BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,

Principal Bench, New Delhi

In

Original Application No. 935/2018

In the Matter of: -

Anumolu Gandhi **Applicant**

Vs.

State of Andhra Pradesh **Respondent(s)**

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(Nazimuddin)
Scientist 'E'
Central Pollution Control Board
Parivesh Bhawan, East Arjun Nagar
Delhi-110032

Place: Delhi
Date: 20th July, 2020

EVALUATION AND VALIDATION OF REPORTS SUBMITTED BY STATE OF ANDHRA PRADESH TO HON'BLE NGT BY COMMITTEE COMPRISING OF EXPERT APPRAISAL COMMITTEE (NON-COAL MINING) OF MINISTRY OF ENVIRONMENT FOREST & CLIMATE CHANGE, CENTRAL POLLUTION CONTROL BOARD (CPCB), INDIAN SCHOOL OF MINES, DHANBAD AND INDIAN INSTITUTE OF SCIENCE, BENGALURU IN THE MATTER OF OA. NO. 935/2018 SUBMITTED TO HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, DELHI AS PER ORDER DATED FEBRUARY 14, 2020

Submitted to

Hon'ble National Green Tribunal

Principal Bench, New Delhi

July, 2020

1.0 Preamble

In the matter of Original Application no. 935 of 2018, Anumolu Gandhi Vs State of Andhra Pradesh, the Hon'ble National Green Tribunal (NGT), Principal Bench vide Order dated 23.07.2019 directed State of Andhra Pradesh to undertake detailed study like Bathymetric Survey and Ecological Assessment Study and to submit the report within three months. Department of Mines & Geology, Andhra Pradesh awarded the study on "Ecological Impact Assessment Study on Flora and Fauna of River Krishna" to Acharya Nagarjuna University(ANU). Water Resource Department (WRD), Andhra Pradesh was assigned to carry out Bathymetric Survey. Government of Andhra Pradesh did not submit the reports within time duration given by Hon'ble NGT. Hon'ble NGT vide order dated 19.12.2019 directed Govt. of A.P to involve CPCB and furnish the report within one month. In compliance to directions, Department of Mines & Geology, Andhra Pradesh submitted the reports to Hon'ble NGT on 19.01.2020 and was taken up for hearing on 14.02.2020.

2.0 Orders of the Hon'ble Tribunal dated 14.02.2020

"We are of the view that in view of conflicting versions, the report needs to be independently evaluated and validated. For this purpose, we constitute an Expert Committee comprising members of Expert Appraisal Committee on the subject of the MoEF&CC, nominees of CPCB, Indian School of Mines, Dhanbad and the Indian Institute of Science, Bengaluru. The joint Committee may be assisted by the Andhra Pradesh State PCB. The CPCB will be the nodal agency for coordination and compliance. The applicants will be free to give their view point/submissions to the CPCB within two weeks. The CPCB will provide all documents to the members of the Committee. The report may be furnished within two months by email at judicial-ngt@gov.in."
Copy of the Hon'ble NGT order dated 14.02.2020 is placed as Annexure-I.

3.0 Composition of the Committee

As directed by the Hon'ble Tribunal, the committee was constituted comprising of following members:

1. Sharath Kumar Pallerla, Scientist-F, Member Expert Appraisal Committee- Non-coal mining, Ministry of Environment, Forest and Climate Change
2. Prof. V K Sinha, Adjunct Professor, Department of Mining Engineering, Indian school of Mines, Dhanbad

3. Prof. M. Sudhakar Rao and Dr. K S Nanjunda Rao, Department of Civil Engineering, Indian Institute of Science, Bengaluru
4. Smt. Mahima T, Scientist-D, Central Pollution Control Board, Regional Directorate, Bengaluru

4.0 Methodology of Study

- As per Hon'ble NGT order, the scope of the committee was to independently evaluate and validate reports submitted by Govt. of Andhra Pradesh to Hon'ble NGT. CPCB being the nodal agency forwarded copy of the following reports to the committee members and requested to evaluate the reports:
    a. **Report submitted by Water Resource Department including findings of Bathymetric survey:** It is a scientific study done 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 foreshore water submerged area which is considered as reservoir. It is mentioned in the report that the capacity of Prakasam barrage is arrived as 2.982 TMC and the silt volume above original Bed Level to be removed is 1,24,77,704 Cum. Copy of the report is enclosed as Annexure-II.

    b. **"Ecological Impact Assessment Study on Flora and Fauna of River Krishna" carried out by Acharya Nagarjuna University**: The qualitative analysis of phytoplanktons, zoo-planktons, Benthos and riparian vegetation including fish fauna & avian fauna is carried out in the study for all reaches in Prakasam barrage during October- December, 2019. The study also covers water quality, Socio-Economic Effects of Desiltation in River Krishna (Upstream of Prakasam Barrage), Vijayawada. Copy of the report is enclosed as Annexure-III.

5.0 Observation of Committee Members

In compliance to Hon'ble NGT order, the committee members evaluated the reports. The comments of the committee members with respect to the reports submitted by State of Andhra

Pradesh (Water Resource Department and Achraya Nagarjuna University) to Hon'ble NGT are summarized as follows:

5.0 a. Observations & Comments of Ministry of Environment, Forest and climate change

i. The Scour gates could not be operated for almost 10 years due to operational constraints. Therefore, continuous accumulation of silt formation in the reservoir. The accumulation of silt need to be de-silted/ dredged keeping the safety of the barrage.

ii. It is to submit that as per the Appendix IX of EIA Notification 2006 issued vide amendment to EIA Notification, 2006 number S.O. 141(E) dated the 15th January, 2016, dredging of de-siltation of dams and canals for the purpose of their maintenance and to up-keep disaster maintenance is exempted. However, said notification vide S.O. 141(E) dated 15.01.2016 has been kept aside by the Hon'ble NGT in the Executive application No. 55/2018 in OA No. 520/2016 in the matter of Vikrant Tongad Vs Union of India, vide order dated 11th December, 2018. Further, it is to submit that the Ministry is already in the process of notification of exemption of certain cases, *inter alia*, including dredging of de-siltation of dams and canals for the purpose of their maintenance and to up-keep disaster maintenance, as given at Appendix IX of impugned notification. Further, the Ministry has published Notification S.O 1224(E) dated 28.03.2020, inter alia, for aligning the provision of the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957), and set an exemption of certain cases from requirement of environmental clearance as mention in "Appendix-IX. The Copy of the said Notification is attached herein and marked as Annexure- IV.

iii. The study carried out by Acharya Nagarjuna University reveals that there is no damage to the riverine ecosystem. Further it is to submit that impact on the eco-system may not be attributed to any specific activity, as the impact is attributable to several natural and anthropological activities of the area. The report of Acharya Nagarjuna University is found to be satisfactory.

iv. Report submitted by Water Resource department are satisfactory.

5.b. Observations & Comments of Central Pollution Control Board

i. In compliance to Hon'ble NGT direction dated 19.12.2019, the Water Resource Department has carried out Bathymetric Survey in the entire 13.5 KM of Prakasam barrage by adopting standard equipment and method.

ii. As per preliminary assessment in 2015 by Irrigation department, the quantity of sediments is 71 lac Cum and as per latest Bathymetric survey the total quantity of sediments is 1,24,77,704 Cum above original bed level. Even after carrying out desiltation for more than two years in Prakasam barrage during 2015 to 2018, huge quantity of sediment is still deposited above the bed level.

iii. As per BIS IS 7349:2012- Barrages and weirs Operation and Maintenance Guidelines, dredging/ desiltation is required to establish satisfactory flowing conditions and restore desired capacity. In case of Prakasam barrage, the design storage capacity is 3.071 TMC (when constructed during 1954-57) and as per the Bathymetric survey carried out during December, 2019 to January, 2020 present storage capacity is 2.982 TMC and loss in storage capacity is 0.089 TMC only. In future, if the State of Andhra Pradesh proposes to desilt the barrage, it may be carried out to the tune of 25,18,176 Cum to restore the lost storage capacity of 0.089 TMC.

iv. Acharya Nagarjuna University has carried out qualitative study to assess the ecological impact on flora & fauna of river Krishna due to sand mining during October to December 2019. From the report, it can be concluded that there is abundant phytoplanktons, zoo planktons, benthic crustaceans, molluscs, fishes, avian fauna and dense vegetation growth in both desiltation areas and reference site.

v. As per report given by water Resource department, the desiltation activity was stopped during September 2018. The impact assessment study was carried out one year after stopping desiltation activity which indicates that the desiltation activity in Prakasam barrage may not have serious long term impacts on flora & fauna. In future, if desiltation activity is undertaken in Prakasam barrage, a study may be carried out by the State of Andhra Pradesh post desiltation to assess the immediate & short-term impacts of desiltation on flora & fauna.

vi. 2019 floods in Andhra Pradesh may also have contributed to enriching & flourishing the ecosystem in Prakasam barrage. Additionally, the State of Andhra Pradesh may also carry

out Quantitative analysis study in the barrage and the study results may serve as baseline data in future to understand the impacts.

vii. Both the reports are found to be satisfactory.

5.c Observations and Comments of Indian School of Mines, Dhanbad

i. It has been stated in the WRD report that due to operational constraints, scour gates of Prakasam Barrage could not be operated for almost 10 years which resulted in heavy sediments in the reservoir thus reducing the live capacity of the reservoir by about 25%.

ii. The need for desiltation arose due to heavy deposition of silt coupled with increased demand of water in the region. A study by Irrigation department in 2015 assessed 71 Lakh m^3 of silt deposit in the Krishna River upto 13.5 Km upstream of Prakasam Barrage. It is observed that in 2015 assessment, the quantities for 5 to 10 Km have been shown as zero and it is informed by Water Resource Department that the average depth of accumulation of sand in the Km 5.00 to Km 10.00 was less than 2 m and as such the reaches were not considered for de-siltation.

iii. Desiltation was undertaken and desilted quantities by motor boat and dredger were 33 Lakh m^3 and 9.95 Lakh m^3 respectively in phase-I.

iv. Bathymetric survey was carried during December, 2019 to January, 2020 in upstream of Prakasam Barrage upto 13.5 Km using Single Beam Echo Sounder, Positioning and Navigation System. Based on this study, the capacity of Prakasam barrage has been observed as 2.982 TMC at 12' (+17.39 Metre). The study also mentions that water storage capacity will increase by 0.441 TMC after desiltation of 1,24,77,704 m^3 above original bed level.

v. Ecological assessment is a study on ecological impact in River Krishna in upstream of Prakasam Barrage upto 13.5 km due to desiltation covering water quality analysis, study of phytoplanktons, diversity and community composition of fishes, Benthonic fauna, riparian vegetation and avian fauna apart from Socio-Economic impact.

vi. In the study report, Undavalli (from Km 2.00 to Km 3.200 of KRF bank) has been assumed as non-desiltation area and chosen as reference site to compare the impacts. The above study is carried out in 9 locations which included all the 8 locations alleged in NGT Case OA 935/2018.

vii. Overall both the reports are satisfactory.

5.d Observations and Comments of Indian Institute of Science

Comments with respect to report submitted by Water Resource Department and Bathymetric survey

i. Sedimentation in reservoirs/barrages is a critical issue all over the globe. This aspect must be considered while designing the reservoirs for the storage capacity for a finite period. Thereafter, scientifically established protocols must be mandated for assessing and managing sedimentation in reservoirs/barrages as it can become a potential threat to social, environmental and economic efficiency and finally to the safety of the reservoir/barrage itself. In this context, the studies carried out by Water Resource Department are in order.

ii. The ill effects of sedimentation in reservoirs/barrages are (a) loss of storage capacity (b) alterations in flow regimes which can cause damage to flood banks and inundate large surrounding areas in case of floods, (c) enhanced static and dynamic loads on hydraulic control structures.

iii. The Government of Andhra Pradesh has put in place a sand mining policy which in the opinion of the IISc nominated member is quite stringent.

iv. The methods adopted for sediment removal/de-silting like dredging and use of mechanised boats are in conformity with established practices and guidelines recommended by Bureau of Indian Standards.

v. The cost for removal of sediment from the reservoir bed is quite significant and hence it is a good practice to consider the material removed as a natural resource and to use it for beneficial purposes (if not harmful to human beings and environment). For accomplishing this task, the physical and chemical analyses of the material need to be performed. Based on the outcome of the analysis the material can be utilised for topsoil enhancement and agricultural use, land reclamation and improvement, beach nourishment and shore protection, building construction material etc. The reuse of sediment material will help in recovering cost incurred for removal of the sediment. It is not advisable to dump the sediment removed from the riverbeds on the flood banks.

vi. The methodology adopted for carrying out bathymetric survey is in conformity with the established and recommended practices. The basic objective of assessing and managing reservoir sedimentation is to estimate the loss of storage capacity by removal of sediments/ desiltation. In this context according to the findings of the Bathymetry survey conducted

during December 2019 to January 2020, the present water storage capacity of Prakasam barrage reservoir is 2.982 TMC. The design water storage capacity of Prakasam barrage reservoir is 3.071 TMC. Therefore the loss in storage capacity is 0.089 TMC. In order to restore the lost water capacity of 0.089 TMC due to sediment deposition, it can be concluded that the volume of sediments to be removed or desilted will be 25,20,200 Cu.m which is equivalent to 0.09 TMC.

vii. The query raised by IISc on bathymetric survey is enclosed as Annexure-V, clarification given by Water resource department (WRD) and the concluding remarks of IISc with respect to report submitted by W.R.D is enclosed as annexure-VI.

Comments of IISc with respect to Ecological Assessment Study

viii. The Evaluation Report of IISc Expert Member on Ecological assessment is enclosed as annexure-VII and subsequent Clarifications from ANU on the Evaluation Report of IISc Expert Member is enclosed as Annexure-VIII and Follow-Up Report on ANU Clarifications by IISc Expert member as Annexure-IX.

ix. Section Va of the Ecological assessment report indicates that samples were collected at two depths (1.5 and 2m) at each site, while, the ANU clarification states that samples were collected at one depth only (1.5 m or 2 m) from each site. Hence, there is inconsistency in number of samples collected in Ecological assessment Report submitted to Hon'ble NGT (108 samples) and ANU Clarifications (54 samples).

x. Volume of water used in TSS measurement is not consistent with BIS: 3025 (Part 11) – 1984, Section 4.2 Sample volume requirement for water samples with turbidity less than 50 units.

xi. Ecological assessment Report or subsequent ANU Clarifications, does not state that the river water samples were vigorously shaken or stirred with Teflon coated magnetic stirrer, before filtration as per BIS : 3025 (Part 11) – 1984 requirement. Lack of sample homogenization affects the TSS and turbidity values.

xii. Compliance of relevant BIS codes to determine TSS and turbidity in laboratory is not stated in Section Va of the report.

xiii. Use of triplicates along with percent variation from the average for TSS and turbidity measurements is not stated in Section Va of the report.

xiv. The other portions of the report are satisfactory

6. 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.

Sharath Kumar Pallerla
Scientist-F, Member Expert Appraisal Committee-
Non-coal mining
Ministry of Environment, Forest and Climate Change

Prof. V K Sinha
Adjunct Professor
Department of Mining Engineering
Indian school of Mines, Dhanbad

Prof. M. Sudhakar Rao
Department of Civil Engineering
Indian Institute of Science, Bengaluru

Dr. K S Nanjunda Rao
Department of Civil Engineering
Indian Institute of Science, Bengaluru

Mahima T, Scientist-D
Central Pollution Control Board, Regional
Directorate, Bengaluru

Item No. 03 Court No. 1

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No. 935/2018
(I.A. No. 342/2019)

(With affidavit of State of Andhra Pradesh dated 20.01.2020)

Anumolu Gandhi Applicant(s)

Versus

State of Andhra Pradesh Respondent(s)

Date of hearing: 14.02.2020

CORAM: **HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON**
HON'BLE MR. JUSTICE S.P WANGDI, JUDICIAL MEMBER
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER
HON'BLE MR. SIDDHANTA DAS, EXPERT MEMBER

For Applicant(s): Mr. Sravan Kumar

For Respondent(s): Mr. R. Venkataramani, Senior Advocate and
Mr. G.N. Reddy, Advocate for State of A.P.
Ms. Vipra Bhardwaj, Advocate for CPCB
Mr. TVS Raghvendra Sreyas, Advocate for APPCB

ORDER

1. This order is being passed in continuation of order dated 19.12.2019. The question for consideration is the remedial action against the illegal mining in the name of desilting in the State of Andhra Pradesh damaging river Krishna and the environment. After considering the matter in the light of report dated 02.01.2019 by joint Committee of CPCB and the State PCB that mining being conducted was unscientific and damaging the environment, the Tribunal vide order dated 04.04.2019, required the State of Andhra Pradesh to deposit a sum of Rs. 100 Crores to be recovered from

the violators of law. It was found that the illegal mining was in violation of judgement of the Hon'ble Supreme Court in *Deepak Kumar v. State of Haryana, (2012) 4 SCC 629.*

2. In the light of order of the Hon'ble Supreme Court dated 09.05.2019, the State of Andhra Pradesh moved this Tribunal by way of an application which was considered on 23.07.2019. The plea of the State of Andhra Pradesh was that desilting was being done by Inland Waterways Authority of India, without adversely affecting the environment.

3. The Tribunal directed a study of Impact, including replenishment study, which is prerequisite before desilting is done. In view of the CPCB report dated 04.07.2019, further time was given to the State of Andhra Pradesh with reference to the observations in the report as follows:-

> *"A large number of dead shells of bivalves and gastropods were observed in the sand deposited at the bank of Krishna River. This indicates that the benthic fauna may be affected due to sand mining. Similarly, large numbers of avifauna were also observed in all the mining locations. Hence, a detailed study on avifauna, aquatic flora and fauna including benthic community is required to assess the extent of damage.*
>
> ***6. RECOMMENDATIONS***
>
> 1. *It is recommended that a detailed study covering scope of work mentioned in Annexure - 2 is to be carried out.*
>
> 2. *As such no physical damage to the river and associated structures has occurred except at Lingayapalem and Rayapudi where extensive sand mining has been carried out. It is recommended that a detailed land survey is to be carried out at both the said places for assessing the volume of sand required to restore the floodplain. Once the volume of sand required for restoration of floodplain shall be assessed then the cost of the restoration shall be estimated accordingly.*

3. *Due to non-availability of the bathymetric survey of the reservoir extending up to its fetch, the committee could not assess the extent of mining from the river bed. In view of this, it is recommended that bathymetric survey of the reservoir is to be carried out for the assessment of depth of mining and siltation in the reservoir.*

4. *The detailed study based on the scope of the work mentioned at Annexure-2 shall be assigned to a reputed institution based on the expertise. The Hon'ble NGT is also requested to identify the funding agency who will provide funds for meeting the consultancy fee of the Institute.*

5. *It is to inform that the nominated representative from Madras School of Economics, Chennai is not responding to the communications made from CPCB related to committee and not attending any meetings, site visit or discussions of the committee constituted in compliance to the Hon'ble NGT directions."*

4. Thereafter, the matter was considered on 19.12.2019 and last opportunity was given for furnishing a credible study by an institute of repute.

5. In pursuance of the above, an affidavit has been filed on behalf of the State of Andhra Pradesh on 20.01.2020 to the effect that Bathymetric survey work was entrusted to M/s BSP Hydro Dredging works through tender process who submitted the Bathymetric survey report, duly scrutinized by the Central Pollution Control Board (CPCB). It is also stated that a new sand policy has now been introduced. The report filed along with the affidavit is titled as 'Ecological Impact Assessment Study on Flora and Fauna of River Krishna (Upstream of Prakasam Barrage, up to 13.05 KM) and Socio-Economic Effects due to Desiltation'.

