *Nostoc* sps., *Phormidium* sps., *Spirulina* sps., Diatoms: *Pinnularia* sps.
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus diversicornis, Brachionus falcatus, Brachionus forficula, Brachionus quadridentatus, Brachionus rubens, Keratella trophica, Asplanchna sp.* (Asplanchnidae), *Filinia longiseta* (Trochosphaeridae), *Hexthra sp.* (Hexarthridae), , *Habrotrocha zanette* (Habrotrochidae), *Macrothrix sp.* **(Macrothricidae)** Cladocerans: *Daphnia carinata* (Daphniidae), *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma excisum* (Sididae), *Diaphanosoma Senegal, Moina micrura* (Moinidae), *Moina macrocopa, Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Pseudochydorus sp., Alona sp., Biapertura sp., Indialona sp., Bosmina sp.* (Bosminidae) Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Eucyclops semidenticulatus* (Cyclopidae), *Microcyclops varicans, Mesocyclops leuckarti, Mesocyclops hyalinus, Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Paracyclops sp., Calanoid nauplii* (Calanidae),*Parastenocaris sp.* (Parastenocarididae) Protozoa: *Vorticella sp.* (Vorticellidae)
3	Benthos	Crustacens Ostracoda: *Cypris condona* (Cypridídae), *Cypris obensa, Cypris subglobosa, Cypris sp., Hemicypris falcatus, Cypretta sp., Candonocypris dentatus, Herpetocypris sp., Parastenocypris major, Parastenocypris biswasi, Parastenocypris sp., Candona sp.* (Candonidae) Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic Insects Bugs: *Lethocerus* sp. (Belostomatidae),(Nepidae), *Ranatra sp., Gerris* sp. (Gerridae), *Enithares sp.* (Notonectidae) Beetles: *Dineutus sp.* (Gyrinidae), *Noteridae sp.* (Noteridae), *Hydaticus sp., Laccophilus sp.* Insect larvae: *Glossosoma sp.* (Glossosomatidae), *Hydropsyche sp.* (Hydropsychidae), *Chironomous*

		(Chironomidae), *Chaoborus* (Chaoboridae), *Thalerosphyrus* (Heptageniidae), *Manayunkia speciosa* (Fabriciidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Gabbia sp.* (Bithyniidae), *Digoniostoma sp., Thiara lineate* (Thiaridae), *Thiara scabra, Thiara sp., Thiara tuberculata, Melania scabra, Melanoides tuberculatus, Lymnaea luteola* (Lymnaeidae), *Indoplanorbis sp.* (Planorbidae), *Gyraulus convexiusculus, Gyraulus sp., Cryprozona sp.* (Ariophantidae), *Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia favidens, Parreysia caerulea, Parreysia sp.*
4	Riparian vegetation plants	*Acacia nilotica, Alternanthera sessilis, Boerhavia diffusa, Calotropis procera, Cleome viscosa, Corchorus aestivans, Cyanodon dactylan, Cyperus flavidus, Cyperus sps., Eclipta alba, Eichhornia crassipes, Hydrilla verticillata, Ipomoea aquatica, Ipomoea repans, Pithecellobium dulce, Polygonum glabrum, Prosopis juliflora,Ricinus communis, Saccharum spontaneum.*

Figure showing riparian vegetation at Guntupalli site

Figure showing Molluscs in river Krishna at Guntupalli

Figure showing collection of plankton sample at Guntupalli site

VI.b. 9. Ibrahimpatnam

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Table 10. Consolidated list of flora and fauna observed at Ibrahimpatnam site (Desiltation area) during six samplings during the study period (Oct – Dec, 2019).

S. No.	Particulars	Observed Species
1	Phytoplankton	Green algae: *Actinastrum* sps., *Monoraphidium* sps., *Pediastrum* sps., *Spirogyra* sps., *Ulothrix* sps. Blue green algae: *Anabaena sps., Aphanizomenon* sps., *Arthrospira* sps., *Lyngbya* sps., *Microcystis* sps., *Nostoc* sps., *Oscillatoria* sps., *Phormidium* sps., *Spirulina* sps., Diatoms: *Asterionellopsis* sps., *Pinnularia* sps.
2	Zooplankton	Rotifera: *Brachionus angularis* (Brachionidae), *Brachionus bidentatus, Brachionus calyciflorus, Brachionus caudatus, Brachionus dichotomus, Brachionus diversicornis, Brachionus quadridentatus, Brachionus rubens, Asplanchna sp.* (Asplanchnidae), *Cephalodella sp.* (Notommatidae), *Habrotrocha rosa* (Habrotrochidae), *Habrotrocha zanette* Cladocerans: *Daphnia carinata* (Daphniidae), *Scapholeberis sp., Ceriodaphnia cornuta, Diaphanosoma excisum* (Sididae), *Diaphanosoma Senegal, Moina micrura* (Moinidae), *Macrothrix spinosa* (Macrothricidae), *Pleuroxus aduncus* (Chydoridae), *Alona sp., Biapertura sp., Chydorus sp., Bosmina sp.* (Bosminidae), *Bosminopsis deitersi* Copepods: *Allodiaptomus raoi* (Diaptomidae), *Heliodiaptomus viduus, Phyllodiaptomus blanci, Sinodiaptomus (Rhinediaptomus) indicus, Eucyclops semidenticulatus* (Cyclopidae), *Halicyclops spinifer, Mesocyclops hyalinus, Mesocyclops sp., Thermocyclops sp., Cyclopoid nauplii, Eucyclops serrulatus, Calanoid nauplii* (Calanidae)
3	Benthos	Crustacens Ostracoda: *Cypris condona* (Cypridídae), *Cypris obensa, Cypris subglobosa, Cypris sp., Strandesia indica, Hemicypris falcatus, Cypretta sp., Candonocypris dentatus, Stenocypris sp., Parastenocypris biswasi, Parastenocypris sp., Candona sp.* (Candonidae) Clamp shrimp: *Cyclestheria hislopi* (Cyclestheriidae) Aquatic Insects Bugs: *Lethocerus* sp. (Belostomatidae), *Lacotrephes* sp. (Nepidae), *Ranatra sp., Gerris* sp. (Gerridae), *Enithares sp.* (Notonectidae) Beetles: *Noteridae sp.* (Noteridae), *Sandracottus sp.*

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		(Dytiscidae), *Hydaticus sp., Laccophilus sp.* Insect larvae: *Glossosoma sp.* (Glossosomatidae), *Hydropsyche sp.* (Hydropsychidae), *Chironomous* (Chironomidae), *Chaoborus* (Chaoboridae), *Manayunkia speciosa* (Fabriciidae) Crab: *Paratelphusa jacquemontii* (Gelechiidae) Prawns: *Macrobrachium malcolmsonii* (Palaemonidae), *Macrobrachium rosenbergii, Macrobrachium lamarrei* Leech: *Hirudinea sp.* (Hirudinidae) Molluscs: *Pila virens* (Ampullariidae), *Pila globosa, Pila sp., Bellamya bengalensis* (Viviparidae), *Bellamya dissimilis, Gabbia sp.* (Bithyniidae), *Digoniostoma sp., Thiara lineate* (Thiaridae), *Thiara scabra, Thiara sp., Thiara tuberculata, Melanoides tuberculatus, Lymnaea acuminate* (Lymnaeidae), *Lymnaea luteola, Amnicola sp.* (Hydrobiidae), *Indoplanorbis sp.* (Planorbidae), *Gyraulus convexiusculus, Cryprozona sp.* (Ariophantidae), *Lamellidens marginalis* (Unionidae), *Lamellidens sp., Parreysia favidens, Parreysia caerulea, Corbicula straitella* (Cyrenidae)
4	Riparian vegetation plants	*Acacia nilotica, Calotropis procera, Commelina benghalensis, Corchorus aestevans, Cordiospermum helicacabum, Cyanatis cristata, Cyanotis axillaris, Eclipta alba, Eucalyptus sps., Ficus hispida, Ipomoea repans, Mimosa pudica, Pithecellobium dulce, Portulaca quadrifida, Prosopis juliflora,Tinospora cardifolia, Ziziphus jujuba, Ziziphus mauritiana.*

Figure showing riparian vegetation at Ibrahimpatnam site

Figure showing riparian vegetation at Ibrahimpatnam site

In comparison with the Undavalli site, the phytoplankton observed at other different desiltation sites viz., Penumaka, Venkatayapalem, Uddandarayunipalem, Lingayapalem and Rayapudi on Guntur district side, and Surayapalem, Guntupalli and Ibrahimpatnam on Krishna district side was more or less similar with a deviation of presence or absence of one or two genera of phytoplankton at one site or the other. In that

context, few genera (3 or 4) of total phytoplankton identified were positively present at one or the other desiltation sites which were not found at non desiltation site namely Undavalli. At the reference site, only *Pinnularia* sps. of diatoms group was found, whereas a second genus namely *Asterionellopsis* of diatoms was also recorded at Penumaka, Uddandarayunipalem, Surayapalem and Ibrahimpatnam sites in addition to *Pinnularia* sps.