6. We are of the view that in view of conflicting versions, the report needs to be independently evaluated and validated. For this purpose, we constitute an Expert Committee comprising members

of Expert Appraisal Committee on the subject of the MoEF&CC, nominees of CPCB, Indian School of Mines, Dhanbad and the Indian Institute of Science, Bengaluru. The joint Committee may be assisted by the Andhra Pradesh State PCB. The CPCB will be the nodal agency for coordination and compliance. The applicants will be free to give their view point/submissions to the CPCB within two weeks. The CPCB will provide all documents to the members of the Committee.The report may be furnished within two months by email at judicial-ngt@gov.in.

7. A copy of this order be sent to the MoEF&CC, CPCB, Indian School of Mines, Dhanbad and the Indian Institute of Science, Bengaluru and the State PCB by email for compliance.

List for further consideration on 13.05.2020.

Adarsh Kumar Goel, CP

S.P Wangdi, JM

Dr.Nagin Nanda, EM

Siddhanta Das, EM

February 14, 2020
Original Application No. 935/2018
(I.A. No. 342/2019)
AK

REPORT SUBMITTED TOHON'BLE NGT, PRINCIPAL BENCH, DELHI IN THE MATTER OF M.A. No. 152/2019 IN ORIGINAL APPLICATION No.516/2015 AND O.A. No. 935/2018, AS PER HON'BLE NGT ORDERS DATED 19.12.2019.

I History of Prakasam Barrage:

Prakasam Barrage was constructed upstream of the breached and damaged century old Anicut across the River Krishna near Vijayawada city in Andhra Pradesh. It is a regulator built on sand foundations, combined with a road bridge for two lane traffic with 1.52m (5ft) wide footpath on either side, connecting Chennai – Kolkata Highway.

Fig.1.Prakasam Barrage

The River Krishna drains a total area of 2,58,948Sq.Km at the barrage site. The structure was designed for a maximum flood level observed over the Anicut during its 100 years life, with an ample free board of 2.74 m over the maximum observed M.F.L. to account for a probable higher flood that may occur in future during the life span of the barrage. It was

located with its gates at a distance of 31.83m upstream of the line of shutters of the old Anicut. The regulator floor was designed as per Khosla's theory for the design of weirs on permeable foundations with three rows of R.C.C. well cut-offs. It was joined into the body wall of the Anicut after removing its upstream jeddystone apron. The entire Anicut structure with its system of aprons on the downstream side is made to function as an integral part of the regulator, after reconstructing the first rough stone sloping apron of the Anicut as a stepped apron in cement concrete. The barrage was constructed during the years 1954 –57 at a total cost of Rs.2.78 Crores.

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.

Salient features:

Barrage		
Constructed Year	:	1957
Length of Barrage	:	1232.92 Mt (4045.00 Ft)
Length of Reservoirforeshore	:	13.50KM
Average width of Reservoir foreshore	:	2500 Mt
Average depth of Reservoir foreshore	:	6 Mt
Latitude	:	$16^0$30'34"
Longitude	:	$80^0$37'57"
Total Catchment area(Sq.Kms)	:	251372
Area capacity Curves (Water spread area)	:	30.00 Sq. Kms
Regulator	:	70 Nos of 12.19 M X 3.66

		M (40' X 12') each
Scouring sluices		
Left Side	:	6 Nos of 5.18 M X 3.66 M (17' X 12') each
Right Side	:	8 Nos of 5.18 M X 3.66 M (17' X 12') each
Levels		
Floor of Regulator	:	+ 12.21 M (+40.05 Ft)
Floor of Scour Vents	:	+ 11.06 M (+36.30 Ft)
Sill Level of Regulator gates	:	+ 13.73 M (+45.05 Ft)
Top of Regulator gates	:	+ 17.39 M (+57.05 Ft)
Average River Bed Level at Regulator site	:	+ 11.28 M (+37.00 Ft)
Bottom Level of the Floor of Sitanagaram Under sluices	:	+ 8.53 M (+28.00 Ft)
Vijayawada Under Sluices	:	+ 9.69 M (+31.80 Ft)
Bottom of Wells	:	+ 4.88 M (+ 16.00 Ft)
M.F.L. of Barrage (Designed)	:	+ 22.13 M (+72.60 Ft)
Bottom of "T" Beams	:	+ 23.65 M (+ 77.60 Ft)
Top of Road way on Bridge	:	+ 25.02 M (+ 82.10 Ft)
Top of Regulator Hoist Bridge	:	+ 30.36 M (+ 99.06 Ft)
Height of Shutters	:	3.66 M (+ 12-0 Ft)
Three rows of cutoff wells of size	:	2.13 M X 3.81 M (7 X 12.5 Ft)

16/9/2020

II Siltation and Shoal Formation in the barrage

Usually, the sediment in the reservoir 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, drinking water to Vijayawada and Guntur cites, the scour gates could not be operated for almost 10years. This has resulted in heavy sediment deposit in the reservoir and reduced by approximately 25% of the live capacity i.e.,about 0.767 TMC.

The frequency of operating the gates has become very low because the discharge of flood decreases gradually after 2009 floods but the accumulated silt is gradually increases due to receiving of water from Upstream of the Barrage for regular needs. Further, on completion of Pattiseema lift scheme (lifting of water from River Godavari to River Krishna through Polavaram Right Main Canal) the water contains high silt content and resulted deposition of sediment from the year 2015-16 onwards.

Statement showing the water lifted from River Godavari to River Krishna through Pattiseema:

S.No	Year	Pattiseema Water reached at Prakasam Barrage in TMC
1	2015-16	8.99
2	2016-17	48.47
3	2017-18	90.19
4	2018-19	81.39
5	2019-20	26.69
Total		255.73

III Assessment of Silt Deposits by Scientific Studies

III.a. Assessment of Silt Quantities using Sounding Data in 2015:

In the year 2015 to assess the siltation in reservoir, a study was conducted by the Irrigation Department taking up soundings (which was approximate method).The sedimentation areas of the Krishna River upto 13.50 Kms upstream and to assess the quantum of de-silting quantity are calculated by taking river cross sections at an interval of 1 km upstream from location 0.50 km upstream of the barrage. Also from the total river width at each location, the width of lanka lands, margin lands and below bed level portion are deducted out of the available extraction and considering the essential area to be de-silted is assumed as 71 Lakh Cum of the sediments.

STATEMENT OF QUANTITIES OF SAND /SILT PROPOSED TO BE DESILTED FROM THE RIVER BED AT U/S OF PRAKASAM BARRAGE.				
KM	Length	Area	Mean Area	Quantity in m3
0.00 i.e 0.50 KM		1323.5		
1.00	1000	1145.13	1234.31	1234313
2.00	1000	1955.38	1550.25	1550250
3.00	1000	467.63	1211.5	1211500
4.00	1000	804.13	635.88	635875
5.00	1000	0.00	402.06	402063
6.00	1000	0.00	0.00	0
7.00	1000	0.00	0.00	0
8.00	1000	0.00	0.00	0
9.00	1000	0.00	0.00	0
10.00	1000	0.00	0.00	0
11.00	1000	1947.47	973.73	973734
12.00	1000	0.00	973.73	973734
13.00	1000	116.16	58.08	58081
14.00	1000	0.00	58.08	58081
Total				7097631
Total Quantity In lakhs				70.97 Lakhs
Add Extra				0.03 Lakhs
Grand Total				**71 Lakhs**

III.b. Assessment of Silt Quantities using Remote Sensing Data in 2016:

In the year 2016, the IrrigationDepartmentwas conducted a study to assess the silt quantities using Remote Sensing Data in foreshore of PrakasamBarrage.The approximate quantity of the silt has been computed by identifying the shoals from satellite imagery from 1988 to 2016 and Remote sensing data and levels from the Topographic & Bathometry survey data and found approximately 272.66 Lakh Cubic meters of deposits have been formed in the Prakasam Barrage reservoir. This quantity represents the formations visible in the satellite images only.

In view of the rapid changes in the catchment and flash floods due to climate change, the rate of sedimentation has increased in the recent days, which is diminishing the economic life of the reservoir gradually.

Approximate Silt Volume occupied by Shoals in the Prakasam Barrage Reservoir:

S. No	Shoal	Approximate Area in Sq.m	Average Top level	Average Bed Level	Depth in m	Approximate Quantity in Cum
1	Area 1	93105.643	+18.79 m	+11.39 m	7.4	688982
2	Area 2	138595.00	+16.39 m	+11.39 m	5	692975
3	Area 3	579300.756	+19.85 m	+11.39 m	8.46	4900884
4	Area 4	148189.026	+17.60 m	+11.39 m	6.21	920254
5	Area 5	84395.999	+18.05 m	+11.39 m	6.658	561909
6	Area 6	2081000.00	+17.07 m	+11.39 m	5.683	11826323
7	Area 7	286841.22	+18.89 m	+11.39 m	7.501	2151596
8	Area 8	942693.923	+17.25 m	+11.39 m	5.859	5523244
	Total	4354122 m2				27266166 Cum

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IV Need for desiltation

As mentioned in above a paragraph there was heavy deposition of silt in prakasam Barrage. Heavy siltation coupled with increased water demand in the region necessitated desiltation. Besides Irrigation needs, the Prakasam barrage also caters the drinking & industrial water needs all along River Krishna below Nagarjunasagar Project, of four districts namely Krishna, West Godavari, Guntur and Prakasam districts and major source of drinking water for Vijayawada Corporation, Municipalities Gudivada, Jaggaiahpeta, Machilipatnam, Nuzivid, Pedana, Guntur Corporation, Municipalities Magalagiri, Tadepalle, Tenali and part of West Godavari district.

After Government of Andhra Pradesh declared "Amaravathi" as New Capital city in 2015, as of October 2016, majority of departments and officials of the Andhra Pradesh State Government are now functioning from Velagapudi area of Amaravati. Meanwhile High Court for the state of Andhra Pradesh is also established in January 2019 in Amaravathi. The surrounding areas Vijayawada, Mangalagiri, and Tadepalli became more convenient residential zone for employees. 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 adjacent to River Krishna. It results requirement of water is increased in both Vijayawada Corporation and Mangalagiri municipality. The only source to meet the additional requirement is Prakasam Barrage.

Due to in-operation of scour gates the age of Barrage will decrease. As per ISI Code IS: 7349: 2012 for BARRAGES AND WEIRS – OPERATION AND MAINTANANCE Guide lines Under

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

De-siltation of Irrigation Structures is done periodically and it is a continuous process. The de-siltation process of sediment in the barrage is difficult and expensive in under water. It requires lot of Government land along the banks of river practically very difficult to place the de-silted sediment.

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

Prakasam Barrage has been receiving heavy sediment inflows from the catchment due to change in climatic conditions, deforestation and urbanization.The sediment expulsion devises 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. Scientific studies proved that the shoals and sediment deposits have occupied considerable portion of the live storage capacity. Study of available satellite images from 1988 to 2016 and change detection analysis proved that the

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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 endangers the safety of Barrage & flood banks and damages the environment and infrastructure.

Hence, to safeguard the structural and economical life of Barrage and flood banks, as a part of maintenance in accordance with the Indian Standard Recommendations (IS 7349:2012), de-siltation of the mounds and shoals were taken up.This is only removal of the accumulated sediment deposits using dredging operation, and cannot be classified as mining activity as there is no commercial intent. There is zero or negligible disturbance to the environment and ecology owing to the de-siltation of Barrage. To have a correct idea of exact quantity of siltation bathymetric survey has been conducted as directed by the Hon'ble NGT.

V Sand Policy of Government

Mention about prevailing sand mining/ de-silting rules/ acts in A.P and what does the Rule say (A.P WALTA Rules etc)

As per Andhra Pradesh Government New Sand Mining Policy-2019 GO.MS.No:70, INDUSTRIES, INFRASTRUCTURE, INVESTMENT AND COMMERCE (MINES-II) DEPARTMENTDated:04/09/2019

De-silting of dams/reservoirs/Barrage/Large Tanks:

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(a)The Irrigation Department shall take-up de-siltation of Dams, Reservoirs, Barrages and large tanks directly or by allotting the work to M/s APMDC Ltd.

(1) In case of Irrigation Department undertaking the de-silting work directly, they shell put in place a suitable administrative mechanism, as per the rules, at the field level to efficiently supervise the de-silting process.

The sand available after de-silting should be handed over to M/s APMDC Ltd for transporting to stockyards for supply to Government works and public use as per the procedures laid down by M/s APMDC Ltd.

(2) In case of handing over the De-silting areas to M/s APMDC Ltd shall undertake the de-siltation works by following the norms.

As per Andhra Pradesh Government New Sand Mining Policy-2019 GO.MS.No:71 INDUSTRIES, INFRASTRUCTURE, INVESTMENT AND COMMERCE (MINES-II) DEPARTMENTDated:04/09/2019

Identification of Sand Reaches in IV, V and Higher order streams:

(1)Constitution of District Level Sand Committee (DLSC):

The identification of feasible sand bearing areas in IV, V and above order streams/ rivers for extraction shall be done by the District Level Sand committee. The members of the committee are as follows:

a. District Collector: Chairman
b. Joint Collector : Vice Chairman
c. *Project Officer, ITDA concerned.: Member

d. Superintendent of police: Member
e. District Panchayat Officer: Member
f. Regional Transport Officer: Member
g. Dy.Director, Ground Water Dept.: Member
h. Executive Engineer, Irrigation/River Conservator : Member
i. Executive Engineer, Rural Water Supply : Member
j. Environmental Engineer, Andhra Pradesh state Pollution Control Board. Member
k. Assistant Director of Mines & Geology concerned: Member
l. Deputy Director of Mines & Geology concerned: Member
m. Representative from M/s Andhra Pradesh Mineral Development Corporation Limited: Member
n. Any other invitees as suggested by the Chairman

*incase of sand reaches falling partly or fully in scheduled Areas.

(2)The Member-Convener shall convene the District Level Sand Committee (DLSC) meetings frequently to ensure sand availability in the District.

(3)The Deputy Director of Mines & Geology concerned shall identify the potential sand bearing areas on regular basis and place proposals for extraction before District Level Sand Committee.

(4) The chairman, District Level Sand Committee shall order for joint inspection of identified sand bearing areas and obtain reports from the following:

a. The Revenue Department shall demarcate the specified sand bearing area, where sand is feasible for extraction, as

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per the geo-coordinates recorded along with two permanent references points and furnish the sketch.

b. The Ground water Dept. shall issue the feasibility report under Water, Land and Tree Rules, 2004 or any subsequent rules/ amendments to be issued by the Govt. from time to time, record the geo- coordinates of the specified sand bearing area as marked on ground by the Revenue Dept., with two permanent reference points along with specific recommendations on the thickness and mode of sand extraction.

c. The Executive Engineer/ River Conservator shall issue clearance for the specified sand bearing areas with Geo-coordinates along with details of the ramps.

d. The Assistant Director of Mines & Geology concerned shall arrive at the quantity of sand feasible to be extracted basing on the Ground water Department's feasibility report.

e. Representation from M/s Andhra Pradesh Mineral Development Corporation Limited shall accompany the team during the joint inspection to plan the subsequent operations.

(5)The Collector & Chairman, District Level Sand Committee shall finalize the specified sand bearing areas based on Joint Inspection report and order the Deputy Director of Mines & Geology to obtain Approved Mining Plan, environmental Clearance, Consent for Establishment and consent for operation from the competent authorities in the name of District Collector.

(6)After obtaining Statutory Clearances, District Collector shall entrust the work to M/s APMDC Ltd. And M/s APMDC Ltd. shall start extraction from the specified sand bearing area.

The General conditions imposed by River Conservator, River Krishna.

1. The Clearance is valid for one year only i.e from issue of work order to boats men Societies and the Societies should take clearance for in case of lease period was extended.
2. The sand quarry shall not be permitted within 15 mts or $1/5^{th}$ of width of the stream bed from bank whichever is more.
3. The sand quarrying operations should be done by leaving a safe margin of 100 Mts from the toe of flood bank of river.
4. The societies should approach the River Conservator before taking over the site with specific boundaries where the quarrying is proposed to be done by abiding the rules according to R.C act.
5. No Damages shall be caused to the river bank and high margin due to in discrimination quarrying and plying of vehicles.
6. The existing notified ramps should be renovated before plying the vehicles at their own cost of lease by getting permission from the river conservator as the existing ramps may be in dilapidated condition.
7. The societies should abide by the R.C Act- 1884 and other conditions as stipulated by the Irrigation Department.
8. The societies should not excavate the sand by using machinery.
9. The societies should not obstruct the improvement works on Flood Banks of Krishna River.
10. The societies should not excavated the sand with in the 500 Mts distance on either side of structures, bridges R.S. groins, revetments permanent structures and prohibited areas like public utility places including Historical places, temples etc.,

11. The sand vehicles should not ply along the flood bank except crossing at the authorized ramps where ever permitted.
12. The societies should attend repairs required for ramps on bank, margins and Donka Roads etc.,
13. The societies should leave safe a margin of 200 M around the Lanka Land in Krishna River.
14. The societies should not enter in to the leased lands of societies and individuals in certain Lanka and Margin Lands.
15. The societies should not utilize the Ramps & paths which are not notified by the River Conservator and should not open any new Ramps.
16. The societies should not excavate the sand more than specified considering the thickness specified.
17. The River Conservator and his nominee reserve the right to stop the quarrying of sand for violation of conditions of R.C Act without assigning any notice.
18. The societies should not conduct any other operations except the sand quarrying operations.
19. The societies should not have any right on Lanka lands.
20. The societies should not obstruct of the vehicles of ryots of the neighbouring villages on ramps and open for public utility purpose.
21. The societies should not stock the sand either on marginal land or by the side of the Flood flank.
22. The societies shall be responsible for any damages caused to the Government property and will be recovered from the lessee of the respective sand reaches.
23. The societies should obtain necessary clearance from concern Tahsildar if any patta land comes into ramp where ever required.
24. The non-refundable amount will paid only after expiry of lease period of sand reach and removal of temporary path.

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25. The societies should close the ramps during the flood period duly considering the flood warnings issued from the Irrigation department.
26. The societies should not transport the sand during the flood and the Department is no way responsible for any loss of lives and properties etc.
27. The societies should produce his valid permits seigniorage receipts, Records to the conservator and his nominee on demand for checking.
28. The societies should not cause any pollution of River water while utilizing the boats or any other equipment.
29. The societies should use the fitness certified boats only.
30. The societies should not use the heavy dredger.
31. The depth of sand excavation for quarrying shall be as per the recommendation of A.P Ground Water Department and AP WALTA Rules.

As per the above conditions the Irrigation Department monitor the excavation and depth.

<u>AS per the ANDHRA PRADESH WATER, LAND AND TREES RULES, 2004 of section 23:</u>

Sand mining:-

1. In areas where sand mining is affecting ground water regime, such of the areas shall be notified and transportation of sand shall be prohibited and mining and transportation of sand shall be banned in notified over exploited ground water micro basins / mandals and for other areas the following conditions shall apply for exploitation of sand.

(1) (a) Sand mining shall not be permitted in notified areas except for local use in the Village or towns bordering the streams. Transportation of sand from these notified areas

through mechanical means out of the local jurisdiction shall be banned.

(b) In IVth orders stream, sand mining shall be restricted to specified areas.

(c) In Vth order and above rivers, viz., Godavari, Krishna, Pennar etc., Sand mining may be permitted without affecting the existing sources for Irrigation for drinking water or industrial purpose.

(2) The sand leaseholders shall not carryout quarrying within 500m. Of any existing structure such as bridges, dams, weirs or any other cross drainage structure.

(3) Vehicles carrying sand shall not ply over the flood banks except at crossing points or bridges or on a metal road.

(4) Permission to quarry sand shall not be granted within 500 Meters of any ground water extraction structures (s) either for irrigation or drinking water purposes.

(5) The streams / rivers where the thickness of sand is quite good (more than 8.00 Meters) the depth of removal may be extended to 2.00 Meters but in no case beyond two meters.

(6) Sand quarrying shall not be permitted within 15 meters or 1/5 of the width of the stream bed from the bank whichever is more.

(7) Sand mining shall not be permitted in streams where the thickness of sand deposition is less than 2.00 meters.

(8) The depth of removal of sand shall be restricted to one meter particularly in minor streams where the thickness is more than 3.00 meters and less than 8.00 meters.

(9) The sand quarrying shall be restricted to depths above the water table recorded during monsoon and in no case effect / disturb the water table.

(10) The quantity of sand deposited annually in every stream or river shall be monitored by establishing observation stations along the stream course.

2. The Ground Water Department shall take up joint inspection along with officials of Mines and Geology Department or other concerned departments whenever cases are referred to study the impact of sand mining in an area and shall give its recommendations.

As per Government New Sand Policy-2016 GO.MS.Nos:19,20INDUSTRIES & COMMERCE (MII) DEPARTMENT Dated:15/01/2016. The then Executive Engineer/ River Conservator, Krishna Central Division, Vijayawada vide letter nos camp-1 Dated:18/01/2016 while addressing both the Chairman's of district level sand committee's Guntur & Krishna has informed that, huge quantities of sand / silts is accumulating in either side of the Krishna reservoir area up to a length of 13.50 Kms of Prakasam Barrage. i.e, in Krishna District 9 lakh Cum and Guntur District 24 lakh Cum.

Later free sand policy came into force vide Memo No.3066/MII(1)/2016-3 Dated:04-03-2016. The Government has reviewed the sand policy announced vide Go.MS.Nos: 19& 20 INDUSTRIES & COMMERCE (MII) DEPARTMENT Dated:15/01/2016 and decided to change the policy as Sand shall be made available to the public without charging any fee from 2nd March 2016.

VI De-siltation of PrakasamBarrage:

The Indian Standard Code for BARRAGES AND WEIRS – OPERATION AND MAINTANANCE GUIDE LINES (IS: 7349:

2012), Under section 6.5 suggests "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 dredging by the use of suitable dredgers to the extent possible so that satisfactory flowing conditions are established and also desired capacity is re stored".

Hence, to safeguard the barrage, as a part of maintenance activity and to regain the storage of the reservoir it is decided to remove the shoals and sediment deposits formed on the riverbed. In Phase-I it is decided to remove 33 Lakh cum of silt through Mechanised Boats and 10 Lakh cum silt through dredging operation, out of the total preliminary estimated silt quantity 71 Lakh cum. The total de-silted quantities and locations where de-silting activity carried out through Mechanised boats in both districts as shown below.

In Guntur District side

Sl. No.	Location above Barrage	De-silted Qty in Cum	Ramp Point
1.	Undavalli from Km 2.000 to Km 3.200 of K.R.F Bank.	2,00,000	At 3.200 Km
2.	Penumaka from Km. 3.200 to Km 4.400 of K.R.F Bank	3,00,000	At 4.20 Km
3.	Venkatapalem from Km 5.000 to Km 6.400 of K.R.F Bank	6,00,000	At 6.400 Km
4.	Uddandarayunipalem from Km 9.000 to Km 10.800 of K.R.F Bank	2,00,000	At 10.800 Km
5.	Lingayapalem from Km 12.000 to Km 12.750 of K.R.F Bank	4,00,000	B/W 10.800 Km to 12.000 Km
6.	Rayapudi – 1 from Km 12.000 to Km 12.750 of K.R.F Bank	4,00,000	B/W 12.000 Km to 12.750 Km
7.	Rayapudi – 2 from Km	3,00,000	B/W 12.750

	12.750 to Km 13.500 of K.R.F Bank		Km to 13.500 Km
	Total Quantity Cum	**24,00,000**	

In Krishna District side

Sl. No.	Location above Barrage	De-silted Qty in Cum	Ramp Point
1.	Bhavanipuram from Km 1.00 to Km 2.500 of K.L.F Bank	1,00,000	At 1.136 Km
2.	Gollapudi from Km 2.000 to Km. 4.500 of K.L.F Bank	2,00,000	At. 3.443 Km
3.	Surayyapalem from Km 6.000 to Km 7.000 of K.L.F Bank	2,00,000	At 6.015 Km
4.	Guntupalli from Km 7.000 to Km 9.000 of K.L.F Bank	2,00,000	At 7.450 Km
5.	Ibrahimpatnam from Km 10.000 to Km 13.500 of K.L.F Bank	2,00,000	At 13.500 Km
	Total Quantity Cum	**9,00,000**	

VI.a. Methods adopted for De-siltation:

The Dredging/De-silting operations is not a mining/ quarrying activity and that too, it is done in submergence area of irrigation reservoirs/streams/rivers, 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.

There are two methods are available for de-siltation activity

1) Dredger:

In dredging operation the total slurry will be pumped into a pond with surrounding bunds of suitable strength for containing dredged material with a facility to drain out the clear water.

The Dredger deployed is ELLICOT-370 model with a capacity of 250 cum of silt + water to be dredged per hour. Assuming 60% of silt& 40% of water to be dredged. The siltdredged per hour is 250 x 60% = 150

cum/per hour. The machinery works for 12 hours per day and 22 days per month leaving the remaining time for maintenance.

Fig.2.ELLICOT-370 Dredger

Fig.3. Discharge Pipe

Specification of Dredger:

- Fuel consumption 16 to 84 Lts per hour
- Idle Fuel consumption 6 Lts per hour
- Family series 370 HP
- Discharge Pipe dimension 10" (245 mm)
- Suction Pipe Dimension 12"(304 mm)
- Maximum Dredging Depth 20' (6.1 m)
- Dredger total Power 440 HP (328 KW)
- Dredge Pump Power 320 HP (239 KW)
- Cutter Power 40 HP (30 KW)
- Nominal Pump capacity range – upto 250 Cum per hour

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- Dredger RPM 1800 RPM(full)
- Length of Delivery – 1 KM
- Capacity of dredger to dredge coarse sand at 1800 RPM – 100 to 200 Cum per hour
- Fine Sand or silt at 1800 RPM – 200 to 240 Cum per hour(only sand output)
- Engine model No. Caterpilar 3406
- Fuel tank capacity 3050 Lts (including both sides)
- Hydraulic tank capacity (920 Lts)
- Hydraulic capacity 140 HP
- Swing Distance 22 to 25 m.

2) Mechanised Boats:

De-silting through mechanised Boats, the total slurry would be pumped into boat through sucking pump and the dredged material will remain in cargo portion of boat mean while water will be drained out.

Specification of Mechanised Boat:

- Length over all 19.90Mts
- Breadth 6.50Mts
- Depth 2.70m Mts
- Main Engine 108HP@2000RPM
- Sucking pump 6"X6"
- Water Pump (jet pressure) 3"X2.5"
- Cargo capacity 93MT
- Gross Tonnage 73MT
- Net Tonnage 22MT

VI.b. De-siltation:

Further, the Government has decided vide G.O.Rt.No. 148 WR (WRG:GRC) Dept. dt.24-02-2016 to de-silting work of reservoir of Prakasam Barrage at Vijayawada using dredgers in the water spread area on pilot basis for increasing the storage capacity above Prakasam Barrage. Accordingly, the tenders were called for the work " Dredging of silt and sand from the foreshore of Prakasam barrage by deploying suitable inland cutter suction Dredger and depositing the dredging material on either side of banks of Krishna River wherever government land is available". The work has been entrusted to M/s NAS Babu Constructions Pvt Ltd, Gudivada to a quantity of 10Lakh Cum.The de-silting activity was started on 27/6/2016 in Thallayapalem Village limits of ThullurMandal in Guntur District, but limited quantity of silt about 15,822cum only could be de-silted in this reach. Later, the work was shifted to Lingayapalem Village of Thullur Mandal in Guntur District and Ibrahimpatnam Village/Mandal in Krishna district on 06/11/2016 where huge quantity of silt was observed in middle of reservoir. Hence, the de-silting activity through dredging operation was carried out in between Ibrahimpatnam and Lingayapalem village limits and about 9,78,930 cum was dredged and the de-silted material was supplied to Government works taken up in the Amaravathi Capital city. The dredging work was completed on 24/09/2018 as the permitted quantity was reached i.e, 9,94,752 cum.

VII Bathymetric survey

In compliance with Hon'ble NGT directions, Irrigation department has carried out bathymetric survey in upstream of

Prakasam Barrage i.e., (From KM 0.00 to KM 13.50). "Bathymetric 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 riverand it 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). Downstream areas not come under the purview of de-siltation. The area of study is only foreshore 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 has prior experience in conducting Hydrographic Surveys required for National Waterway-4 in Krishna River from Harischandrapuram to Chamarru and conducted Bathymetry surveys in Krishna River. Further, the firm has conducted Bathymetry &Hydrographic Survey for design of floating barge in Krishna River for CRDA Zone-1, Amaravathi.

Methodology followed to undertake Bathymetric survey indicating the technical points.

METHODOLOGY:

Prior to rigging up of survey equipment on to survey boat, a pre-task meeting was held at the AP Irrigation Office between project team to determine and adopt best strategies for executing the survey. Preliminary installation of equipment on board the survey boat commenced after the pre-task meeting.

Bathymetry and positioning equipment were installed and tested prior to commencement of survey activities. All relevant location data, geodetic parameters, as well as, working drawings of the survey areas were provided by Executive Engineer, K.C Division, Water Resources Department, Vijayawada.

Fig.4.Bathymetry survey Boat.

1. Calibration:

Integrity tests on all analog survey equipment were carried out before commencement of the Survey.

2. Bar Check:

Bar check was carried out on the Single Beam Echo Sounder (SBES) in order to check for index error. The bar check was carried out using a bar plate tied with marine rope and calibrated every 1m.

DATA AQUISITION:

Bathymetry Survey data acquisition was carried out using Single Beam Echo Sounder. Water level in Krishna River observed during the survey.

The Survey lines were run at line spacing of 10m perpendicular to channel centre line to achieve full data coverage

Bathymetric data have been reduced using Sounding Datum referenced to the FRL of Prakasam Barrage on Krishna River, which is +17.39m above MSL.

Field operations were conducted with FRP Speed boat fitted with Outboard Motor

1.Navigation/Positioning:

The Navigation system was properly checked with given geodetic parameters. All equipment interfaces were properly checked for established communication with the sensors. The Differential Global Positioning System (DGPS) Satellites Receiver received not less than 8 satellites and Position Dilution of Precision (PDOP) of less than 3 throughout the duration of the survey. This provided a very high level of positional accuracy throughout the survey. All positioning data was referenced to the World Geodetic Spheroid (WGS–1984) datum and Universal Transverse Mercator (U.T.M.) Zone 44 Projection parameter.

2.Bathymetry:

Syqwest BATHY-500 Multi-Frequency Single Beam EchoSounder was used for the bathymetric survey with associated cabling and all necessary software so that when interfaced to appropriate peripheral sensors, the user can acquire, process, display, present and print high resolution bathymetry data.

Data received from the transducer was synchronized with the online navigation computer where they were dumped with each fix by the graphic recorder. Bathymetric data was recorded with the SBES for acquisition.

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Bathymetry and positioning equipment were installed and tested prior to commencement of survey activities. All relevant location data, geodetic parameters, as well as, working drawings of the survey areas were provided by AP irrigation. All coordinates quoted in this report and shown on the charts are referenced to UTM/WGS84 Projection.

The following equipment and software were deployed for acquisition and processing:

1. Survey Boat with Outboard Motor (OBM)
2. Hemisphere R-110 DGPS Satellite Receiver Unit and accessories
3. Syqwest BATHY-500 DF Single Beam EchoSounder
4. Hypack Navigation System and Accessories

POSITIONING SYSTEM:

All positioning were referenced to the WGS-84 Spheroid, and UTM Zone 44 Projection. The spheroid and grid projection parameters used in computations are tabulated below:

WGS-84 –Spheroid Parameters	
Ellipsoid	WGS-84
Semi Major Axis	6378137.000 meters
Semi Minor Axis	6356752.314 meters
Flattening(1/f)	298.2572236
Projection Parameters	
Projection Type	UTMZone44
Central Meridian	081°00'00''E
ReferenceLatitude	$00^0$00'0.00"N
ScaleFactor	0.9996000
FalseEasting	500000m
FalseNorthing	0m

Geodetic Parameters.

VIII Findings of Bathymetric Survey

VIII.a.Details on Siltation with qty removed.

As explained in point number VI, the total de-silted quantity in Krishna River above Prakasam Barrage in both Krishna and Guntur Districts is 42,94,752 Cum.

The capacity of Prakasam Barrage is 3.071 TMC at 12' (+17.39 Mts) Level from crest level i.e., F.R.L (Full Reservoir Level). After conducting the Bathymetric survey, based on the reports the capacity of Prakasam barrage is observed as 2.982 TMC at 12' (+17.39 Mts)

VIII.b.Critical areas in barrage i.e., low/medium/high in barrage w.r.t bed level along with GPS coordinates indicating in reservoir area.

After conducting the bathymetric survey, analysing the data the following areas are critical.

S.No	Village name	DepthinMt	GPS Coordinates
1	Gollapudi	3.0	1632.2381,8033.3658
2	Venkatayapalem	3.0	1631.3973,8032.5441
3	Lingayapalem	3.0	1634.8838,8030.5596
4	Surayapalem	4.0	1632.4663,8033.1526
5	Guntupalli	4.5	1634.1632,8031.5177
6	Uddandrayunipalem	5.0	1633.5291,8031.2338

VIII.c.Areas that can be proposed for de-siltation w.r.t original bed levels.

As per the Bathymetric survey in foreshore area of Prakasam Barrage from KM0.00 to KM13.50 the capacity of

16/01/2023

Prakasambarrage is arrived as 2.982 TMC and the silt volume above original Bed Level to be removed is 1,24,77,704 Cum.

TOTAL VOLUME OF WATER FROM KM 0.000 TO KM 13.500 AS PER BATHYMETRIC SURVEY

Sl. No.	Mileage	Water Volume				Silt volume to be removed above original bed level (in Cum)
		Water Spread Area (in Sqm)	Average Depth in Mts	Volume (in Cum)	Total Volume of Water (in TMC)	
1	From Km 0.000 to Km 2.000	2671237.75	5.910	15787314.79	0.558	2021790
2	From Km 2.000 to Km 3.000	1487279.16	5.259	7821388.16	0.276	1627318
3	From Km 3.000 to Km 4.000	1593436.71	4.521	7203199.65	0.254	2346845
4	From Km 4.000 to Km 5.000	1859762.88	4.606	8566502.61	0.303	2148367
5	From Km 5.000 to Km 6.000	1523688.22	5.181	7893813.06	0.279	1079361
6	From Km 6.000 to Km 7.000	1066669.47	5.380	5739206.71	0.203	357011
7	From Km 7.000 to Km 8.000	1499978.08	4.996	7493786.48	0.265	392878
8	From Km 8.000 to Km 9.000	1439689.88	3.419	4922549.82	0.174	1310469
9	From Km 9.000 to Km 10.000	1176250.15	4.401	5177135.73	0.183	508263
10	From Km 10.000 to Km 11.000	1024197.37	4.146	4246709.11	0.150	184515
11	From Km 11.000 to Km 12.000	1251583.74	3.657	4576726.21	0.162	278960
12	From Km 12.000 to Km 13.000	1138964.68	3.343	3807335.09	0.134	215358
13	From Km 13.000 to Km 13.500	396600.48	3.002	1190437.48	0.042	6570
TOTAL		**18129338.57**			**2.982**	**12477704**

VIII. d. Increase in Water storage capacity after conducting de- siltation activity.

After conducting the bathymetric survey the total existing capacity of the Prakasam Barrage reservoir is arrived at 2.982 TMC.Increase in Water storage capacity after conducting de-siltation of 1,24,77,704 cum quantity as per Bathymetry survey will be 0.441TMC.

VIII.e.Depth of accumulation and quantity of sand that can be removed in the Villages of Lingayapalem and Rayapudi and indicate the foreshore area boundary map covering these two Villages.

After conducting the bathymetric survey it is observed the silt accumulated as patches in between KM 10.80 to KM12.700 in Lingayapalem Village to a total quantity of 4,29,710 Cum and in between KM 12.700 to 13.500 in Rayapudi Village to a quantity of 71,177 cum can be proposed for di-siltation.

Fig.5.Lingayapalem

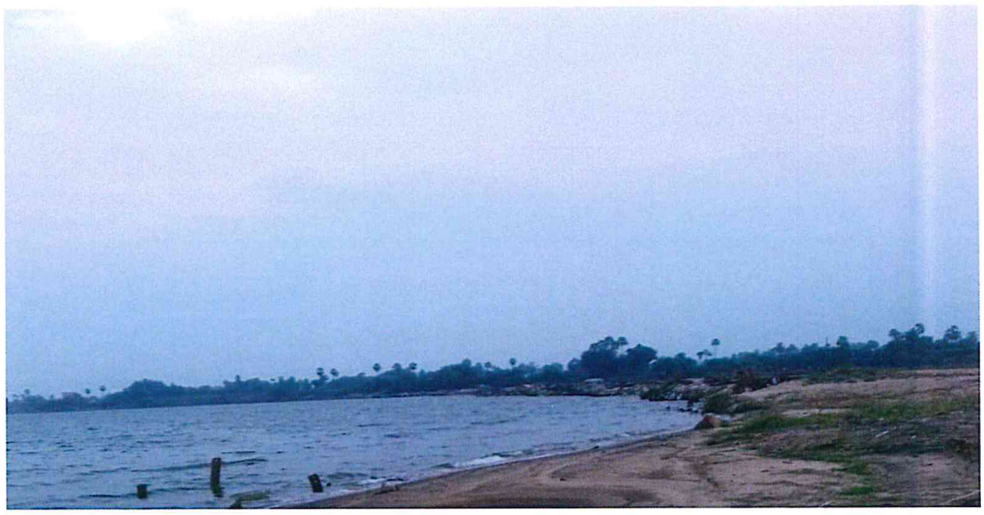

Fig.6.Rayapudi

Fig.7.Foreshore area of Prakasam Barrage Boundary Map.

VIII.f.Details of Flood Bank in the foreshore area:

The original flood banks have been formed between the years 1882 and 1892. One perusal of 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 recorded flood recorded till then, it was decided to raise the tops of flood banks by 2'.

Subsequently high floods occurred again in 1914 and 1916. As a result of these floods, a committee had been appointed in 1917 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 their recommendations, the flood banks have been raised to 3' over the highest recorded levels during the years 1903, 1914 and 1916. Subsequently another high flood occurred in 1949. Though the maximum flood level at the Anicut in 1949 is actually less than the level observed in 1903 by 2.4' the observed high flood levels in the River in the tail reaches were higher than those observed in 1903 by about 0.3Mt. The flood levels in higher reaches were more or less same as those observed in 1903. This lead to the conclusion that the River bed is getting silted up with the consequent higher M.F.L.S.