The phytoplankton study results showing good presence and distribution of most common and different freshwater phytoplankton members in river Krishna waters at different study sites during the study period. The distribution of phytoplankton was found without much qualitative variation among the sampling sites. In general among all the study sites including the Undavalli (reference site), *Actinastrum*sps., *Pediastrum* sps., *Spirogyra* sps., and *Ulothrix* sps., of green algae group, and *Microcystis* sps., *Oscillatoria*sps., *Phormidium* sps., *Spirulina* sps., and *Nostoc* sps., of blue-green algae group were found in more richness over the other members of their groups. In the diatoms group, only *Pinnularia* sps., of the two genera recorded in the study was present uniformly in all the samples.

In general, the riparian vegetation at the study sites of river Krishna upstream from Prakasam barrage at Vijayawada consists of trees, shrubs, herbs and submerged to floating hydrophytes both on islands in the middle of the river and along the riverbank sides. During the study, about 30-40 plants species belonging to different families were observed as a part of riparian vegetation. The list of the plant species of riparian vegetation observed and identified was given in a consolidated table 2-10.

From the qualitative analysis, it is observed that riparian vegetation in reference site and desiltation areas are similar which implies that the desiltation and dredging is not having serious impact on vegetation. Of the tree species observed at the sites, *Acacia nilotica*, *Acacia leucophoea*, *Pithecellobium dulce*, *Prosopis juliflora* were found commonly and abundantly in almost all sites giving dense vegetation appearance. Shrubs like *Calotropis procera*, *Polygonum glabrum*, *Ziziphus jujuba*, *Ziziphus mauritiana* and *Corchorus aestivans*, and herbaceous plants namely *Sida acuta*, *Achyranthus aspera*, *Cleome viscosa* and *Aerva lanata* were found in abundance. Of the hydrophytic plants, *Ipomoea aquatica* and *Eichornia crassipes* were abundant and *Hydrilla verticillata* plant was also seen at some sites. Differentgrass species belonging to genera viz., *Cyperus*,

Cyanodon, *Dactyloctenium* and *Saccharum* were observed so commonly and in abundance at all sites. However, some of the plant species mentioned in the list were moderate to low in abundance due to their presence or absence at one or the other sites of the study.

Zooplankton of river Krishna, upstream water was represented by three groups viz., Rotifera, Cladocera and Copepoda. The species diversity was more in Rotifer and Cladocera in all desiltation sites as well as non-desiltation area (Tables 2-10), and abundance of *Brachionus* species seems to be reasoned to physico-chemical conditions of riverine ecosystem that supporting the growth and distribution. The Copepoda was found as the second largest group observed in the non- desiltation /reference site. The same trend was observed in the desiltation areas of river Krishna.

Benthos are the organisms which are living in or on the bottom materials, mainly represented by ostrocodes, clamshrimp, aquatic bugs, beetles, insects and molluscs (Table 2-10). When compared the benthic community of desiltation and non-desiltation areas, molluscs were found as a dominant constituent followed by ostrocodes and crustaceans. In the present investigation, the other freshwater macro and micro benthic fauna were observed to be at moderate level in river Krishna, upstream waters of desiltation areas. The good distribution and abundance of benthic fauna recorded in river Krihna upstream waters indicating that desiltation activity hs no affect n the benthic community.

Fish fauna of river Krishna

Table 10. List of fish fauna recorded from Krishna River upstream of Prakasam barrage 13.5 km

S. No.	Orders	Family	Genus	Species	Local Name
1	Osteoglossiformes	Notopteridae	*Notopterus*	*Notopterus notopterus*	Ullinkaya
2	Elopiformes	Megalopidae	*Megalops*	*Megalops cyprinoides*	Kondinga
3	Anguilliformes	Anguillidae	*Anguilla*	*Anguilla bengalensis*	Baimuchhu
4	Cypriniformes	Cyprinidae	*Catla*	*Catla catla*	Bochhe
5			*Cirrhinus*	*Cirrhinus mrigala*	Jadumosu
6				*Cirrhinus reba*	Teegamosu
7			*Ctenopharyngodon*	*Ctenopharyngodon idella*	Gaddi chepa
8			*Labeo*	*Labeo bata*	Chamarai

9				*Labeo boga*	Boga labeo
10				*Labeo calbasu*	Nalla Chamarai
11				*Labeo rohita*	Rohu
12			*Osteobrama*	*Osteobrama cotio*	Chedu parige
13			*Puntius*	*Puntius chola*	Chedu bethe
14				*Puntius conchonius*	Chukka bethe
15				*Puntius gelius*	Bethe
16				*Puntius guganio*	Bethe
17				*Puntius filamentosa*	Bethe
18				*Puntius sophore*	Bethe
19				*Puntius terio*	Bethe
20				*Puntius ticto*	Bethe
21			*Chela*	*Chela cachius*	Jobidai
22			*Salmostoma*	*Salmostoma phulo*	Nettallu
23			*Amblypharyngodon*	*Amblypharyngodon mola*	Ilambrai
24			*Rasbora*	*Rasbora daniconius*	Chedu parige
25			*Danio*	*Danio devario*	Aata Parigi
26	Siluriformes	Bagridae	*Mystus*	*Mystus armatus*	Gaddi jella
27				*Mystus bleekeri*	Nara jella
28				*Mystus cavasius*	Aaku jella
29				*Mystus gulio*	Yeti jella
30				*Mystus vittatus*	Aata jella
31			*Aorichthys*	*Aorichthys seenghala*	Mutte jella
32		Siluridae	*Ompok*	*Ompok bimaculatus*	Guggidama
33			*Wallago*	*Wallago attu*	Waluga
34		Schilbeidae	*Pseudeutropius*	*Pseudeutropius atherinoides*	Sunku jella
35		Clariidae	*Clarias*	*Clarias batrachus*	Marpu
36		Heteropneustidae	*Heteropneustes*	*Heteropneustes fossilis*	Ingilayee
37		Loricariidae	*Pterygoplichthys*	*Pterygoplichthys pardalis*	Deyyapu chepa
38	Cyprinodontiformes	Hemiramphidae	*Hyporhamphus*	*Hyporhamphus limbatus*	Kovasi
39		Belonidae	*Xenentodon*	*Xenentodon cancila*	Yeti kovasi
40	Perciformes	Centropomidae	*Lates*	*Lates calcarifer*	Pandugappa
41		Ambassidae	*Chanda*	*Chanda nama*	Chedu bethhe
42		Lutjanidae	*Lutjanus*	*Lutjanus johni*	Keesani guraka
43		Nandidae	*Nandus*	*Nandus nandus*	Keesu guraka
44		Cichlidae		*Etroplus canarensis*	Duvvena guraka

45			*Etroplus*	*Etroplus maculatus*	Duvvena chepa
46			*Oreochromis*	*Oreochromis mossambica*	China guraka
47				*Oreochromis niloticus*	Guraka
48	Mugiliformes	Mugilidae	*Mugil*	*Mugil cephalus*	Katti parige
49		Gobiidae	*Glossogobius*	*Glossogobius guiris*	Isakadontu
50		Anabantidae	*Anabas*	*Anabas testudineus*	Natu goraka
51		Channidae	*Channa*	*Channa punctatus*	Bonta mattagidisa
52				*Channa marulius*	pumeenu
53				*Channa striatus*	Korameenu
54	Mastacembeliformes	Mastacembelidae	*Macrognathus*	*Macrognathus aral*	Bommidai
55				*Macrognathus pancalus*	Chinna bommidai

Fish catching and selling is the main income source for fisher folks in and around the river Krishna at Vijayawada. They used traditional methods for fish catching which increases the sustainability of fishes in river. They are selling fishes through their fishermen cooperative society. The desiltation and non-desiltation areas of river Krishna, upstream water has represented with the maximum number (55 fishes) of fish species belonging to different groups (Photogrps enclosed Annexures- 2).