These Flood banks were raised to higher standards with respect to the observed high flood levels of 1949. Flood Banks have been reformed after the Floods of 1949 to standards, keeping the top of flood bank at 0.91Mt above the maximum observed flood levels in 1949 (Free Board). The top width of the flood banks is 5.50 mts of carriage way 3.75 Mts with 1 ½ : 1 slope on the waterside and 2:1 slope on the landside.

The flood banks above been generally formed with a minimum distance of 300' from the actual margin of the River. When this minimum distance gets reduced due to erosion of the margins immediately steps will be taken to protect the

margins by various methods appropriate to the please such as Nanal plantation, Revetment Spuns, groynes etc.

As per the records, in the last 10 years no repair works were taken up for restoring the flood banks damaged due to erosion.

Fig.8.Krishnna Right Flood Bank

FLOOD BANKS ABOVE ANICUT (Foreshore Area)

The Left Flood Bank above the Anicut extends from 0.00Km 13.00Km to a point where it abuts on the Ibrahimpatnam Hills.

The Right Flood Bank above the Anicut/Starts from Tadepalli Hill and extends up to Undavalli Hills distance of 1.32Km. Later under Flood Control Programme, this Flood Bank is extended up to Vaikuntapuram Hill for a further distance of 22.60Km.

The flood Banks were stable and no damage was occurred in floods occurred during 2009 and 2019 where the discharge was recorded on 11.10 Lakh Cusecs and 8.05 Lakh Cusecs respectively.

VIII.g.Present status on Bhawani Island and measures taken to protect the island due to de-siltation activities.

As per the records no de-silting activity conducted surroundings of Bhavani Island and no damage was caused due to de-siltation.

Fig.9.Bhavani Island

Due to heavy silt deposits in foreshore of Prakasam Barrage. It is observed that the flow facing portions of the islands are being eroded and the eroded material being deposited on the other side of the island. This phenomenon is causing the islands gradually shifting towards the Barrage structure. Due to which, the flow pattern changes pattern especially during floods and causes erratic and concentrated flows.

Fig.10.Sheet Piling to Bhavani Island

Hence, the Tourism Department has taken up the protection work with Sheet Piling to flow facing portion of Bhavani Island to protect from erosion.

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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

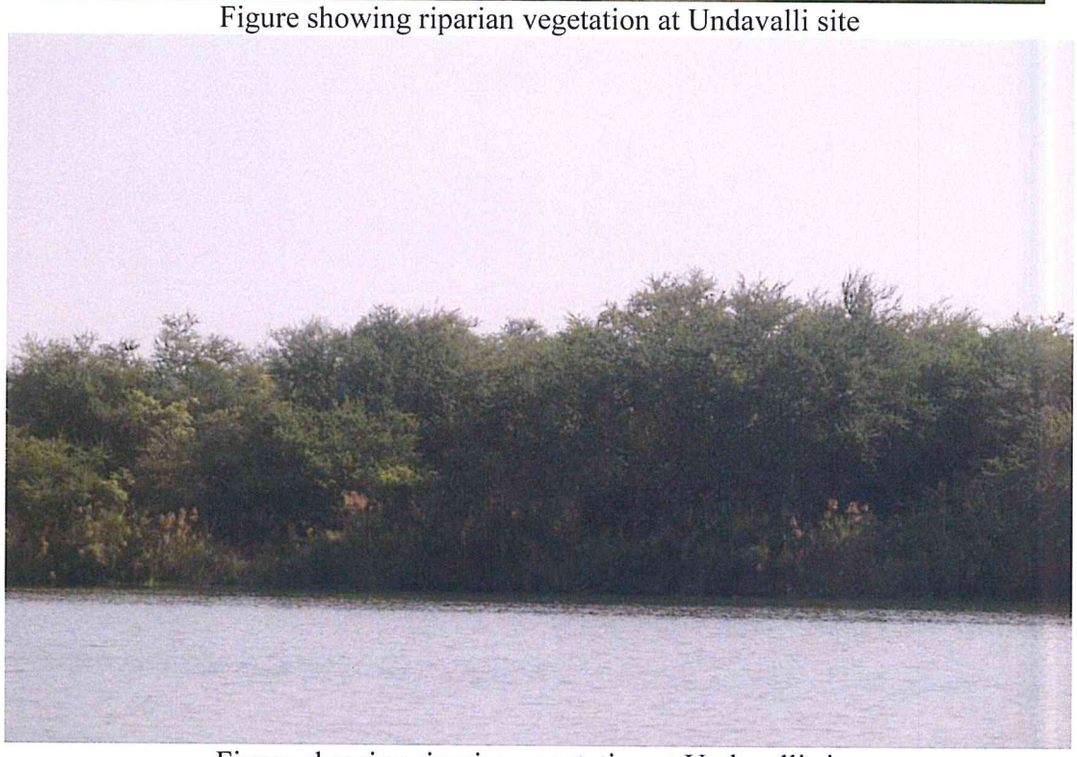


Figure showing riparian vegetation at Undavalli site

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

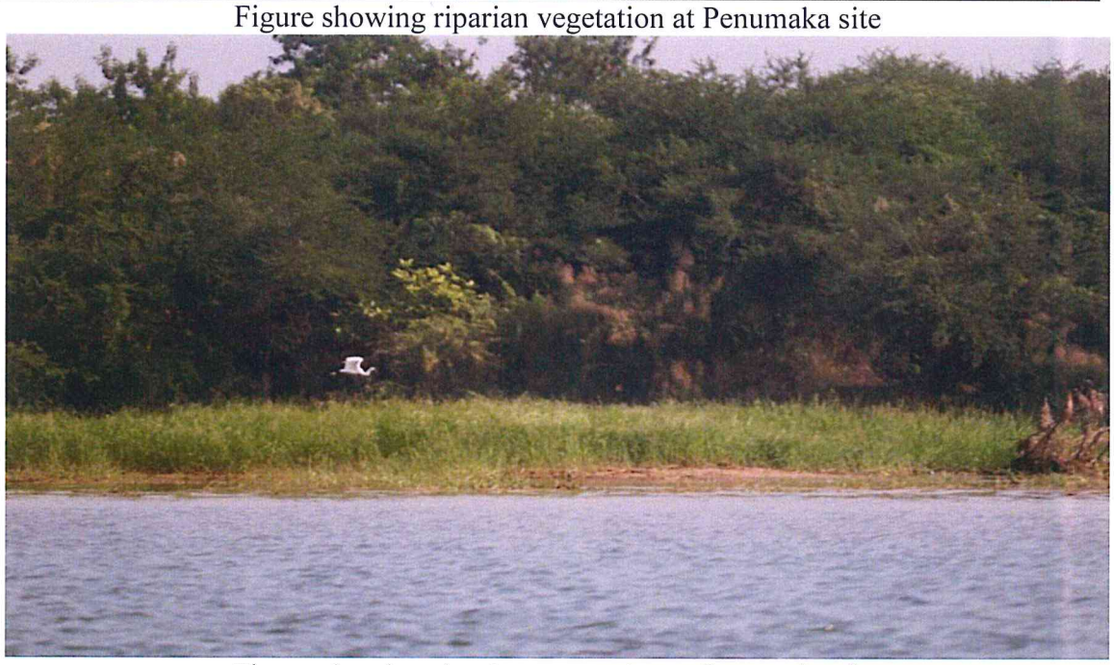


Figure showing riparian vegetation at Penumaka site

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

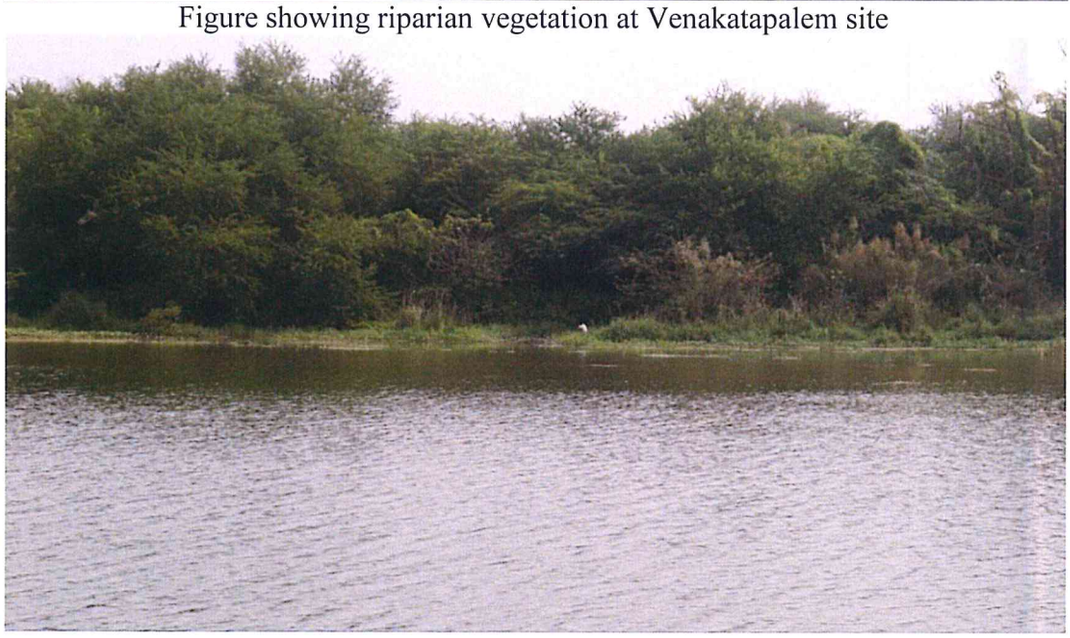


Figure showing riparian vegetation at Venakatapalem site

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* (Cyprididae), *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),

		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.*

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* (Cyprididae), *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

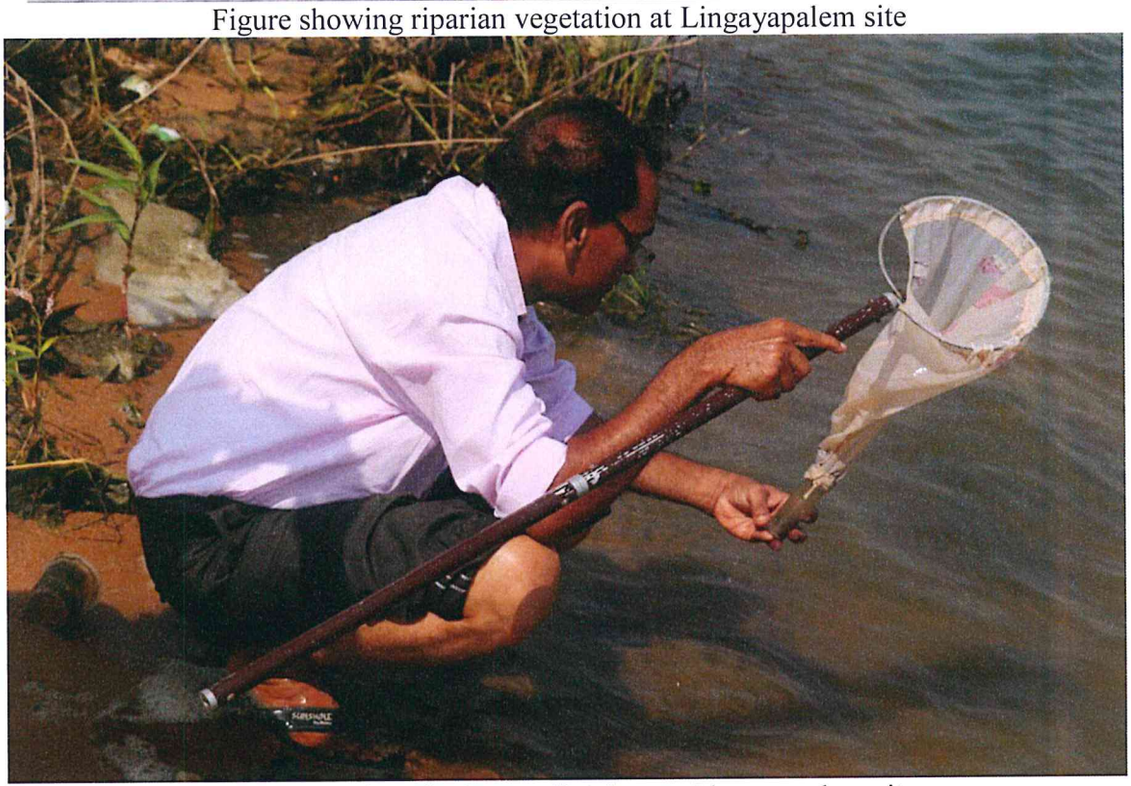


Figure showing plankton collection at Lingayapalem site

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* (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), 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

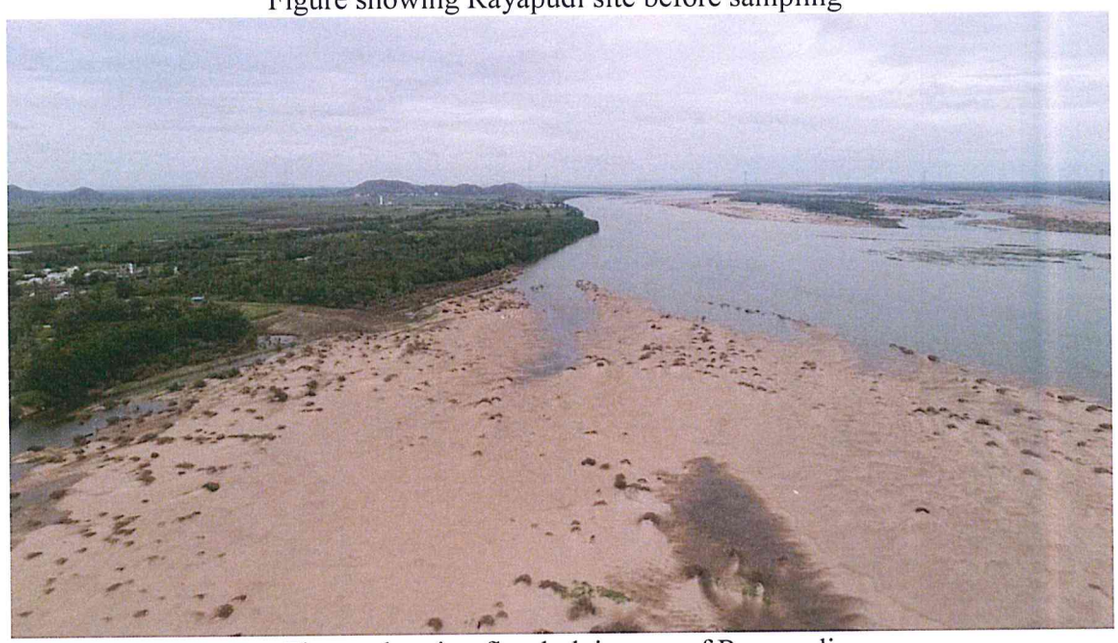


Figure showing flood plain area of Rayapudi

Figure showing riparian vegetation at Rayapudi

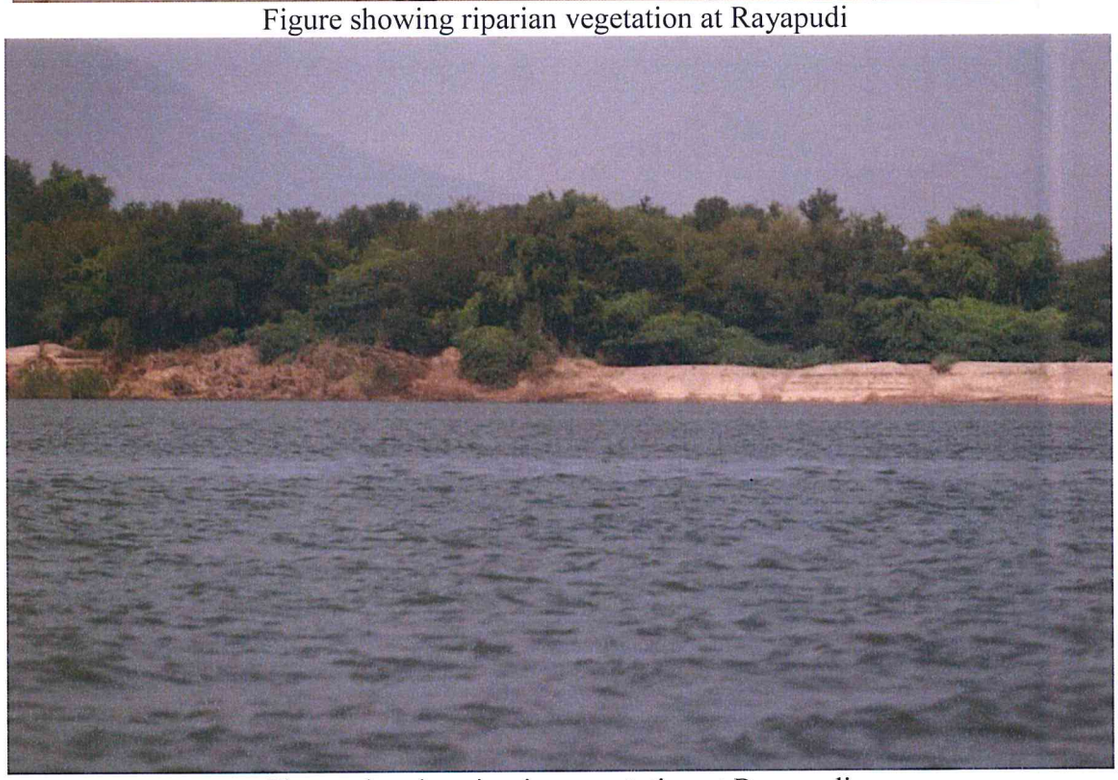


Figure showing riparian vegetation at Rayapudi

Figure showing benthic fauna collection at Lingayapalem site

Figure showing the team interaction with fishermen at Rayapudi

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* (Cyprididae), *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.*

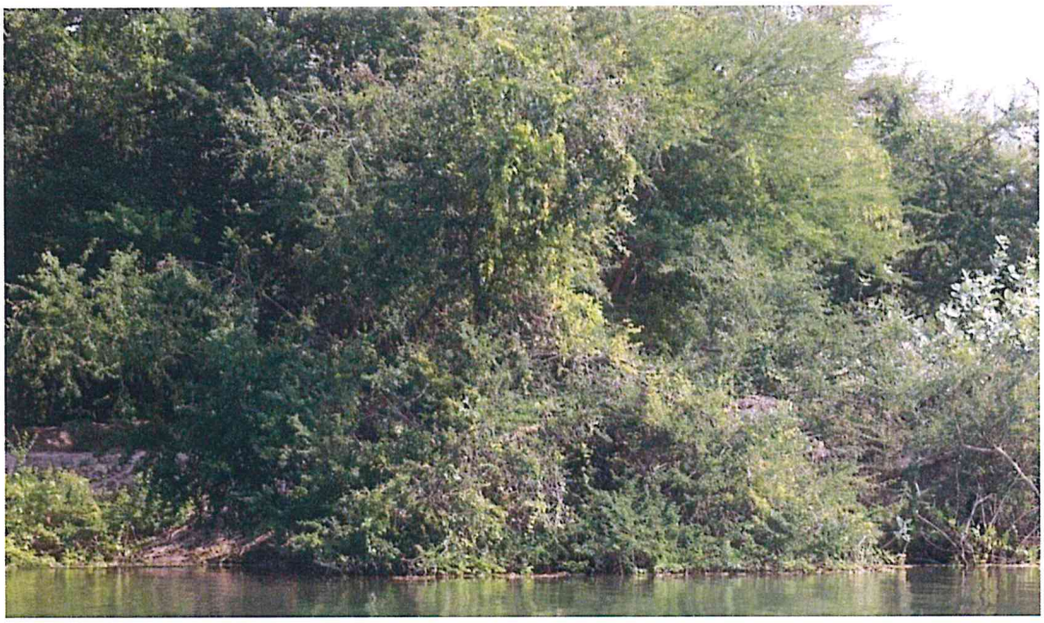


Figure showing riparian vegetation at Surayapalemsite

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

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* (Cyprididae), *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

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.*

		(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

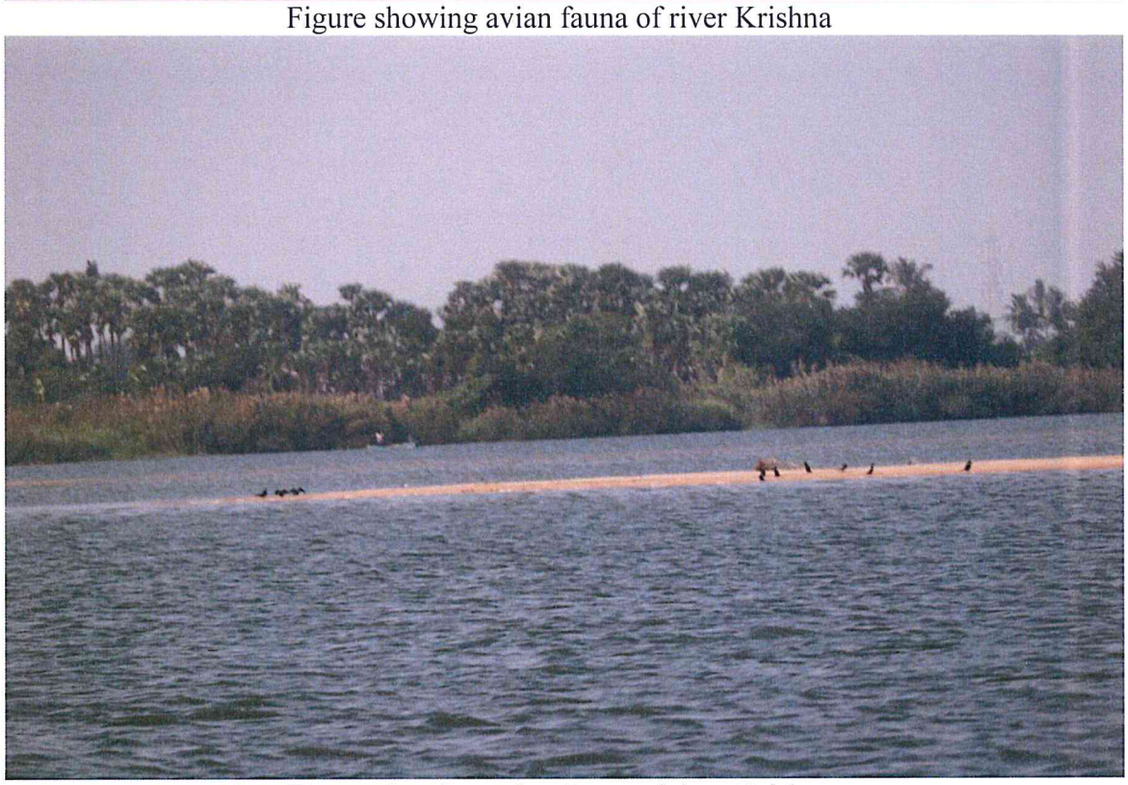


Figure showing avian fauna of river Krishna

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 molluscs 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.

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
Andhra Pradesh

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

ANNEXURE-1

CREDENTIALS OF 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 Highway (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.

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. The University had an excellent infrastructure and on-Campus facilities such as University Library, Computer Centre, Central Research Laboratory, Career Guidance and Placement Cell, Health Centre, Indoor & Outdoor Stadia and Multipurpose Gym, Student Centre & Fast-food Centre; Faculty Club; Dr. H.H. Deichman & Dr. S.John David Auditorium cum Seminar Hall etc.

PROFILE OF THE MEMBERS INVOLVED IN THE STUDY

PROF. G. ROSAIAH

Prof. G. Rosaiah is a senior faculty in the Department of Botany & Microbiology, Acharya Nagarjuna University with 28 years of teaching and research experience. He is specialized in Plant Physiology and his academic account consists publication of 45 National and International research papers and he has attended more than 50 conferences and workshops. Seven Ph.Ds. and 2 M.Phils. were awarded under his guidance, Sofar, he has

completed three Major Research Projects funded by UGC, DBT & ICAR. He is a very good administrator and held different positions like Registrar of Acharya Nagarjuna University, Coordinator - UG Exams, Coordinator - CDE Exams, Director - Directorate of Admissions etc.

G. SIMHACHALAM

Dr. G. Simhachalam is a senior faculty and alumni of Acharya Nagarjuna University, currently he is the Head and Associate Professor of the Department of Zoology & Aquaculture. He is specialized in Taxonomy, Biodiversity and Aquaculture. He gained experience of 25 years in Teaching and Research in ANU. Dr. Chalam has successfully completed the UGC funded Minor Research Project in 2010 and he discovered three new species. Dr. Chalam has published 25 research articles in peer reviewed and refereed International and National Journals and presented more than 55 papers in National/International Seminar/Conferences. Dr. Simhachalam served as Member, Institutional Ethics Committee, Govt. Medical College, Guntur and Advisory Member, Ministry of Fisheries, Govt. of Andhra Pradesh. Under his guidance, research scholars were awarded M.Phil. & Ph.D., degrees in the areas of diversity and distributional aspects of fishes, Ostracods, clam shrimps.

Dr. V. UMAMAHAESWARA RAO

Dr. V. Umamaheswara Rao is a senior faculty and alumni of Acharya Nagarjuna University. Currently he is working as Associate Professor in Department of Botany & Microbiology (UGC-SAP Phase II & DST-FIST Level I funded Department). His specialized areas are plant-microbe interactions and isolation of bioactive principles from different sources. He has put up 28 years of Teaching and 34 years of Research experience in ANU. He worked in one UGC Project and one APSEB Project. He has successfully completed an individual Major Research Project funded by UGC, New Delhi 2014. Life Member in Indian Science Congress and Associate fellow of Andhra Pradesh Akademi of Sciences. Dr. Rao has published 60 research articles in peer reviewed and refereed International and national Journals and presented more than 45 papers in National/International Seminars/Conferences. Under his guidance, sofar, six Ph.D. degrees and five M.Phil. degrees were awarded. Dr. Umamaheswara Rao serving as Referee to several reputed International and National Journals.

Dr. P. BRAHMAJI RAO

Dr. P. Brahmaji Rao is a senior faculty and alumni of Acharya Nagarjuna University, currently he is the Head and Associate Professor of the Department of Environmental Sciences. His specialized areas are Ecology, Biodiversity and Aquaculture in Andhra Pradesh. He has gained 25 years of Teaching and Research experience in ANU. Dr. Brahmaji has published 69 research articles in peer reviewed and refereed in International and national Journals and presented more than 60 papers in National/International Seminars/ Conferences. Under his guidance, 10 Ph.D. and 3 M.Phil. degrees were awarded to students in the areas of Environmental Sciences. Dr. Brahmajirao served as Member Pollution Control Board, Govt. of Andhra Pradesh and he has been involving in Environmental consaltancy.

Dr. MARRAPU TRIMURTHI RAO

Dr. Marrapu Trimurthi Rao is working as faculty in Acharya Nagarjuna University since 23 years with the specialized areas of Community Development, Human Resource Management and Medical& Psychiatric Social Work, received his M.A Social Work from Acharya Nagarjuna University and M.HRM, B.L and Ph. D from Andhra University and received honorary D.Litt from University of South America in 2017. He is currently an Associate Professor in the Department of Sociology and Social Work, Acharya Nagarjuna University, Guntur, Andhra Pradesh. Life Member for Indian Society of Labour Economics, National Institute of Personnel Management, Dr. S. Radhakrishnan Teachers Welfare Association, Mumbai and other professional bodies. Published 43 research articles in National & International Journals and presented more than 65 papers in National/International Seminars/Conferences.

Dr. Trimurthi Rao is Member, Expert Committee, Social Impact Assessment (SIA), Andhra Pradesh Capital Region Development Authority (APCRDA), Govt. of Andhra Pradesh; Member, Institutional Ethics Committee, Govt. Medical College, Guntur and Member, Regional Advisory Committee, Central Board for Workers Education, Vijayawada Region, Govt. of India. Eight Ph.D., degrees and five M. Phil., degrees were awarded under his guidance.

DETAILS OF THE TECHNICAL MANPOWER AND FIELD PERSONAL INVOLVED

1. Mr. K. Govinda Rao, Research Scholar, Department of Zoology and Aquaculture, University College of Sciences, ANU is working on Murrel fish diversity and biology with reference to *Channa striata* and he published seven papers in peer reviewed journals.

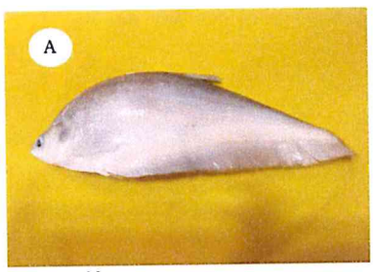
2. Mr. K. Samuel John, Research Scholar, Department of Botany and Microbiology, University College of sciences, ANU is working under supervision of Dr. V. Umamaheswara Rao on Isolation and Characterization of bioactive principles and communicated 2 research papers for publication.

3. Dr. K. Sasidhar, Research Scholar in the Department of Environmental Sciences. Extending research and Environmental Consultancy works carried out in the department. He published 21 peer reviewed research papers in International and National journals. He is having NABET Accreditation in the fields of Ecology and biodiversity.

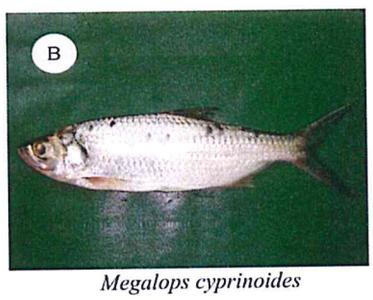
4. Dr. V. Ganga Raju, Research Scholar, did his research work on handloom weavers of Guntur and Krishna Districts of Andhra Pradesh under the Guidance of Dr. M. Trimurthi Rao, Department of Sociology and Social Work, ANU and published 9 research papers.