The abundance of species like *Catla*, Rohu, Mrigala, *Labeo bata* and L. *boga*, *Mystus* and *Channa* was higher than other species available in river Krishna. The highest distribution and abundance of Cyprinidae members (55 species) observed in the present study showing that fish community in river Krishna has not been disturbed by disilatation activity.

Avian fauna of river Krishna

Table 12. List of avian fauna recorded in Krishna River upstream of Parkasam Barrage 13.5

S. No.	Orders	Family	Scientific name	Common name	Category
1	Podicipediformes	Podicipedidae	*Tachybaptus ruficollis* (Pallas)	Little Grebe	R
2	Suliformes	Phalacrocoracidae	*Phalacrocorax fuscicollis* (Stephens)	Indian cormorant	R
3			*Phalacrocorax niger*	Little cormorant	R

			(Vieillot)		
4	Pelecaniformes	Ardeidae	*Ardea cinerea* (Linnaeus)	Grey Heron	R/M
5			*Ardea purpurea* (Linnaeus)	Purple Heron	R
6			*Butorides striata* (Linnaeus)	Little Green Heron	R
7			*Ardeola grayii* (Sykes)	Indian Pond Heron	R
8			*Bubulcus ibis* (Linnaeus)	Cattle Egret	R
9			*Casmerodius albus* (Linnaeus)	Large Egret	R/LM
10			*Egretta garzetta* (Linnaeus)	Little Egret	R/M
11		Threskiornithidae	*Threskiornis melanocephalus* (Latham)	Oriental white Ibis	M
12			*Platalea leucorodia* (Linnaeus)	Eurasian spoonbill	M
13	Ciconiiformes	Ciconiidae	*Mycteria leucocephala* (Pennant)	Painted Stork	R/LM
14			*Anastomus oscitans (Boddaert)*	Asian Open bill stork	R/LM
15	Accipitriformes	Accipitridae	*Pernis ptilorhyncus* (Temminck)	Oriental Honey Buzzard	R/M
16	Gruiformes	Rallidae	*Amauronis phoenicurus* (Pennant)	White- breasted Waterhen	R
17			*Gallinula chloropus* (Linnaeus)	Common Moorhen	R
18			*Fulica atra* (Linnaeus)	Common Coot	R
19	Charadriiformes	Charadriidae	*Vanellus indicus* (Boddaert)	Red- Wattled Lapwing	R
20			*Charadrius dubius* (Scopoli)	Little Ringed Plover	R
21	Columbiformes	Columbidae	*Streptopelia traquebarica* (Hermann)	Red Collared Dove	R
22			*Streptopelia chinensis* (Scopoli)	Spotted Dove	R
23	Coraciiformes	Alcedinidae	*Ceryle rudis* (Linnaeus)	Lesser Pied Kingfisher	R
24			*Alcedo atthis* (Linnaeus)	Small Blue Kingfisher	R
25	Cuculiformes	Cuculidae	*Eudynamys scolopacea* (Linnaeus)	Asian Koel	R
26			*Centropus sinensis* (Stephens)	Greater Coucal	R

27	Passeriformes	Nectariniidae	*Nectarinia minima* (Sykes)	Small sunbird	R
28			*Nectarinia asiatica* (Latham)	Purple Sunbird	R

R. Resident Lm- local migratory m- migratory

Birds are recognized as one of the most important indicators of the state of environment, as they are sensitive to habitat change. The present study on avian faunal diversity carried for three months period at river Krishna upstream from Prakasam barrage. The observed and indentified 28 avian species were found belonging to 12 families of 11 orders (table 12). Seven of the 28 avian species identified were of Ardeidae family belongs to Pelecaniformes order. The identified avian species were classified into Resident, Local & migratory and Migratory categories. Lake Kolleru and Uppalapdu which are situated nearer to river Krishna are the home-grounds for different birds and there from these birds frequently visit river Krishna for feeding. The resident birds at the sites were found to be adapted for habitat, feeding and breeding & hatching purposes, whereas the other species depend only for feeding activity. Krishna upstream having good vegetation and algae at riverbank sides and islands seems to be most favourable feeding grounds for avian fauna.