ANNEXURE-2

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

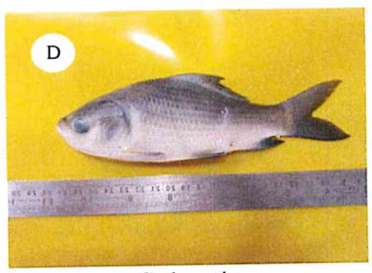


Notopterus notopterus

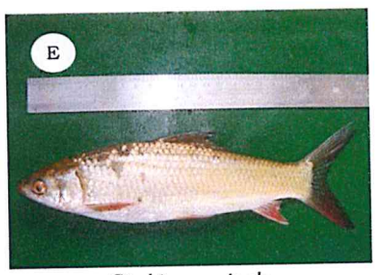


Megalops cyprinoides

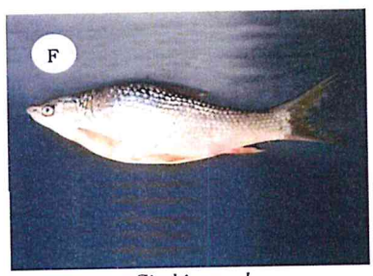
Anguilla bengalensis



Catla catla

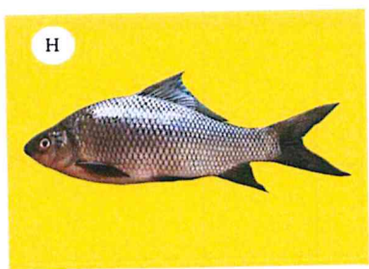


Cirrhinus mrigala

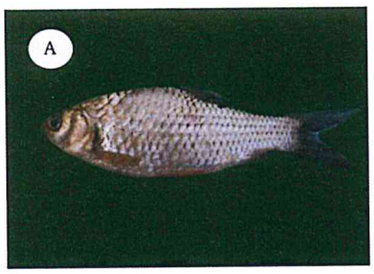


Cirrhinus reba

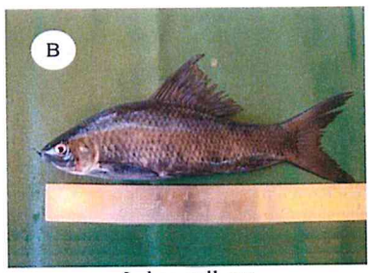
Ctenopharyngodon idella



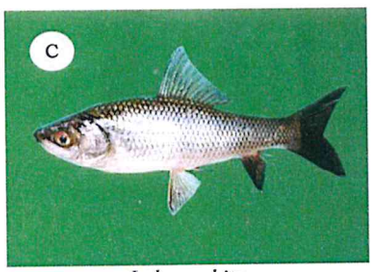
Labeo bata



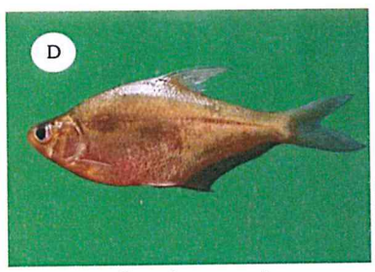
Labeo boga



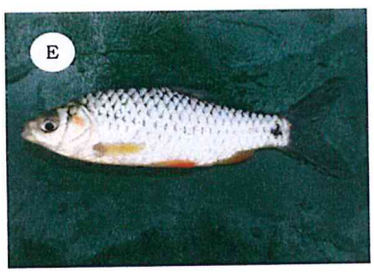
Labeo calbasu



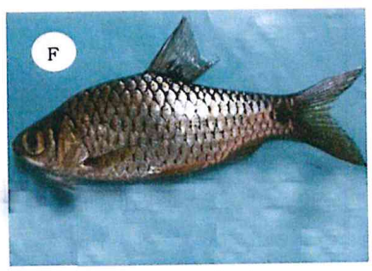
Labeo rohita



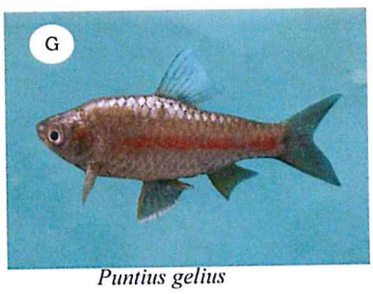
Osteobrama cotio



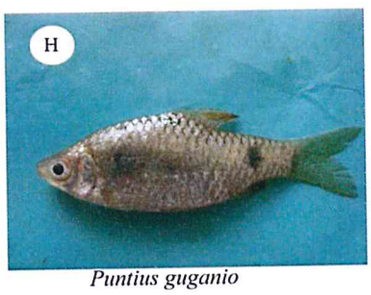
Puntius chola



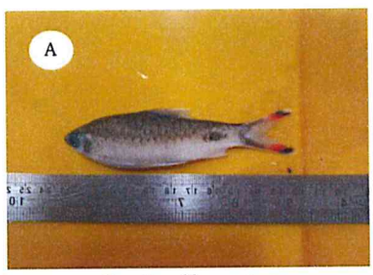
Puntius conchonius



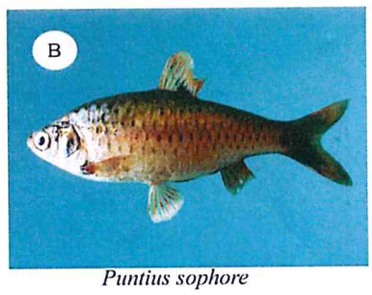
Puntius gelius



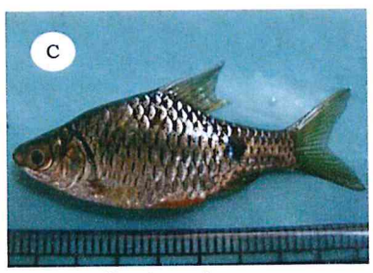
Puntius guganio



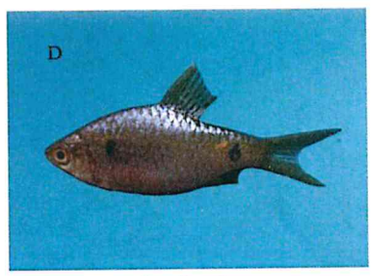
Puntius filamentosa



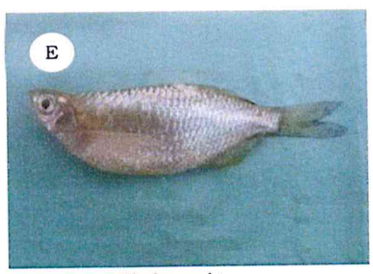
Puntius sophore



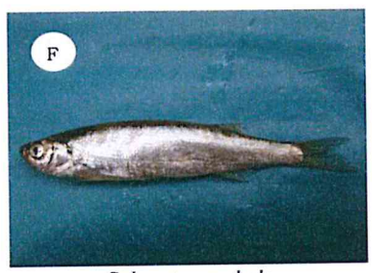
Puntius terio



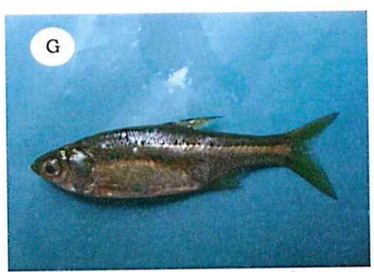
Puntius ticto



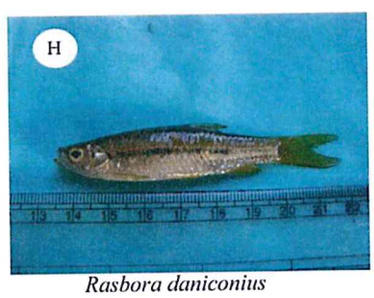
Chela cachius



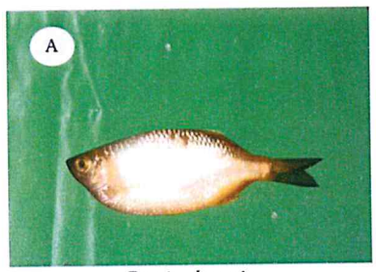
Salmostoma phulo



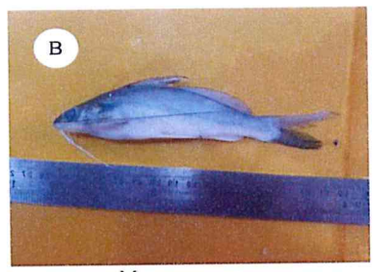
Amblypharyngodon mola



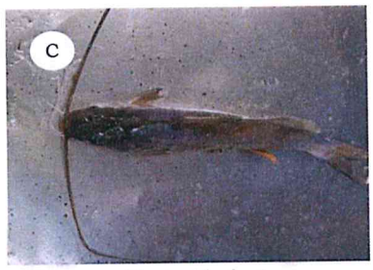
Rasbora daniconius



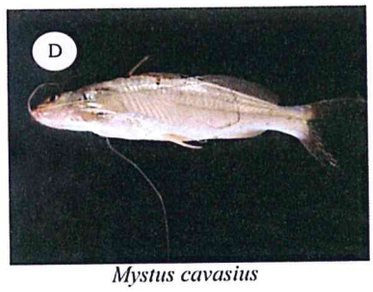
Danio devario



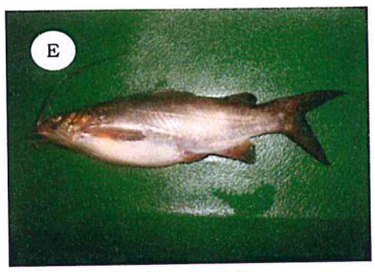
Mystus armatus



Mystus bleekeri

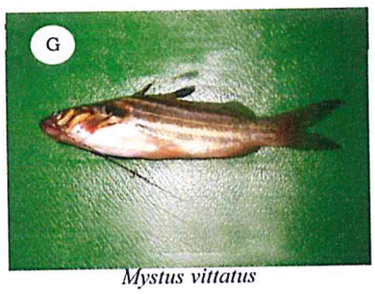


Mystus cavasius

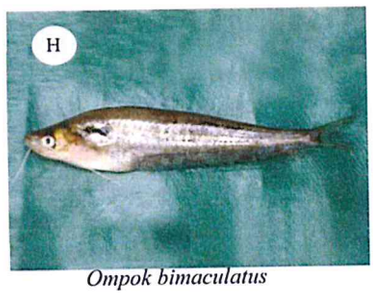


Mystus gulio

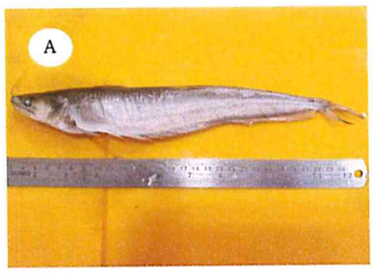
Aorichthys seenghala



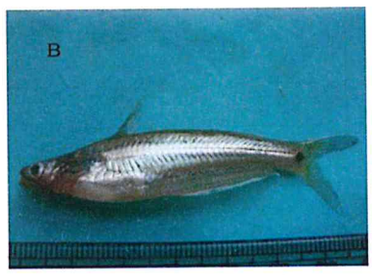
Mystus vittatus



Ompok bimaculatus

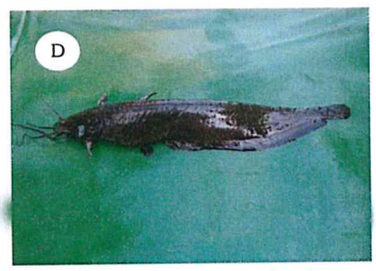


Wallago attu

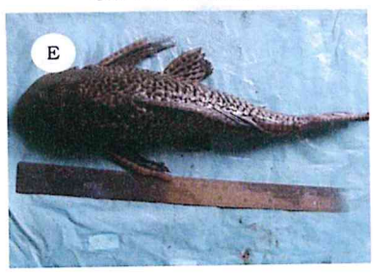


Pseudeutropius atherinoides

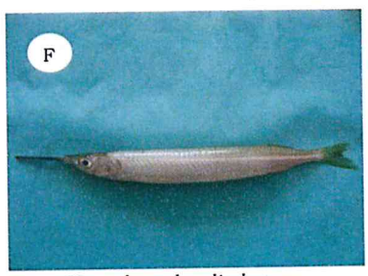
Clarias batrachus



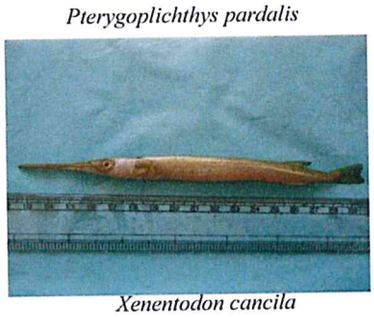
Heteropneustes fossilis



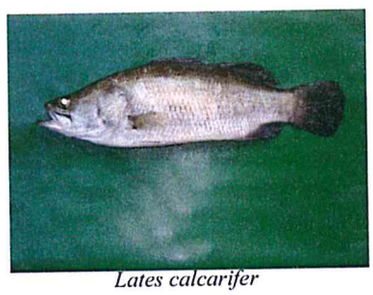
Pterygoplichthys pardalis



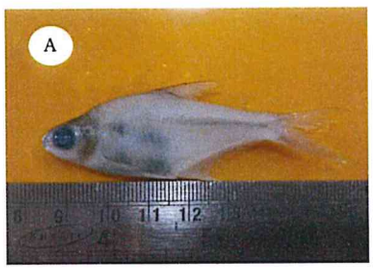
Hyporhamphus limbatus



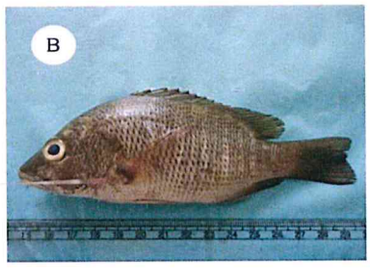
Xenentodon cancila



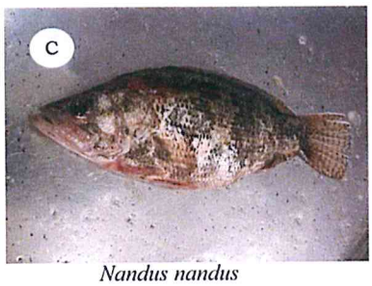
Lates calcarifer



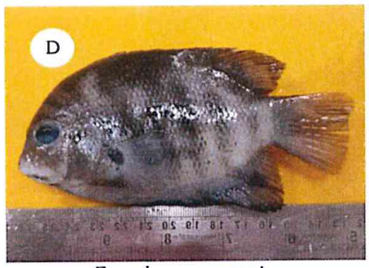
Chanda nama



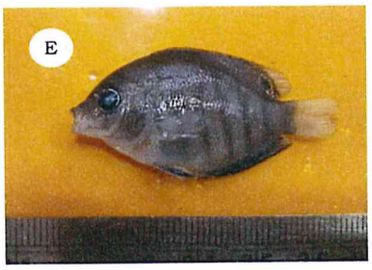
Lutjanus johni



Nandus nandus

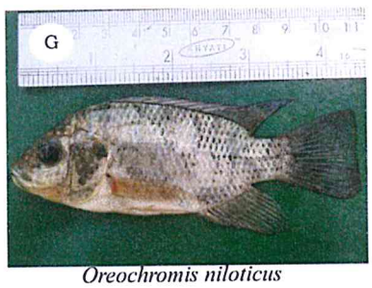


Etroplus canarensis

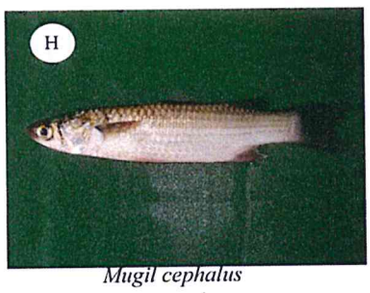


Etroplus maculatus

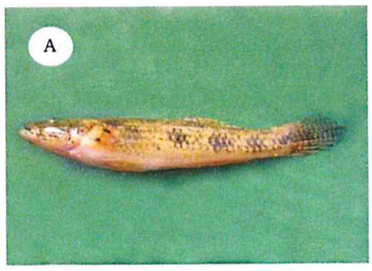
Oreochromis mossambica



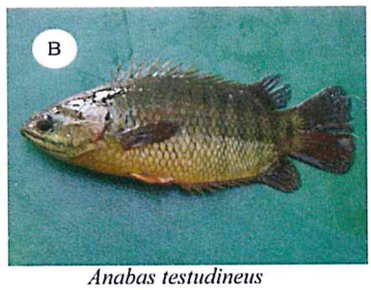
Oreochromis niloticus



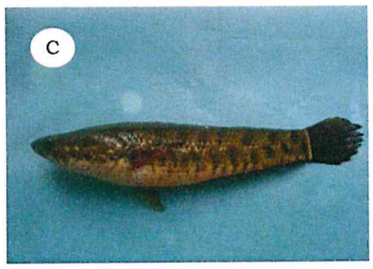
Mugil cephalus



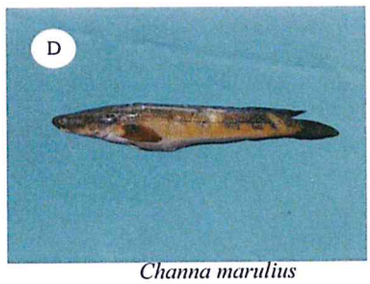
Glossogobius guiris



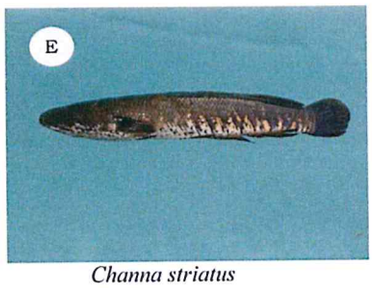
Anabas testudineus



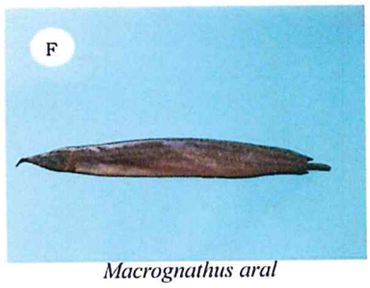
Channa punctatus



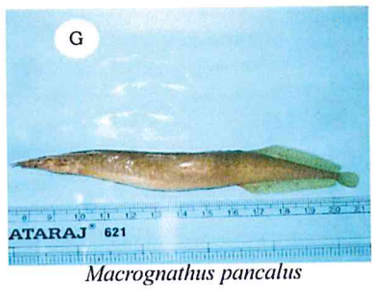
Channa marulius



Channa striatus



Macrognathus aral



Macrognathus pancalus

ANNEXURE-3

Figure showing team members visit to Venkatapalemon 14.10.2019

Figure showing team members interaction with fisher folks at Rayapudi on 14.10.2019

Figure showing team members interaction with fisher folks at Rayapudi on 14.10.2019

Figure showing collection of water sample, flora and fauna
near islandat Guntupallion 15.11.2019

Figure showing collection of water sample, flora and fauna
at riverbank of Penumaka on 15.11.2019

Figure showing water and plankton sample collection at middle of the river Krishna
at venkatapalem on 23.12.2019

Figure showing water and plankton, benthos sample collection at Uddandarayunipalem on 15.11.2019

Figure showing water sample collection at Surayapalem on 15.11.2019

Figure showing water and plankton sample collection at Uddandrarayunipalemon 15.11.2019

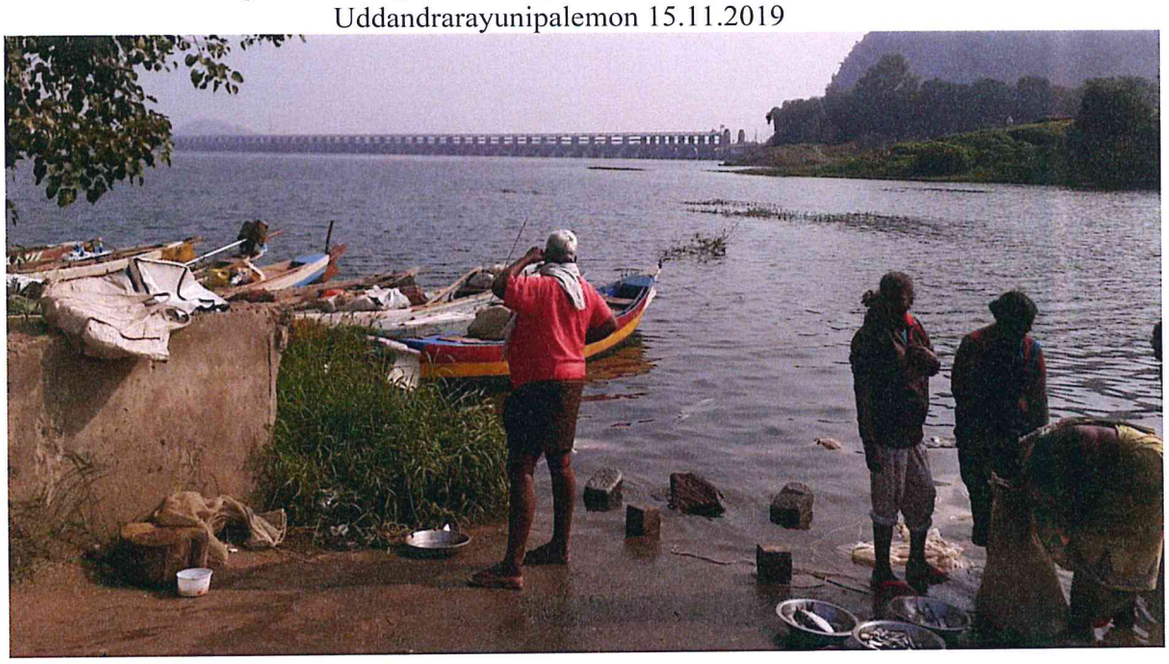


Figure showing Polakampadu fishermen cooperative society fish market at Sitanagaram on 23.12.2019

Figure showing Polakampadu fishermen cooperative society fish market at Sitanagaram on 23.12.2019

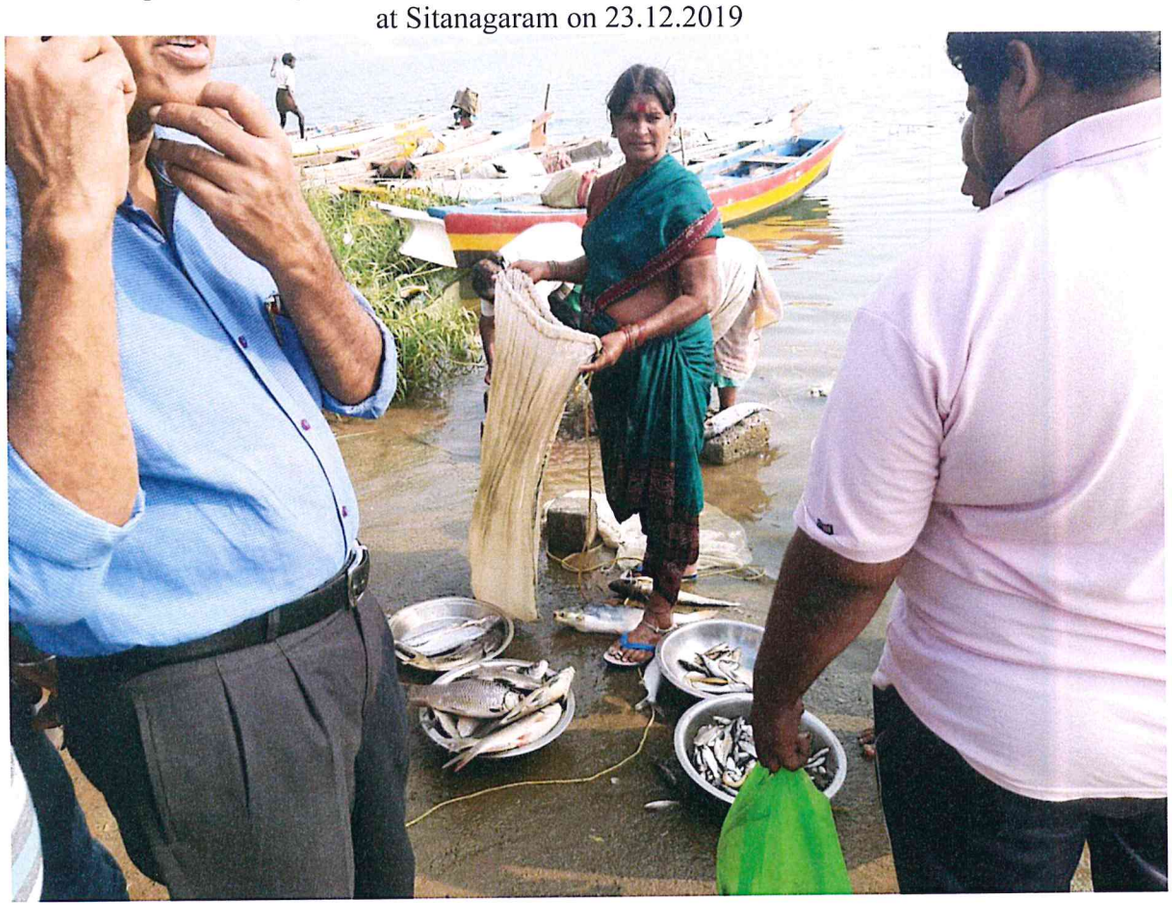


Figure showing fish collection on 23.11.2019 at Sitanagaram

Figure showing benthos collection at Gollapudi on 23.11.2019

Figure showing riparian vegetation near island at Guntupalli on 23.11.2019

Figure showing plankton and benthos collection at island area of Penumaka on 23.11.2019

Figure showing riparian vegetationat Surayapalem on 23.11.2019

Figure showing riparian vegetation collection near island at Surayapalemon 23.11.2019

Figure showing fishes collection by fishermen with the help of bamboo trap at Undavalli site on 23.11.2019

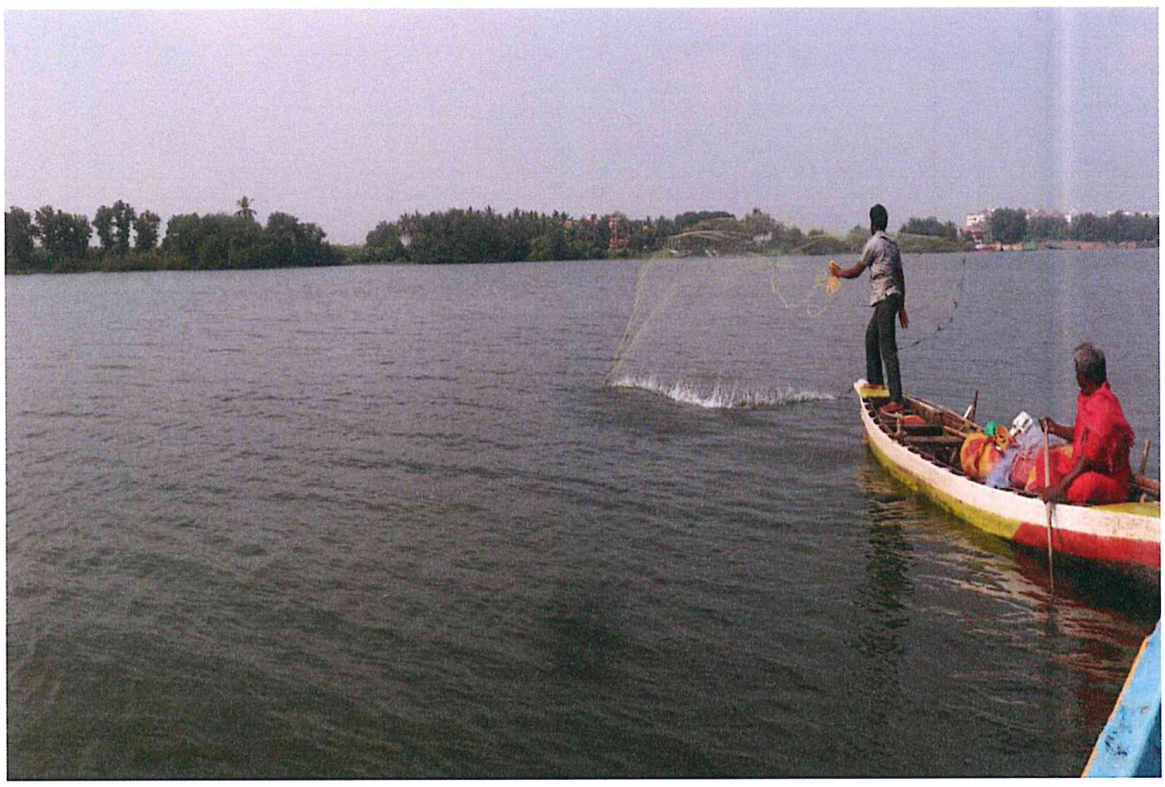


Figure showing fishes collection by fishermen with the help of cast net at Undavalli site on 23.11.2019

Figure showing flora and fauna sample collection at Venkatapalem shore region on 23.11.2019

Figure showing Molluscan fauna at Guntupalli sampling site on 07.12.2019

Figure showing local birds of River Krishna at Lingayapalem on 07.12.2019

Figure showing birds of River Krishna at Rayapudi on 07.12.2019

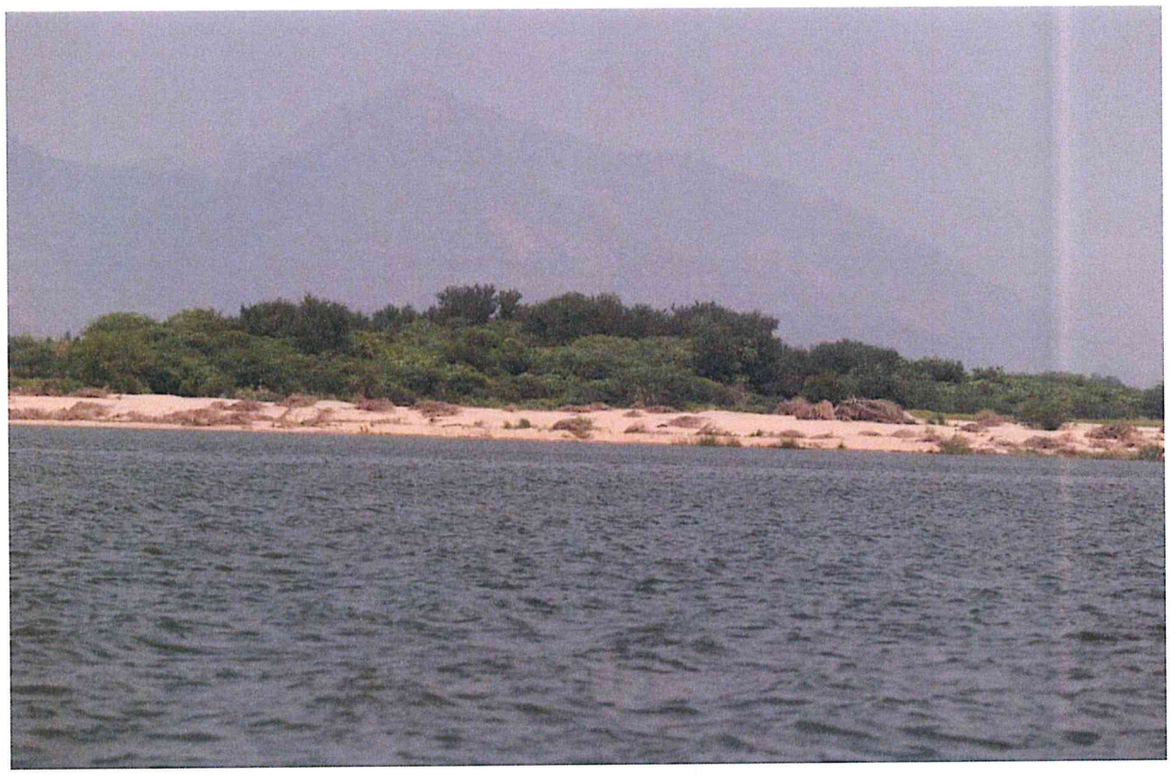


Figure showing sample collection spot at Rayapudi on 07.12.2019

Figure showing newly formed flood plains at Lingayapalam on 07.12.2019

Figure showing team members interaction with fishermen at Rayapudi on 07.12.2019

Figure showing team members interaction with fishermen at Rayapudi on 07.12.2019

Figure showing riparian vegetationat Rayapudi on 07.12.2019

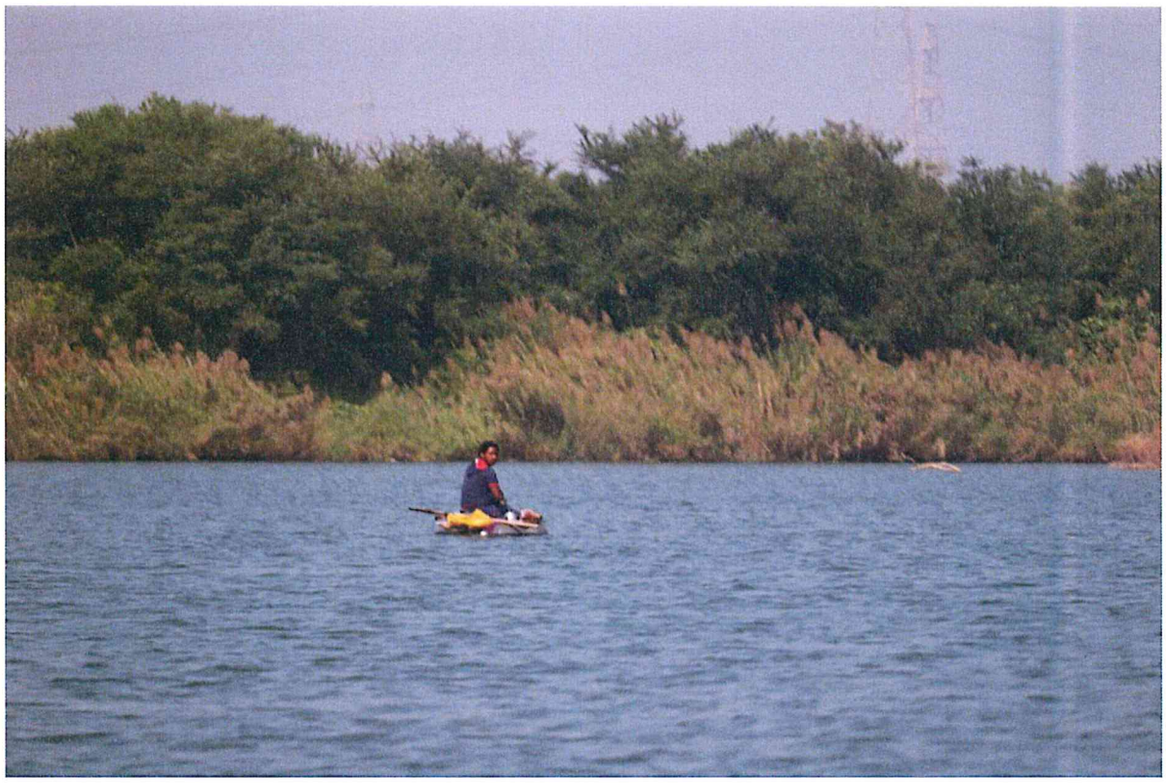


Figure showing fish collection by fisher men using type of craft at Surayapalem on 07.12.2019

Figure showing flora and fauna collection site at Uddandrayunipalemon 07.12.2019

Figure showing flora and fauna collection site at Undavalli site on 07.12.2019

Figure showing team members interaction with fishermenat Ibrahimpatnam on 23.12.2019

Figure showing team members interaction with fishermen at Ibrahimpatnam on 23.12.2019

Figure showing plankton and benthos sample collection near island area at Uddandrayunipalem on 23.12.2019

Figure showing Riparian vegetation at Venkatapalemon 23.12.2019

Figure showing team members visit to Rayapudi village on 30.12.2019

रजिस्ट्री सं. डी.एल.- 33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

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असाधारण
EXTRAORDINARY
भाग II—खण्ड 3—उप-खण्ड (ii)
PART II—Section 3—Sub-section (ii)
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

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पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 28 मार्च, 2020

का.आ. 1224(अ).—खनिज विधि (संशोधन) अधिनियम 2020 (2020 का 2), खान और खनिज (विकास और विनियमन) अधिनियम, 1957 (1957 का 67) (जिसे इसमें इसके पश्चात् एमएमडीआर अधिनियम कहा गया है) द्वारा 10 जनवरी, 2020 से प्रभावी संशोधन किया गया है और अन्य बातों के साथ कानूनी निर्बाधन के अंतरण के लिए उपबंधों से संबंधित नई धारा 8ख का अंत:स्थापन किया गया है;

और, एमएमडीआर अधिनियम की धारा 8ख की उप-धारा (2) यह उपबंध करता है कि इस अधिनियम में या तत्समय प्रवृत्त किसी अन्य विधि में अंतर्विष्ट किसी बात के होते हुए भी, धारा 8क की उप-धारा (5) और उप-धारा (6) के उपबंधों के अधीन अवसान होने वाले खनन पट्टे का सफल बोली लगाने वाला और उस अधिनियम के अधीन या तद्धीन बनाए गए नियमों के अधीन उपबंधित प्रक्रिया के अनुसार नीलामी के माध्यम से अर्जित सभी विधिमान्य अधिकार, अनुमोदन, निकासी, अनुज्ञप्ति और इसी प्रकार दो वर्ष की अवधि के लिए पूर्ववर्ती पट्टेदार पर निहित होना समझा जाएगा;

और, एमएमडीआर अधिनियम की धारा 8ख की उप-धारा (3) यह उपबंध करता है कि तत्समय प्रवृत्त अन्य विधि में अंतर्विष्ट किसी बाते के होते हुए भी, यह उस भूमि पर जिसमें नया पट्टा के प्रारंभ से दो वर्ष की अवधि के लिए पूर्ववर्ती पट्टादार द्वारा खनन संक्रियाएं कार्यान्वित किए जा रहे थे, निरंतर खनन संक्रियाओं को नए पट्टेदार के लिए विधिपूर्ण किया जाएगा;

और, एमएमडीआर अधिनियम को पूर्वोक्त संशोधन के प्रयोजन के लिए केंद्रीय सरकार, भारत सरकार के तत्कालीन पर्यावरण और वन मंत्रालय की अधिसूचना सं. का. आ. 1533 (अ), तारीख 14 सितंबर, 2006 (जिसे इसमें इसके पश्चात् ईआईए अधिसूचना, 2006 कहा गया है) के सुसंगत उपबंधों को सम्मिलित करने के लिए आवश्यक समझती है।

और, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय में सड़कों के लिए साधारण पृथ्वी का उपयोग करने के लिए पूर्व पर्यावरणीय अनापत्ति की अपेक्षा के अधित्याग के लिए अभ्यावेदनों की प्राप्ति पर; और पारंपरिक समुदाय द्वारा अंतर ज्वारीय क्षेत्र के भीतर चूने के गोले (मृत भू-पटल), पवित्र स्थानों, आदि के मैनुअल निकासी;

अत:, अब, केन्द्रीय सरकार, पर्यावरण (संरक्षण) नियम, 1986 के नियम 5 के उप-नियम (4) के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 3 की उप-धारा (1) और उप-धारा (2) के खंड (v) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, लोकहित में, उक्त नियमों के नियम 5 के उप-नियम (3) के खंड (क) के अधीन सूचना की अपेक्षा से अभिमुक्ति के पश्चात् और अधिसूचना सं. का. आ. 4307 (अ), तारीख 29 नवंबर, 2019 को अधिक्रांत करते हुए, ईआईए अधिसूचना, 2006 में निम्नलिखित संशोधन करती है, अर्थात् :-

उक्त अधिसूचना में, -

(i) पैरा 11 में, उप-पैरा (2) के पश्चात् निम्नलिखित उप-पैरा अंत:स्थापित किया जाएगा, अर्थात् :-

"(3) खान और खनिज (विकास और विनियमन) अधिनियम, 1957 (1957 का 67) की धारा 8क की उप-धारा (5) और उप-धारा (6) के उपबंधों के अधीन अवसान होने वाले खनन पट्टे का सफल बोली लगाने वाला और उस अधिनियम के अधीन और तद्धीन बनाए गए नियमों के अधीन उपबंधित प्रक्रिया के अनुसार नीलामी के माध्यम से चयनित नया पट्टा के प्रारंभ की तारीख से दो वर्ष की अवधि के लिए पूर्ववर्ती पट्टेदार पर निहित पूर्व पर्यावरणीय अनापत्ति विधिमान्य अर्जित किया गया समझा जाएगा और यह नया पट्टा प्रारंभ की तारीख से दो वर्ष की अवधि के लिए या उसमें उल्लिखित निबंधनों शर्तों के अनुसार नया पर्यावरणीय अनापत्ति, नया निकासी अभिप्राप्त होने तक, इसमें से जो भी पूर्वतर हो, उक्त पट्टा क्षेत्र पर पूर्ववर्ती पट्टेदार का स्वीकृत पर्यावरणीय अनापत्ति के निबंधनों और शर्तों के अनुसार निरंतर खनन संक्रिया नया पट्टेदार के लिए विधिपूर्ण होंगी;

परन्तु, सफल बोली लगाने वाला नया पट्टा मंजूर करने की तारीख से दो वर्ष की अवधि के भीतर विनियामक प्राधिकरण से पूर्व पर्यावरणीय अनापत्ति के लिए आवेदन करेगा और अभिप्राप्त करेगा।";

(ii) अनुसूची के मद 1 (क) के सामने, स्तंभ (5) के खंड (2) के टिप्पण के पश्चात् निम्नलिखित खंड अंत:स्थापित किया जाएगा, अर्थात् :-

"(3) उक्त पट्टा के अवसान के पश्चात् पूर्ववर्ती पट्टेदार द्वारा खनन और खनिज (विकास और विनियमन) अधिनियम, 1957 (1957 का 67) के उपबंधों के अधीन खनन पट्टे के अवसान होने तक भीतर पड़ी पहले से ही खनिज वाह्य सामग्री का निष्क्रमण या निष्कासन और परिवहन उस अधिनियम के अधीन और तद्धीन बनाए गए नियमों के अधीन उपबंधित प्रक्रिया के अनुसार नीलामी के माध्यम से चयनित सफल बोली लगाने की इस प्रकार अनुज्ञात खनन हैसियत के भाग के रूप में नहीं होगा।"

(iii) परिशिष्ट – IX के लिए, निम्नलिखित परिशिष्ट प्रतिस्थापित किया जाएगा, अर्थात् :-

"परिशिष्ट – 9

कतिपय मामलों के पर्यावरणीय अनापत्ति की अपेक्षा से छूट

निम्नलिखित मामलों को पूर्व पर्यावरणीय अनापत्ति की अपेक्षा नहीं होगी, अर्थात् :-

1. मैनुअल खनन द्वारा साधारण मिट्टी या बालू की कुम्हारों द्वारा मिट्टी के घड़े, लैम्प, खिलौने, आदि बनाने के लिए उनकी प्रथाओं के अनुसार निकासी ।

2. मैनुअल खनन द्वारा मिट्टी की टाइलें बनाने द्वारा जो मिट्टी की टाइलें बनाते हैं, के लिए साधारण मिट्टी या बालू की निकासी।

3. किसानों द्वारा बाढ़ के पश्चात् कृषि भूमि से बालू के जमाव को हटाना।

4. ग्राम पंचायत में अवस्थित स्रोतों से बालू और साधारण मिट्टी को वैयक्तिक उपयोग या ग्राम में समुदाय कार्य के लिए प्रथा के अनुसार खनन।

5. सामुदायिक कार्य जैसे ग्रामीण तालाबों या टैंकों से गाद हटाना, महात्मा गांधी राष्ट्रीय ग्रामीण रोजगार और गारंटी स्कीमों, अन्य सरकारी स्कीमों, प्रायोजित तथा सामुदायिक प्रयासों द्वारा ग्रामीण सड़कों, तालाबों या बांधों का संनिर्माण।

6. सड़क, पाइपलाइन, आदि जैसे रेखीय परियोजनाओं के लिए साधारण मिट्टी की निकासी, निष्कासन या प्रयोग करना।

7. बांधों, तालाबों, मेड़ों, बैराजों, नदी और नहरों की उनके अनुरक्षित तथा आपदा प्रबंधन के प्रयोजन के लिए तलमार्जन और गाद निकालना।

8. गुजरात में गुजरात सरकार की तारीख 14 फरवरी, 1990 की अधिसूचना सं. जीयू / 90 (16)/ एमसीआर–2189 (68) / 5 – सीएचएच द्वारा बंजारा और ओड द्वारा बालू के पारंपरिक उपजीविका कार्य।

9. पारंपरिक समुदाय द्वारा अंतर ज्वारीय क्षेत्र के भीतर चूने के गोलों (मृत भू-पटल), पवित्र स्थानों, आदि के मैनुअल निकासी।

10. सिंचाई या पेयजल के लिए कुओं की खुदाई।

11. यथास्थिति, ऐसे भवनों की नींव के लिए खुदाई जिनके लिए पूर्व पर्यावरणीय अनापत्ति अपेक्षित नहीं है।

12. जिला कलेक्टर या जिला मजिस्ट्रेट या किसी अन्य सक्षम प्राधिकारी के आदेश पर किसी नहर, नाला, ड्रेन, जल निकाय, आदि में होने वाली दरार को भरने के लिए साधारण मिट्टी या बालू का उत्खनन ताकि किसी आपदा या बाढ़ जैसी स्थिति से निपटा जा सकें।

13. ऐसे क्रियाकलाप, जिन्हें राज्य सरकार द्वारा विधान या नियमों के अधीन गैर खननकारी क्रियाकलाप के रूप में घोषित किया गया है।"

[फा. सं. जेड–11013 / 47 / 2018–आई. ए. II (एम)]

गीता मेनन, संयुक्त सचिव

टिप्पण : मूल अधिसूचना भारत के राजपत्र, असाधारण, भाग II, खंड 3, उप-खंड (ii) में सं. का. आ. 1533 (अ), तारीख 14 सितंबर 2006 द्वारा प्रकाशित की गई थी और निम्नलिखित सं. द्वारा पश्चात्वर्ती संशोधन किया गया :-

1. का. आ. 1949 (अ), तारीख 13 नवंबर, 2006;
2. का. आ. 1737 (अ), तारीख 11 अक्तूबर, 2007;
3. का. आ. 3067 (अ), तारीख 1 दिसंबर, 2009;
4. का. आ. 695 (अ), तारीख 4 अप्रैल, 2011;
5. का. आ. 156 (अ), तारीख 25 जनवरी, 2012;
6. का. आ. 2896 (अ), तारीख 13 दिसंबर, 2012;
7. का. आ. 674 (अ), तारीख 13 मार्च, 2013;
8. का. आ. 2204 (अ), तारीख 19 जुलाई, 2013;
9. का. आ. 2555 (अ), तारीख 21 अगस्त, 2013;
10. का. आ. 2559 (अ), तारीख 22 अगस्त, 2013;
11. का. आ. 2731 (अ), तारीख 9 सितंबर, 2013;