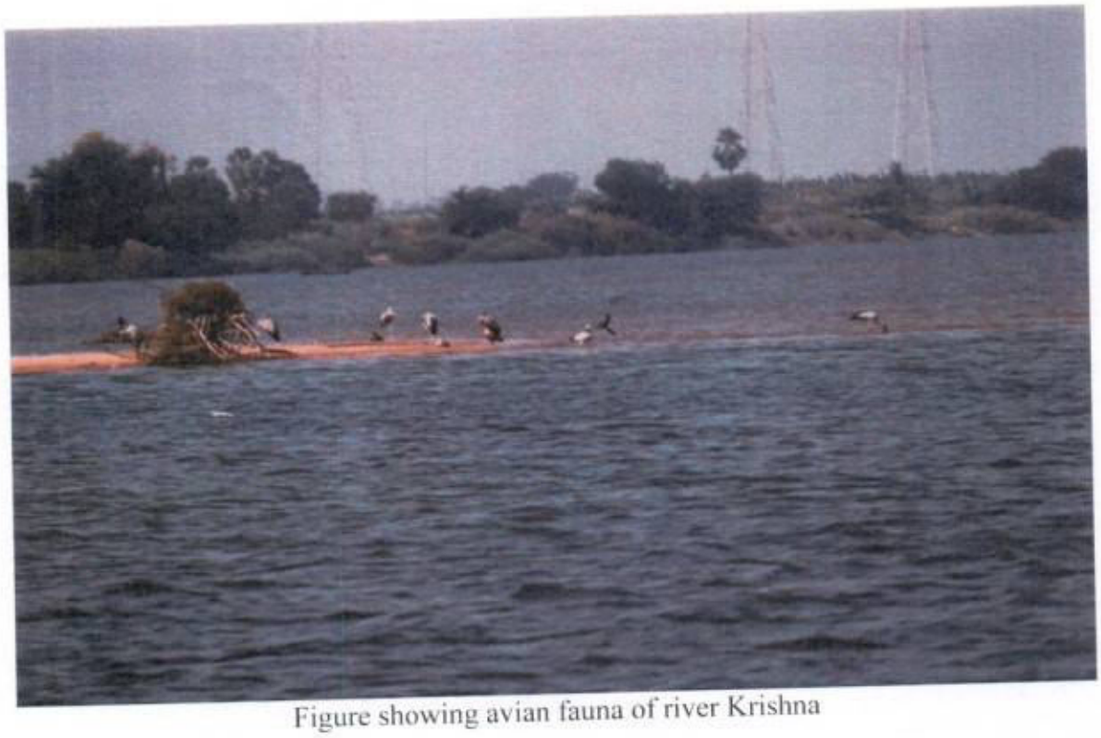

Figure showing avian fauna of river Krishna

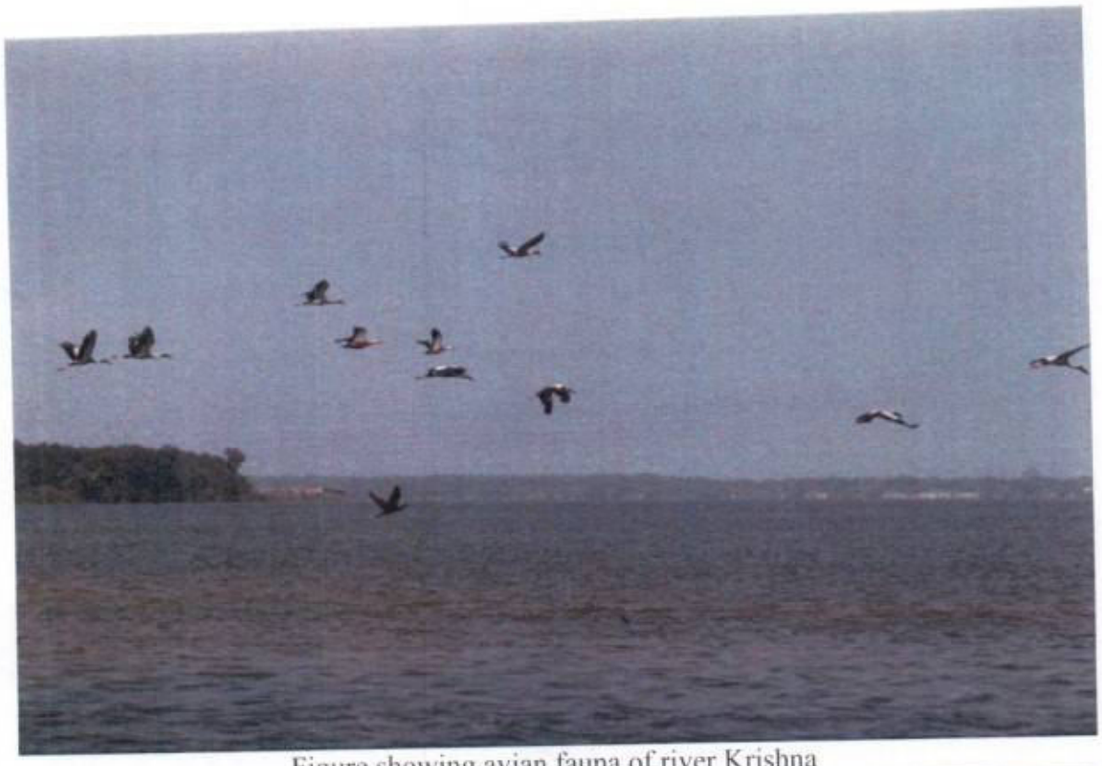

Figure showing avian fauna of river Krishna

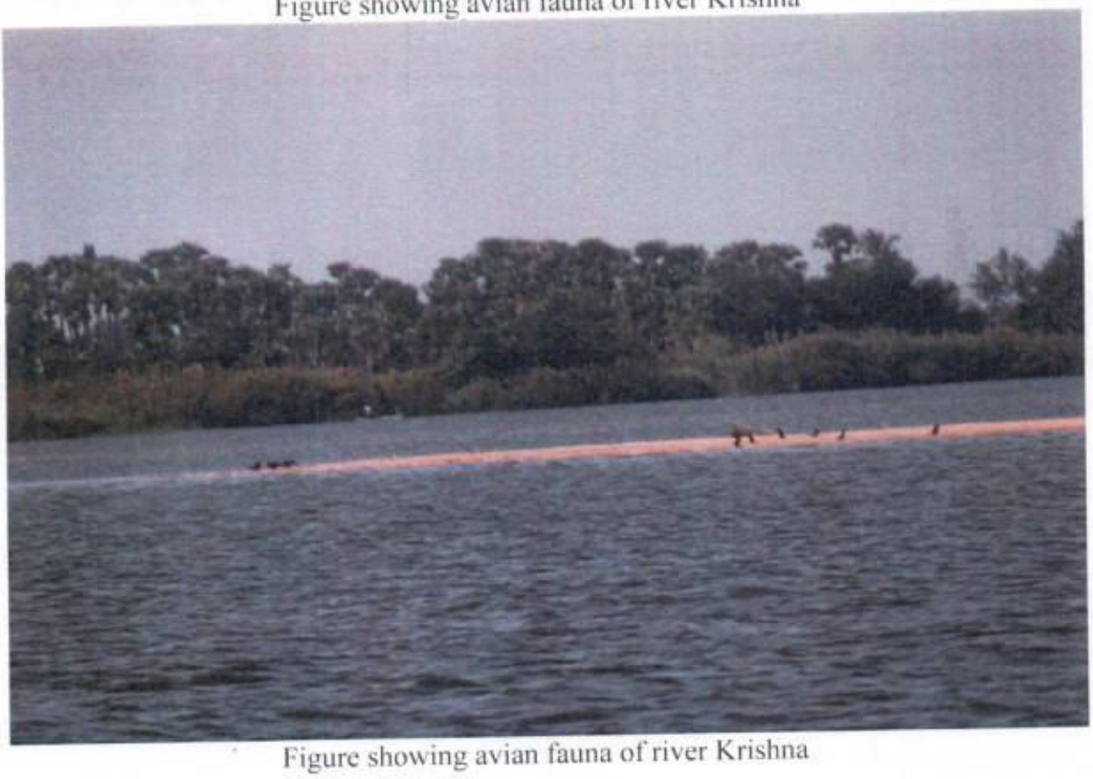

Figure showing avian fauna of river Krishna

VII. SOCIO-ECONOMIC EFFECTS OF DESILTATION IN RIVER KRISHNA (UPSTREAM OF PRAKASAM BARRAGE), VIJAYAWADA

Social effects are evolved from the environmental, social and economic factors; however, it should be emphasized the quantifying socio-economic effects is a difficult task. An assessment and a study on socio-economic effects of desiltation in river Krishna would be helpful in wise decision making in river management. Though some sub-components of desiltation may improve the social conditions i.e., income generation, local revenue, livelihood, employment etc.

The investigator and research assistant have gone through the sand reach points and desiltation places i.e., Undavalli, Venkatayapalem, Lingayapalem, Rayapudi Surayapalem and Ibrahimpatnam villages. The study on Socio-Economic Impacts was conducted at above said places to know the socio-economic effects of people due to desiltation in river Krishna with respect by following methods:

VII. a. Research Methodology

The research methodology used to carry out the study and evaluate the research objectives. It is clearly emphasizesthe research design, nature of the sample, methods of sample selection, size of the sample, data collection tools and techniques and the statistical tools used to analyze the collected data in order to draw inferences and conclude accordingly.

VII.b. Research Design

Research design is the conceived plan and structure of investigation to obtain answers to the research objectives. The problem under the research is to describe certain characteristics such as applications, dependency, acceptability and advantages of the subject matter under consideration. Hence, the research design has adopted for the study is 'analytical research'.

VII.c. Objectives of the Study

The study is conducted with the following objectives:

1) To understand the problems of people effected due to the desiltation at river Krishna, upstream of Prakasam Barrage (13.5 Km), Vijayawada.
2) To study the Socio-economic effects during desiltation stage at different places of river Krishna, upstream of Prakasam Barrage (13.5 Km), Vijayawada.
3) To find out the livelihood conditions of the fishermen community in the selected villages of desiltation in river Krishna, upstream of Prakasam Barrage, Vijayawada.

VII.d. Study Area and Sample Method

The research is designed to conduct the socio-economic effects of fishermen community in the selected upstream villages of river Krishna having the sand reach points and desiltation places i.e. Undavalli, Venkatayapalem, Lingayapalem, Rayapudi, Surayapalem and Ibrahimpatnam villages. The study on Socio-Economic effects were conducted at above said places to study the impact of desiltation and affected families/people depended on river Krishna.

VII.e. Sample Size

The researcher has followed the 'purposive sampling method' to select the sample respondents. The fishermen community from the villages of Undavalli, Venkatayapalem, Lingayapalem, Rayapudi, Surayapalem and Ibrahimpatnam were selected for the study. Twenty-five fishermen families, as respondents, were selected from each village i.e., from six villages, total 150 respondent families were selected to conduct the study.

VII.f. Data Collection Tools

A structured interview schedule was prepared by the investigator and interviews were conducted to the respondent families and desiltation workers for collection of first- hand information as primary data and the data was used for the study.

VII.g. Socio-Economic Study

The objective of the study is to identify Socio-Economic effects and to prepare complete inventory of affected fishermen community/families and dependant persons at desiltation places of river Krishna, upstream (13.5 Km) of Prakasam Barrage, Vijayawada, and to identify the social impacts. In order to capture the primary data for present exercise, an interview schedule was carried out. As a part of the study, socio-economic survey has been conducted by the researcher to identify the effects on livelihood of fishermen families/dependent persons and list out the effects.

The socio-economic effects due to the desiltation in river Krishna, upstream of Prakasam Barrage, Vijayawada have been classified as:

1) Socio-economic effects at beginning of the desiltation stage of river Krishna, upstream of Prakasam Barrage (13.5 Km), Vijayawada.
2) Socio-economic effects during desiltation stage of different places of river Krishna, upstream of Prakasam Barrage (13.5 Km), Vijayawada.

3) Socio-economic effects after desiltation stage of river Krishna, upstream of Prakasam Barrage, Vijayawada.

VII.h. Socio-Economic Household Survey for effected Families/Persons

The study of the families/persons effected with desiltation was conducted in and around of river Krishna. The survey, inter alia, has assessed the effects of the desiltation, the socio-demographic aspects, economical aspects, and living standards of effected persons/families particularly the fishermen communities in Undavalli, Venkatayapalem, Lingayapalem, Rayapudi, Surayapalem and Ibrahimpatnam due to the desiltation in river Krishna. The data was collected on the following aspects during the study:

- Socio-economic conditions of the fishermen communities and the dependent persons;
- Family structure and number of family members of the respondents;
- Literacy levels of the respondents;
- Occupation type and income levels of the respondents;
- Inventory of household assets;
- Indebtedness of the respondents;
- Loss of immovable assets due to the desiltation and degree of loss;
- Accessibility to the community facilities;
- Perceptions on the resettlement and rehabilitation measures;
- Perceived income restoration measures;
- Willingness to participate in the desiltation; and
- Present livelihood status.

VII.i. Data Analysis and Interpretation

The collected data is tabulated and interpreted to understand the results of the study.

VII.i.1. Age wise Distribution of the Respondents

Table 13. Age Group of the Respondents

S. No.	Age Group	No. of Respondents	Percent
1	21 to 30	18	12.00
2	31 to 40	45	39.00
3	41 to 50	59	39.33
4	Above 51	28	18.67

Total	**150**	**100.00**

Age group of the respondents in the study gives good idea about area and its people because if the number of aged people working in specific area then there can be different problems and attitudes of that respective study area. If the number of younger people is high then social problems, attitudes can be different like unemployment. So, the understanding of the age pattern is very important and age data of all the effected persons of desiltation is given in table 13.

VII.i.2. Family Structure of the Respondents

Table 14. Family System of the Respondents

S. No.	Family System	No. of Respondents	Percent
1	Joint Family	27	18.00
2	Nuclear Family	123	82.00
Total		**150**	**100.00**

Table 14 shows that the nuclear families are dominating in the study area of fishermen communities with an incidence of 82 percent, while the remaining 18 percent were observed living in joint family system.

VII.i.3. Religion of the Respondents

The social division of the households in the study area of fishermen community, the figure show that (113 families out of 150) 75.33 percent of the total households are belongs to Hindu religion and it is followed by 22.67 percent (34 families out of 150) of the respondents are Christians and only 2 percent are Muslims were settled in the study area. Majority of the fishermen community belongs to the backward classes in the social system their basic profession is fishing catching and netting for fishes.

Table 15. Religion of the Respondents

S. No.	Religion	No. of Respondents	Percent
1	Hindu	113	75.33
2	Christian	34	22.67
3	Muslim	3	2.00
4	Others	--	--
Total		**150**	**100.00**

VII.i.4. Marital Status of Desiltation effected persons

The analysis on marital status of the desiltation effected fishermen community persons indicates that 85.33 percent of respondents are married, while 12 percent are unmarried and 2 percent are living alone, whereas 0.67 percent is divorced are living in the study area. The marital status of the respondents is depicted in the following Table.

Table 16. Marital Status of the Respondents

S. No.	Marital Status	No. of Respondents	Percent
1	Married	128	85.33
2	Unmarried	18	12.00
3	Single	3	2.00
4	Separated	1	0.67
Total		**150**	**100.00**

VII.i.5. Educational Status of the Respondents

Table 17. Educational Status of the Respondents

S. No.	Education	No. of Respondents	Percent
1	Illiterate	79	52.67
2	Up to 5th Class	35	23.33
3	Up to 7th Class	14	9.34
4	Up to 10th Class	11	7.33
5	ITI/Intermediate	8	5.33
6	Diploma/Graduation	3	2.00
Total		**150**	**100.00**

Among the total 150 respondents more than half (52.67%) of the respondents are illiterates, since they have no facility for education, and they attained more than 40 years of age. From among the total respondents, 23.33 percent of the respondents had education up to 5th standard they can put their signature only, whereas 9.34 percent of the respondents having education up to 7th class and 7.33 percent had studied up to 10th class. The small group (5.33%) of the respondents studied ITI/Intermediate and only 2 percent have studied diploma/graduation. The educational status of the fishermen community is very low the data is enumerated in the above table.

VII.i.6. Occupation of the Respondents

Table 18. Occupation of the Respondents

S. No.	Occupation	No. of Respondents	Percent
1	Fishing	28	18.67
2	Netting	5	3.33
3	Desiltation	111	74.00
4	Labour Work	4	2.67
5	Others	2	1.33
Total		**150**	**100.00**

The above table 6 revealed that the occupation of the respondents. The investigator has enquired that out of total 150 respondents, majority (74%) of them are settled in desiltation work from several years, because they are getting the regular and more income than fishing and compare with other professions. Only 18.67 percent of the respondents felt that their profession is fishing and few respondents (3.33%) are settled in fish netting in the river Krishna, but they are not getting the regular income, where as 2.67 percent attending labour work and only 1.33 percent are doing self-employment in their locality.

Traditionally, the community was into fishing activity. During 2015, when the de-siltation works started, in addition to fishing the people native to the region have taken debt and invested in dredging machinery like boats etc. It was informed by the public that before the debts taken for dredging machinery is cleared the desiltation activity is stopped due to which the economic condition of the people has deteriorated.

VII.i.7. Daily Income level of the Respondents

Table 19. Daily Income Level of the Respondents

S. No.	Daily Income in Rupees	No. of Respondents	Percent
1	Below 500/-	6	4.00
2	501/- to 800/-	25	16.67
3	801/- to 1200/-	67	44.67
4	1201/- to 1500/-	38	25.33
5	Above 1501/-	14	9.33
Total		**150**	**100.00**

Income of the respondents is presented in the table 19, out of the total 150 respondents, 4 percent are getting Rs.500/- per day, 16.67 percent are getting daily income between Rs.501/- to Rs.800/- per day. Majority (44.67%) of the respondents expressed that their daily income is between Rs.801/- to 1200/- per day, whereas 25.33 percent of the respondents expressed that their daily income is between Rs.1201/- to 1500/- and only 9.33 percent are getting the income per day is above 1500 rupees per day. Since the investigator has thoroughly interacted with all the respondents that they are attending the desiltation work in the river Krishna that is only source of regular income to them, and expressed that they have purchased the desiltation machine boats and have settled in the sand collection and desiltation work in the river Krishna.

VII.i.8. Type of Housing assets owned by the Respondents

Table 20. Type of House of the Respondents

S. No.	Type of House owned	No. of Respondents	Percent
1	Owned Pukka	105	70.00
2	Owned Kacha	20	13.34
3	Rented Pukka	17	11.33
4	Rented Kacha	8	5.33
Total		150	100.00

The above table 20 depicts that the type of housing assets having by the respondents, among the total 150 respondents, majority (70%) of the them have owned permanent/pukka houses in their communities, it is followed by 13.34 percent have owned kacha houses since the government has provided the housing colony is developed to their communities. The remaining 16.66 percent of the respondents felt that they are recently migrated to these localities for getting of desiltation work in river Krishna, that's why they are staying in the rented houses. On the overwhelm, we can understand most of the respondents having owned houses in the colony or own constructed houses.

VII.i.9. Indebtedness of the Respondents

Table 21. Indebtedness of the Respondents

S. No.	Indebtedness in Rupees	No. of Respondents	Percent

1	Below 1Lakh	24	21.24
2	1to 3Lakhs	35	30.97
3	3 to 5Lkhs	31	27.43
4	5 to 7Lakhs	18	15.93
5	Above 7Lakhs	5	4.43
Total		**113**	**100.00**

Table 21 revealed that the indebtedness of the respondents, among the total 113 respondents more than 75 percent have the indebts. Out of 113 respondents, 30.97 percent have below 3 lakhs indebtedness and 27.43 percent have below 5 lakhs indebted, whereas 21.24 percent have below one lakh and 15.93 percent of the respondents were indebted with more than 7 lakhs. All the respondents felt that they have indebts because of they purchased the desiltation machine boats on finance based and received the loans from local financiers on interest basis. The loan amount being remitted daily or weekly basis to the loan lenders. The respondents expressed that if the government provides the loans, the indebts will be reduced and they may be tension free with the indebtedness.

VII.i.10 Accessibility to the Community Facilities

Table 22. Accessibility to the Community Facilities

S. No.	Opinion	No. of Respondents	Percent
1	Good	27	18.00
2	Satisfactory	85	56.67
3	Bad	38	25.33
Total		**150**	**100.00**

Table 22 explains the accessibility with the community facilities to the respondents, more than half (56.67%) of the respondents felt that they are satisfying with the available facilities in the community and it is followed by 18 percent expressed that the present facilities in the community is good. On the other hand, one fourth (25.33%) of the respondents opined that existing facilities in the community is bad. The government and NGOs shall take initiation to provide the education, health and infrastructural facilities to develop their communities.

VII.i.11. Perception on Resettlement and Rehabilitation Measures

Table 23. Perception on Resettlement and Rehabilitation Measures

S. No.	Opinion	No. of Respondents	Percent
1	Immediate	42	28.00
2	Some what	65	43.33
3	In future	43	28.67
Total		150	100.00

The present legal policy and government policy of the desiltation is stopped in the upstream of river Krishna, all the people who worked in desiltation they have no work since more than 9 months and they are not interested to attend other works since they habitat with the same work. Table 23 describes about the respondents' perception on resettlement and rehabilitation measures, out of 150 respondents, 28 percent expressed that the facilities shall provide immediately and 43.33 percent felt that some what measures shall be initiated on resettlement and rehabilitation. On the other hand, 28.67 percent of the respondents opined that in future the measures can be initiated for their settlement.

VII.i.12. Perceived income for restoration measures

Table 24. Income for Restoration Measures

S. No.	**Opinion**	**No. of Respondents**	**Percent**
1	Yes	127	84.67
2	No	23	15.33
Total		**150**	**100.00**

The above table explains the opinion on measures for restoration of income, among the total 150 respondents most (84.67%) of the respondents expressed that present they have no work in the river Krishna so that they wanted to restore the present income generation measures to maintain their livelihoods. Whereas 15.33 percent opined that there is no need of measures to restoration of income.

VII.i.13. Present Livelihood Status

Table 25. Present Livelihood Status

S. No.	**Opinion**	**No. of**	**Percent**

		Respondents	
1	Good	6	4.00
2	Satisfactory	23	15.33
3	Bad	94	62.67
4	Very difficult	27	18.00
Total		**150**	**100.00**

Table 25 narrates that the present livelihood status of the respondents in the study area, out of total 150 respondents majority (62.67%) expressed that the present condition of livelihood status is bad due to at present they have no work and almost have the indebts for purchase of machine boats for desiltation, and it is followed by 18 percent of the respondents expressed that their present livelihood is very difficult to meet the food and groceries. Whereas only 4 percent are in good condition. The government and NGOs have to take initiation to meet their daily needs and to improve the livelihood conditions of the fishermen community and other dependants in the study area.

VII.i.14. Findings of the Study

Interviews and observations were carried out with fishermen community/families, individuals and other dependents. Village level consultations were held during socio-economic study and important issues were discussed with the fishermen community. The issues are related to occupation, income, loss of livelihood, and provision of livelihood opportunities during and after desiltation in river Krishna 13.5km upstream of Prakasam Barrage were asked.

The following findings are presented based on the study:

1) Regarding the age group, 80 percent of the respondents attained the age between 31 to 50 years. Regarding the family system the nuclear families are dominating in the study area of fishermen communities with an incidence of 82 percent. Majority (75.33%) of the respondents of the total households are belong to Hindu religion. Majority of the fishermen community persons in the study area indicates (85.33%) that are married.

2) The aspect of education of the respondents, more than half (52.67%) of the respondents are illiterates and remaining are low literate, since they have no facility for education and now they have attained more than 50 years of age.
3) Regarding the occupation, majority (74%) of the respondents were settled in desiltation work since several years, because they are getting regular and more income compare with fishing other local professions.
4) The aspect of daily income of the respondents, majority (44.67%) of them expressed that their daily income is between Rs.801/- to Rs.1200/- per day, whereas 25.33 percent of the respondents getting daily income is between Rs.1201/- to Rs.1500/- but they have to pay the instalments for indebtedness.
5) The aspect regarding the own house, majority (70%) of the respondents have owned houses in their communities/villages.
6) Regarding indebtedness, out of 113 respondents, 30.97 percent have below 3 lakhs indebtedness and 27.43 percent have below 5 lakhs indebted, and 15.93 percent of the respondents were indebted with more than 7 lakhs. All the respondents felt that they have indebts because they purchased the desiltation machine boats on finance based and barrowed the loans from local financiers on payment of interest and instalment basis.
7) The facilities available in the community, more than half (56.67%) of the respondents are satisfied with the available facilities in the community, but there is a need to improve the community facilities.
8) Perception on resettlement and rehabilitation measures, 28 percent expressed that the facilities shall provide immediately, and 43.33 percent felt that some what measures shall initiated on resettlement and rehabilitation.
9) The issue of present income generation, most (84.67%) of the respondents expressed that they have no work in the river Krishna, so they wanted to restore the present income generation measures to maintain their livelihoods.
10) Most (86%) of the respondents willing to participate in the desiltation since there is no way to get the income and work in other areas, because they know the present work from several years.

11) Majority (62.67%) of the respondents expressed that the present condition of livelihood is bad, because of not having any work and almost all the people are indebted for acquiring of the sand mine boats.

VII.i.15. Socio-Economic Effects

The investigators gone through the study findings, discussions with the community, the details of socio-economic study conducted in the villages of Undavalli, Lingayapalem, Venktayapalem, Surayapalem, Rayapudi, and Ibrahimpatnam villages in the upstream (13.5km) of Prakasam Barrage, river Krishna. The researchers have visited the villages and sand reach points in the river at different places.

VII.i.16. Economic Activity and Livelihood Pattern

The fishermen community in the study area include families, dependants and all the respondents i.e., those who have been engaged desiltation for some economic activity during the last few years.

Therefore, there is an immense need to address the human costs and the measures to be taken should create trust and hope preferably with immediate monetory gains to establish confidence in the functioning of the system. Concrete plan to avoid impoverishment risks and restore/upgrade the income and livelihood of the effected families shall be made immediately. Food security measures shall be taken for the loss of work in the study area. Therefore, there is a need to create employment to earn their bread but with immediate payment of no work/unemployment gratuity especially based on individuals' minimum needs rather than based on a family because all the members in the study villages are mostly daily wage earners.

VII.i.17. Ameliorative Measures Recommended

In addition to giving suitable positive consideration to the people effected as discussed earlier, the study recommends the following measures:

1) The livelihoods are to be converted into non desiltation livelihoods and take immediate measures for upgradation of skills of the fishermen cum dependents of river Krishna.
2) Provision of ample access to interest free credit to encourage self-employment.
3) All fishermen families and people of the communities in the study villages should provide with healthcare, free quality education and creation of various opportunities.

4) Every family should earn at least Rs.15000/- per month. Further, those affected families may be consider for more entitlements under the regular public distribution system.
5) Establishment of homes for the homeless people, who are poor and loss of livelihood due to the stoppage of desiltation.

Figure showing team interaction with fisher folks at Rayapudi village

Figure showing team interaction with fisher folks at Rayapudi village

Figure showing team interaction with fisher folks at Ibrahimpatnam village

Figure showing interaction with fisher folks at Ibrahimpatnam village

VIII PERSONAL INTERACTION WITH FISHER FOLKS ABOUT THE PRESENCE DEAD MOLLUSCANS AT RAYAPUDI

During the personal interaction with the fisher folks of Rayapudi area about the presence of dead molluscan shells on flood plain areas at Rayapudi, the fishermen clearly expressed that the dead molluscan shells (Death mainly due to predators and age factor) get struck to fishing nets during fish catching, which will be separated from the nets and left at a common shore place itself leading to their accumulation.

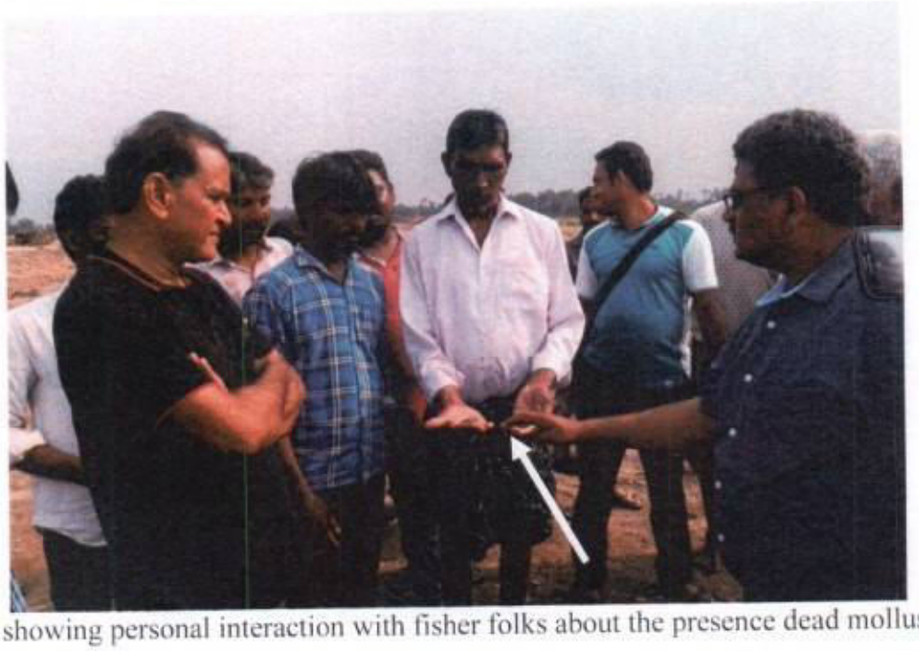

Figure showing personal interaction with fisher folks about the presence dead molluscan

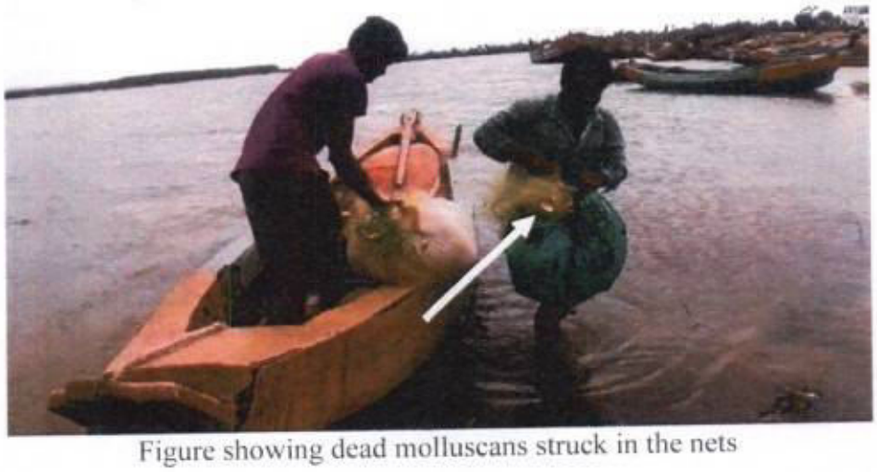

Figure showing dead molluscans struck in the nets

Figure showing dead molluscans separation from the net

*Various other photographs taken at the sampling sites during the study period w.r.t. collection of samples and interaction with fishermen are given in Annexture-3.

IX CONCLUSIONS OF THE STUDY

- During the study period (October – December, 2019), there was no desiltation activity at all the study sites of river Krishna upstream to Parkasam barrage upto 13.5 Kms.
- The present estimated TSS and Turbidity parameters of river Krishna upstream waters are within the permissible limits of fresh waters. These findings are found to be supportive and favourable for flora and fauna towards the sustainability of ecological balance.
- As the observed phytoplankton, during the study period, of the water samples collected from reference and desiltation sites of river Krishna was normal and abundant, it seems that there is no ecological impact on the phytoplankton and thereby primary producers even at the desilting areas.
- The riparian vegetation at all the study sites, both of non-desilted reference site and desiltation sites, was found normal and dense comprising trees, shrubs, herbs etc., except at the point of place where the approach road was laid for the transportation of sand to land.
- The available biotic components of the river Krishna upstream water to show that the water quality of the river. Invertebrates as molluses and vertebrates as fishes

have been used as indicators. In the present investigation in the river Krishna we have recorded good number of Zooplankton, Benthic crustaceans, molluscs, fishes and avian fauna. Among faunal populations *Brachionus, Keritella* of Rotifera; *Ceriodaphnia, Moina, Macrothrix* of Cladocera, different species of Cyclopoid, Calonoid copepods and occurrence of molluscs as *Bellamiya, Thiara, Lamellidens* and the presence of Mayfly nymph, *Gerris* and also fishes like *Catla catla, Labeo bata, L.boga Mystus, Clarias, Puntius* species indicate that the community composition of the ecosystem. These can be used as faunal bio-indicators and water quality of river through biological assessment. Qualitatively the number of genera and species of different taxa found in desiltation area of river Krishna, upstream water to show that the species diversity is more and uniform. This clearly indicates that ecosystem is more or less homogenous. This is corollary to the river characteristics and ecological conditions.

- The types and occurance of avian fauna including the migratory category noticed at the upstream of river Krishna indicating that the habitat environment of river Krishna is favourable to the livelihood for birds in all aspects.
- The Socio-Ecominic study recommends duly taking into consideration of the measures recommended to safeguard livelihoods of the fishermen community and other effected families in the study villages, which are different from the other villages in and around the river Krishna. Certainly, the fishermen community people of these villages feel more loss as ofnow, but they should be made future beneficiaries.

OVERALL CONCLUSION OF THE STUDY

Basing on the above conclusions drawn from different studies, the members opined that there was no notable negative impact on water quality regarding TSS & Turbidity, Phytoplankton, Riparian vegetation, Zooplankton, Benthos, Fishes and Avian fauna at desiltation sites in river Krishna during the study period. However, the members came to understand from the discussions with fishermen, that due to stopping of desiltation activity, there was some impact on the livelihood of dependant fishermen-cum-desiltation workers of the villages.

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SUGGESTIONS

1. Though not found any noticeable disturbance in flora, fauna and riparian vegetation during the study period (October to December,2019) at reference and desiltation sites in river Krishna upstream of Prakasam Barrage (13.5 Km), the frequency and level of desiltation may be optimized to
   - to retain the better water quality of river Krishna
   - to upkeep the storage capacity of Prakasam Barrage to its full capacity, as river Krishna at Vijayawada is the source for irrigation and drinking water.
   - to sustain the primary producers, flora and fauna of river Krishna
   - to have good riparian vegetation at riverbank sides and on islands of river Krishna
2. To create favourable environment in the river for proper fish breeding activity during summer season (15th April to 15th June), desiltation activity may be given interval during summer as that of National policy on fishing holiday.
3. Encourage the usage of good number of manually operated boats, which will improve the livelihood conditions of the local fishermen-cum-desiltation workers as well as to maintain the sustainability of ecological environment in the river Krishna.

SIGNATURES OF THE MEMBERS

1 Mahima T.
Scientist 'D'
Central Pollution Control Board
(Ministry of Environment, Forest & CC, Govt. Of India)
Regional Directorate (South),
Bengaluru

2 Prof. G. Rosaiah
Department of Botany & Microbiology
Acharya Nagarjuna University
Andhra Pradesh

3 Dr.G. Simhachalam
Department of Zoology &
Acqaculture
Acharya Nagarjuna University
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4 Dr. V. Umamaheswara Rao
Department of Botany &
Microbiology
Acharya Nagarjuna University
Andhra Pradesh

5 Dr. P. Brahmaji Rao
Department of Environmental
Sciences
Acharya Nagarjuna University
Andhra Pradesh

6 Dr. M. Trimurthi Rao
Department of Sociology &
Social Work
Acharya Nagarjuna University
Andhra Pradesh

Item No.05 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

Original Application No. 935/2018

(With report dated 20.07.2020)

Anumolu Gandhi Applicant(s)

Versus

State of Andhra Pradesh Respondent(s)

Date of hearing: 24.08.2020

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE S. P. WANGDI, JUDICIAL MEMBER
HON'BLE DR. SATYAWAN SINGH GARBYAL, EXPERT MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER

Applicant(s): Mr. Sravan Kumar, Advocate

Respondent(s): Mr. R. Venkataramani, Senior Advocate with Mr. G.N. Reddy for State of Andhra Pradesh
Mr. TVS Raghvendra Sreyas, Advocate for State PCB
Mr. Aman Bhalla, Advocate for CPCB

ORDER

1. Whether the activity termed as 'de-silting' by the State authorities is in fact 'illegal mining' in Krishna river in Andhra Pradesh, as alleged by the applicant, is the question for consideration.

2. Vide order dated 14.02.2020, the Tribunal referred to earlier proceedings and finding conflicting versions in the report, sought a report from an Expert Committee.

3. Accordingly, a report dated 20.07.2020 has been filed. Overall concluding remarks in the report are:-

"Overall concluding remarks of the Committee Members

i. Water Resource Department, Government of Andhra Pradesh has carried out bathymetric survey in conformity with the established and recommended practices. As per the Bathymetric survey carried out during December, 2019 to January, 2020 present storage capacity of Prakasam barrage is 2.982 TMC. There is loss in storage capacity of 0.089 TMC as compared to the design capacity of 3.071 TMC.

ii. The report submitted by Water Resource Department, Govt. of Andhra Pradesh to Hon'ble NGT is satisfactory.

iii. From the Ecological assessment report it can be inferred that the ***cautious use of dredgers & mechanised boats and judicious desilting activity may not have serious impacts on flora and fauna in Prakasam barrage****.*

*iv. Overall the Ecological assessment report is satisfactory excepting the section on Water quality.****"***

4. In view of above, no further order is necessary except that the operations be overseen by the same Expert Committee to ensure that no damage is caused to the environment.

A copy of this order be forwarded to the members of the Expert Committee by e-mail.

All pending applications do not survive and are disposed of.

Adarsh Kumar Goel, CP

S. P. Wangdi, JM

Dr. Satyawan Singh Garbyal, EM

Dr. Nagin Nanda, EM

August 24, 2020
Original Application No. 935/2018
A

By Regd.Post with Ack.Due

GOVERNMENT OF ANDHRAPRADESH
WATER RESOURCES DEPARTMENT

From:
Sri C. Narayana Reddy, M.Tech.,
Chief Engineer,
Krishna Delta System,
Vijayawada.
Ph No. 0866-2575314,
E-Mail ID: cekdsvja@gmail.com

To:
Smt. MahimaT;
Senior Environmental Engineer,
Central Pollution Control Board;
Regional Directorate(South);
1st & 2nd floors, Nisarga Bhawan;
7th D cross, Thimmaiah Road;
Shivanagar, BENGALURU-560079
Off:08-23233827; Fax:080-23234059;
E-mail: mahima.cpcb@nic.in

Letter No. CE/KDS/VJA/OT-3/AE-10/F-De-salting/ 1107 Dt:-09-06-2021

Sir,

Sub:- Water Resources Department - "De-silting of silt from the foreshore of Prakasam Barrage in Krishna River" -12 Nos of Works going to be started - **Requested for Expert Committee directions** - Regarding

Ref:- 1) The Hon`ble National Green Tribunal Principal Bench, New Delhi original application No. 935/2018, Order Dated:24/08/2020.
2) Minutes of meeting held between Mining department and Water Resources Department for De-siltation of Prakasam Barrage Krishna River on Dated: 16.12.2020
3) Water Resources (Projects.II) Department G.O Rt.No:81 Dated:15/03/2021.
4) Superintending Engineer, Irrgn.Circle, Vijayawada Letter No. SE/IC/VJA/DB/ATO/178CE, Dated:20.05.2021

*****

I submit that in reference 1st cited, The Hon`ble National Green Tribunal Principal Bench, New Delhi original application No. 935/2018 between Anumolu Gandhi Vs. State of Andhra Pradesh, Date:24/08/2020 stated that the Ecological assessment report it can be inferred that the cautious use of dredgers & mechanized boats and judicious de-silting activity may not have serious impacts on flora and fauna in Prakasam Barrage and also stated that the operations be overseen by the same Expert Committee to ensure that no damage is caused to the environment.

Further, it is to submit that in the meeting held between Mining department and Water resources department on de-siltation from the fore shore of Prakasam barrage on 16.12.2020 vide 2nd cited it is decided that

- Water resources department shall undertake de-siltation operation to restore the storage capacity of the Prakasam barrage which has been silted over the years.
- A minimum quantity of fifty lakh tons of silt is to be de-silted in the next six months.
- The appointed agency shall be required to comply with the orders issued by Hon'ble National Green Tribunal in O.A.No.935 of 2018.
- The silt obtained through De-siltation process shall be handed over to M/s APMDC Ltd (or any other Agency as appointed by the State Government) for subsequent disposal.

In this regard, the SE, IC, VJA Executive Engineer, K.C.Division, Vijayawada reported under reference 4th cited, the Government A.P, Water Resources Department accorded administrative approval vide reference 3rd cited for an amount of Rs.102.447 Crores as detailed shown below for taking up 12 Nos. of de-silting works on upstream side of Praksama Barrage for extracting 50 Lakhs tones of de-silted material for use in priority works of the Government and to restore the original capacity of the Barrage. The entire cost of de-silting operations shall be met by M/s APMDC Ltd. The de-silting operations are taken up in strict conformity with the directions of the Hon'ble NGT in O.A No.935/2018.

S.No	Name of the Work	Quantity in Cum	Amount in Rs
1	Desilting of silt from the foreshore of Prakasam Barrage from KM 0.50 to KM 1.00 in Krishna River.	430000	71400000
2	Desilting of silt from the foreshore of Prakasam Barrage from KM 1.40 to KM 2.00 in Krishna River.	530000	87850000
3	Desilting of silt from the foreshore of Prakasam Barrage from KM 2.25 to KM 2.50 in Krishna River.	510000	84570000
4	Desilting of silt from the foreshore of Prakasam Barrage from KM 2.90 to KM 3.20 in Krishna River.	540000	89500000
5	Desilting of silt from the foreshore of Prakasam Barrage from KM 3.50 to KM 3.70 in Krishna River.	540000	89500000
6	Desilting of silt from the foreshore of Prakasam Barrage from KM 3.90 to KM 4.10 in Krishna River.	500000	82800000

7	Desilting of silt from the foreshore of Prakasam Barrage from KM 4.30 to KM 4.50 in Krishna River.	490000	81200000
8	Desilting of silt from the foreshore of Prakasam Barrage from KM 4.80 to KM 5.20 in Krishna River.	510000	84500000
9	Desilting of silt from the foreshore of Prakasam Barrage from KM 5.70 to KM 6.50 in Krishna River.	540000	89400000
10	Desilting of silt from the foreshore of Prakasam Barrage from KM 7.50 to KM 8.40 in Krishna River.	563000	93200000
11	Desilting of silt from the foreshore of Prakasam Barrage from KM 8.80 to KM 9.30 in Krishna River.	530000	87750000
12	Desilting of silt from the foreshore of Prakasam Barrage from KM 11.00 to KM 13.50 in Krishna River.	500000	82800000
Total		6183000	1024470000

In this connection, the tenders have been invited for the 12 Nos. of works in Reverse Tendering system. After finalizing the qualified bibbers, the letter of acceptances were issued to the lowest bidder on Dt:30/04/2021 and the works are going to start duly deploying the men and machinery. The agency names are shown below.

S.NO	Dredging Chainage	Name of the Agency
1	From KM.0.500 to KM.1.000	Reach Dredging Ltd. Kalkatta
2	From KM.1.400 to KM.2.000	Reach Dredging Ltd. Kalkatta
3	From KM.2.250 to KM.2.500	IRP Infra Tech Pvt. Ltd.,Guntur
4	From KM.2.900 to KM.3.200	IRP Infra Tech Pvt. Ltd.,Guntur
5	From KM.3.500 to KM.3.700	Reach Dredging Ltd. Kalkatta
6	From KM.3.900 to KM.4.100	Reach Dredging Ltd. Kalkatta
7	From KM.4.300 to KM.4.600	Reach Dredging Ltd. Kalkatta
8	From KM.4.800 to KM.5.200	Santhulan Infra JV. Hyderabad
9	From KM.5.700 to KM.6.500	Reach Dredging Ltd. Kalkatta
10	From KM.7.500 to KM.8.400	Reach Dredging Ltd. Kalkatta
11	From KM.8.800 to KM.9.300	Nas Babu Constructions Pvt. Ltd., Gudivada
12	From KM.11.000 to KM.13.000	Nas Babu Constructions Pvt. Ltd., Gudivada

In view of the above, I request Smt. Mahima T, Senior Environmental Engineer, Central Pollution Control Board, Regional Directorate(South), Bengaluru, Expert Committee appointed by Hon'ble NGT Case No. O.A No.935/2018, that the operations be overseen by the same Expert Committee to ensure that no damage is caused to the environment. The date of execution of works will be intimated in due course.

This is submitted for information and further taking necessary action.

Yours faithfully,

AE-10 OT-3 Dy.CE

Chief Engineer,
Krishna Delta System,
Vijayawada.

Copy to the Superintending Engineer, Irrigation Circle, Vijayawada for inofmration and necessary follow up action.

AE-10 OT-3 Dy.CE

Chief Engineer,
Krishna Delta System,
Vijayawada.

DESPATCHED
ON.....09/06/2021.....
Despatch Clerk