12. का. आ. 562 (अ), तारीख 26 फरवरी, 2014;
13. का. आ. 637 (अ), तारीख 28 फरवरी, 2014;
14. का. आ. 1599 (अ), तारीख 25 जून, 2014;
15. का. आ. 2601 (अ), तारीख 7 अक्तूबर, 2014;
16. का. आ. 2600 (अ), तारीख 9 अक्तूबर, 2014;
17. का. आ. 3252 (अ), तारीख 22 दिसंबर, 2014;
18. का. आ. 382 (अ), तारीख 3 फरवरी, 2015;
19. का. आ. 811 (अ), तारीख 23 मार्च, 2015;
20. का. आ. 996 (अ), तारीख 10 अप्रैल, 2015;
21. का. आ. 1142 (अ), तारीख 17 अप्रैल, 2015;
22. का. आ. 1141 (अ), तारीख 29 अप्रैल, 2015;
23. का. आ. 1834 (अ), तारीख 6 जुलाई, 2015;
24. का. आ. 2571 (अ), तारीख 31 अगस्त, 2015;
25. का. आ. 2572 (अ), तारीख 14 सितंबर, 2015;
26. का. आ. 141 (अ), तारीख 15 जनवरी, 2016;
27. का. आ. 648 (अ), तारीख 3 मार्च, 2016;
28. का. आ. 2269 (अ), तारीख 1 जुलाई, 2016;
29. का. आ. 2944 (अ), तारीख 14 सितंबर, 2016;
30. का. आ. 3518 (अ), तारीख 23 नवंबर, 2016;
31. का. आ. 3999 (अ), तारीख 9 दिसंबर, 2016;
32. का. आ. 4241 (अ), तारीख 30 दिसंबर, 2016;
33. का. आ. 3611 (अ), तारीख 25 जुलाई, 2018;
34. का. आ. 3977 (अ), तारीख 14 अगस्त, 2018;
35. का. आ. 5733 (अ), तारीख 14 नवंबर, 2018;
36. का. आ. 5736 (अ), तारीख 15 नवंबर, 2018;
37. का. आ. 5845 (अ), तारीख 26 नवंबर, 2018;
38. का. आ. 345 (अ), तारीख 17 जनवरी, 2019;
39. का. आ. 1960 (अ), तारीख 13 जून, 2019;
40. का. आ. 236 (अ), तारीख 16 जनवरी, 2020;
41. का. आ. 751 (अ), तारीख 17 फरवरी, 2020; और
42. का. आ. 1223 (अ), तारीख 27 मार्च, 2020 ।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 28th March, 2020

S.O. 1224(E).—WHEREAS, *vide* the Mineral Laws (Amendment) Act, 2020 (2 of 2020), the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957) (hereinafter referred to as MMDR Act) has been amended with effect from the 10th day of January, 2020 and, *inter alia*, new section 8B relating to the provisions for transfer of statutory clearances has been inserted;

AND WHEREAS, sub-section (2) of section 8B of the MMDR Act provides that notwithstanding anything contained in this Act or any other law for the time being in force, the successful bidder of mining leases expiring under the provisions of sub-sections (5) and (6) of section 8A and selected through auction as per the procedure provided under this Act and the rules made thereunder, shall be deemed to have acquired all valid rights, approvals, clearances, licences and the like vested with the previous lessee for a period of two years;

AND WHEREAS, sub-section (3) of section 8B of the MMDR Act provides that notwithstanding anything contained in any other law for the time being in force, it shall be lawful for the new lessee to continue mining operations on the land, in which mining operations were being carried out by the previous lessee, for a period of two years from the date of commencement of the new lease;

AND WHEREAS, in pursuance of the aforesaid amendment to the MMDR Act, the Central Government deems it necessary to align the relevant provisions of the notification of the Government of India in the erstwhile Ministry of Environment and Forests number S.O. 1533 (E), dated the 14th September, 2006 (hereinafter referred to as the EIA Notification, 2006);

AND WHEREAS, the Ministry of Environment, Forest and Climate Change is in the receipt of representations for waiver of requirement of prior environmental clearance for borrowing of ordinary earth for roads; and manual extraction of lime shells (dead shell), shrines, etc., within inter tidal zone by the traditional community;

Now, therefore, in exercise of the powers conferred by sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986), read with sub-rule (4) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government, after having dispensed with the requirement of notice under clause (a) of sub-rule (3) of the rule 5 of the said rules, in public interest, and in supersession of the notification number S.O. 4307(E), dated the 29th November, 2019, hereby makes the following further amendments in the EIA Notification, 2006, namely:-

In the said notification,-

(i) in paragraph 11, after sub-paragraph (2), the following sub-paragraph shall be inserted, namely:-

"(3) The successful bidder of the mining leases, expiring under the provisions of sub-sections (5) and (6) of section 8A of the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957) and selected through auction as per the procedure provided under that Act and the rules made thereunder, shall be deemed to have acquired valid prior environmental clearance vested with the previous lessee for a period of two years, from the date of commencement of new lease and it shall be lawful for the new lessee to continue mining operations as per the same terms and conditions of environmental clearance granted to the previous lessee on the said lease area for a period of two years from the date of commencement of new lease or till the new lessee obtains a fresh environmental clearance with the terms and conditions mentioned therein, whichever is earlier:

Provided that the successful bidder shall apply and obtain prior environmental clearance from the regulatory authority within a period of two years from the date of grant of new lease.";

(ii) in the Schedule, against the item 1(a), in the column (5), after clause (2) of the Note, the following clause shall be inserted, namely:-

"(3) The evacuation or removal and transportation of already mined out material lying within the mining leases expiring under the provisions of the Mines and Minerals (Development and Regulation) Act, 1957 (67 of 1957), by the previous lessee, after the expiry of the said lease, shall not form the part of the mining capacity so permitted to the successful bidder, selected through auction as per the procedure provided under that Act and the rules made thereunder.";

(iii) for Appendix-IX, the following Appendix shall be substituted, namely:-

"APPENDIX-IX

EXEMPTION OF CERTAIN CASES FROM REQUIREMENT OF ENVIRONMENTAL CLEARANCE

The following cases shall not require Prior Environmental Clearance, namely:-

1. Extraction of ordinary clay or sand by manual mining, by the Kumhars (Potter) to prepare earthen pots, lamp, toys, etc. as per their customs.
2. Extraction of ordinary clay or sand by manual mining, by earthen tile makers who prepare earthen tiles.
3. Removal of sand deposits on agricultural field after flood by farmers.
4. Customary extraction of sand and ordinary earth from sources situated in Gram Panchayat for personal use or community work in village.
5. Community works, like, de-silting of village ponds or tanks, construction of village roads, ponds or bunds undertaken in Mahatma Gandhi National Rural Employment and Guarantee Schemes, other Government sponsored schemes and community efforts.
6. Extraction or sourcing or borrowing of ordinary earth for the linear projects such as roads, pipelines, etc.
7. Dredging and de-silting of dams, reservoirs, weirs, barrages, river and canals for the purpose of their maintenance, upkeep and disaster management.
8. Traditional occupational work of sand by Vanjara and Oads in Gujarat vide notification number GU/90(16)/MCR-2189(68)/5-CHH, dated the 14th February, 1990 of the Government of Gujarat.
9. Manual extraction of lime shells (dead shell), shrines, etc., within inter tidal zone by the traditional community.
10. Digging of wells for irrigation or drinking water purpose.
11. Digging of foundation for buildings, not requiring prior environmental clearance, as the case may be.
12. Excavation of ordinary earth or clay for plugging of any breach caused in canal, nallah, drain, water body, etc., to deal with any disaster or flood like situation upon orders of the District Collector or District Magistrate or any other Competent Authority.
13. Activities declared by the State Government under legislations or rules as non-mining activity."

[F. No. Z-11013/47/2018-IA.II (M)]

GEETA MENON, Jt. Secy.

Note: The principal notification was published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (ii) *vide* number S.O. 1533 (E), dated the 14th September, 2006 and subsequently amended *vide* the following numbers:-

1. S.O. 1949 (E), dated the 13th November, 2006;
2. S.O. 1737 (E), dated the 11th October, 2007;
3. S.O. 3067 (E), dated the 1st December, 2009;
4. S.O. 695 (E), dated the 4th April, 2011;
5. S.O. 156 (E), dated the 25th January, 2012;
6. S.O. 2896 (E), dated the 13th December, 2012;
7. S.O. 674 (E), dated the 13th March, 2013;
8. S.O. 2204 (E), dated the 19th July, 2013;
9. S.O. 2555 (E), dated the 21st August, 2013;
10. S.O. 2559 (E), dated the 22nd August, 2013;
11. S.O. 2731 (E), dated the 9th September, 2013;
12. S.O. 562 (E), dated the 26th February, 2014;
13. S.O. 637 (E), dated the 28th February, 2014;

14. S.O. 1599 (E), dated the 25th June, 2014;
15. S.O. 2601 (E), dated the 7th October, 2014;
16. S.O. 2600 (E), dated the 9th October, 2014;
17. S.O. 3252 (E), dated the 22nd December, 2014;
18. S.O. 382 (E), dated the 3rd February, 2015;
19. S.O. 811 (E), dated the 23rd March, 2015;
20. S.O. 996 (E), dated the 10th April, 2015;
21. S.O. 1142 (E), dated the 17th April, 2015;
22. S.O. 1141 (E), dated the 29th April, 2015;
23. S.O. 1834 (E), dated the 6th July, 2015;
24. S.O. 2571 (E), dated the 31st August, 2015;
25. S.O. 2572 (E), dated the 14th September, 2015;
26. S.O. 141 (E), dated the 15th January, 2016;
27. S.O. 648 (E), dated the 3rd March, 2016;
28. S.O. 2269(E), dated the 1st July, 2016;
29. S.O. 2944(E), dated the 14th September, 2016;
30. S.O. 3518 (E), dated 23rd November 2016;
31. S.O. 3999 (E), dated the 9th December, 2016;
32. S.O. 4241(E), dated the 30th December, 2016;
33. S.O. 3611(E), dated the 25th July, 2018;
34. S.O. 3977 (E), dated the 14th August, 2018;
35. S.O. 5733 (E), dated the 14th November, 2018;
36. S.O. 5736 (E), dated the 15th November, 2018;
37. S.O. 5845(E), dated the 26th November, 2018;
38. S.O. 345(E), dated the 17th January, 2019;
39. S.O. 1960(E), dated the 13th June, 2019;
40. S.O. 236(E), dated the 16th January, 2020;
41. S.O. 751(E), dated the 17th February, 2020; and
42. S.O. 1223(E), dated the 27th March, 2020.

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Evaluation of the "Report submitted by the Water Resource Department, Government of Andhra Pradesh including findings of Bathymetric survey" (Annexure-II) to the Hon'ble NGT in the matter of O.A No. 935/2018

By

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Chief Research Scientist

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20th April 2020

1. Introduction

The Additional Director & Divisional Head – IPC -II, Central Pollution Control Board, Delhi approached the Director, Indian Institute of Science (IISc), Bengaluru vide letter No. CPCB/IPC-II/Mining (OA-935/2018)/2020 dated January 19, 2020 requesting him to nominate a representative to the expert committee constituted in compliance of Hon'ble NGT order in OA No. 935/2018 dated 14-02-2020. The Director, Indian Institute of Science, Bengaluru vide letter No. DIR: N13/DO No. 419 dated 3rd March 2020 informed Shri Nazimuddin, Additional Director & Divisional Head – IPC -II, Central Pollution Control Board, Delhi that he has nominated (1) Professor M Sudhakar Rao, and (2) Dr. K S Nanjunda Rao both from the Department of Civil Engineering, IISc, Bangalore as members of the expert committee. Both Professor M Sudhakar Rao, and Dr K S Nanjunda Rao received an email on 18 March 2020 at 1:19 PM from Mahima T Gowda, Senior Environmental Engineer, Central Pollution Control Board, Regional Directorate (South), 1st & 2nd floors, Nisarga Bhawan, 7th D cross, Thimmaiah Road, Shivajinagar, Bengaluru-560079 enclosing three files (1) Annexure – I NGT order dated 14-02-2020, (2) Annexure – II Report of water resources department including findings of bathymetric survey and (3) Background Information in compliance to Hon'ble NGT order dated 14.02.2020 in the matter of O.A No. 935/2018. The sections to follow presents the evaluation of "Report of water resources department including findings of bathymetric survey".

2. Summary of the contents in the report

The report begins with a history and salient features of the Prakasam Barrage. It states that barrage was constructed in the year 1957, upstream (distance of 31.83m) of breached and damaged century old Anicut across River Krishna. It provides in tabular form various features of the barrage (section number I, page numbers 1 to 3 or page numbers 184 to 186).

In the section numbers II and III (page numbers 4 to 6 or page numbers 187 to 189) of the report information regarding siltation and shoal formation in river Krishna up to 13.5 km upstream of the barrage and its quantitative assessment using Sounding Data and Remote Sensing Data conducted in the years 2015 and 2016 respectively are presented. Based on Remote Sensing Data it is estimated that approximately 272.66 lakh m^3 (cubic meter) of sediments are deposited in Prakasam Barrage reservoir. It is also estimated that 71.0 lakh m^3 (cubic meter) of sediments is to be de-silted. It is stated that for a duration of about 10 years the sediment has not been flushed out by operating scour sluices in order to facilitate passage of water to the cooling canal of Vijayawada thermal power station and to supply drinking water to Vijayawada and Guntur cities. It is opined that there is increased sediment deposition due to linking of River Godavari with River Krishna through Pattiseema lift scheme and it is estimated that 255.73 TMC of water has reached Prakasam Barrage during the period 2015 to 2020.

It is stated that due to sediment deposit there is a reduction in live storage capacity equivalent to about 0.767 TMC.

The section IV of the report (page numbers 7 to 9 or page numbers 190 to 192) presents the justification for undertaking sediment removal and hence to restore the lost storage capacity to meet the increased water demand of the region for drinking, commercial and industrial needs. It is reported that water stored in Prakasam Barrage is the only source for meeting the additional water requirement after the Government of Andhra Pradesh declared "Amaravathi" as new capital city in 2015. The report also cites clause number 6.5 of " IS 7349 : 2012, Barrages and Weirs — Operation and Maintenance — Guidelines", Bureau Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi 110002 for sediment removal to ensure satisfactory flow conditions and to restore designed storage capacity in the barrage.

The sand mining policy and de-silting rules of Government of Andhra Pradesh is presented in section V (page numbers 9 to 17 or page numbers 192 to 200). It provides information regarding protocols to be followed for awarding the works of de-silting of dams/reservoirs/Barrage/large tanks.

The section VI of the report (page numbers 17 to 22 or page numbers 200 to 205) presents information about the de-siltation of Prakasam Barrage already carried out in the districts of Guntur and Krishna. Details of location with quantity of sediment removed is tabulated. It is reported that in phase - I 33 lakh m^3 (cubic meter) and 10 lakh m^3 (cubic meter) of sediment is de-silted through mechanised boats and dredging operation respectively. Further the report states that Government of Andhra Pradesh vide G.O. Rt. No. 148 WR (WRG: GRC) dated 24-02-2016, entrusted the de-silting of sediment through dredging operation to M/S NAS Babu Consruction Pvt. Ltd., Gudivada. The work was titled as "Dredging of silt and sand from the foreshore of Prakasam barrage by deploying suitable inland cutter suction dredger and depositing the dredging material on either side of banks of Krishna river wherever government land is available". It states that de-silting activity started on 26-06-2016 in Thallayapalem village limits of Thullur Mandal in Guntur district and about 15,822 m^3 (cubic meter) of sediment was de-silted. Later the work was shifted to Lingayapalem village in Thullur Mandal in Guntur district and Ibrahimpatnam village/Mandal in Krishna district on 06-11-2016 and about 9,78, 930 m^3 (cubic meter) of sediment was de-silted. It is stated that the de-silted material was supplied to Government works taken up in Amaravathi capital city. It is stated that dredging work was completed on 24-09-2018. The report also discusses the methods adopted for de-siltation like dredging and through use of mechanised boats. It provides information regarding specifications of dredger and mechanised boat used for this operation.

Details of Bathymetric survey conducted, and the methodology followed is presented in section VII (page numbers 22 to 26 or page numbers 205 to 209). It is stated that this survey was done in compliance with Hon'ble NGT directions by the Irrigation department in the upstream of Prakasam barrage from km 0.00 to km 13.5. It is stated that Irrigation department carried out the survey by hiring the services of M/S BSP Hydro Dredging Works, Bhimavaram since they had prior experience. It is stated that Single Beam Echo Sounder, position and navigation systems were employed for conducting the survey. Information regarding equipment's along with software used are also presented.

The findings from the Bathymetric survey conducted in the upstream of Prakasam barrage from km 0.00 to km 13.5 and details of flood bank in the foreshore area are reported in section VIII (page numbers 27 to 34 or page numbers 210 to 217). It is stated that the existing capacity of the Prakasam Barrage is 2.982 TMC. The estimated volume of sediment deposited above the original bed level is 1,24,77,704 m^3 (cubic meter). It is reported that by de-silting the sediment the storage capacity will be increased by 0.441 TMC. Further, the Bathymetric survey has helped in identifying critical areas in the barrage based on depth of sediment above the bed level with GPS coordinates. The study has also shown that there are patches of sediment deposition between km 10.8 to km 12.7 in Lingayapalem village and km 12.7 to km 13.5 in Rayapudi village and the estimated quantity is 4,29,710 m^3 (cubic meter) and 71,177 m^3 (cubic meter) respectively. The report proposes de-siltation of this sediment deposit also. The report also provides information of flood bank in the foreshore area. It is stated the original flood banks were formed in the years 1882 and 1892. It is reported that there were high floods in the years 1896, 1903, 1916 and 1949. After the high floods in 1916, a committee was appointed in 1917 to enquire into the causes of breaches and to recommend measures to be undertaken to minimize the danger in future floods. Based on the re commendations the flood banks were raised by 2 feet. The report also states that whenever the margins of minimum distance gets reduced protection measures should be undertaken employing methods like Nanal plantation, revetment spuns, groynes etc. It is also stated that in the last ten years no works have been taken up to repair damaged flood banks. It is reported that flood banks above Anicut are stable and no damage occurred during the floods in the years 2009 and 2019.

3. Comments on the report

i. Sedimentation in reservoirs/barrages is a critical issue all over the globe. This aspect must be considered while designing the reservoirs for the storage capacity for a finite period. Thereafter, scientifically established protocols must be mandated for assessing and managing sedimentation in reservoirs/barrages as it can become a potential threat to social, environmental and economic

efficiency and finally to the safety of the reservoir/barrage itself. In this context, the studies carried out and reported in Annexure - II in the opinion of the IISc nominated member are in order.

ii. The ill effects of sedimentation in reservoirs/barrages are (a) loss of storage capacity(b) alterations in flow regimes which can cause damage to flood banks and inundate large surrounding areas in case of floods, (c) enhanced static and dynamic loads on hydraulic control structures.

iii. The Government of Andhra Pradesh has put in place a sand mining policy which in the opinion of the IISc nominated member is quite stringent.

iv. The methods adopted for sediment removal/de-silting like dredging and use of mechanised boats in the opinion of the IISc nominated member are in conformity with established practices and guidelines recommended by Bureau of Indian Standards.

v. The methodology adopted for carrying out Bathymetric survey is in conformity with the established and recommended practices. However, there appears to be some discrepancy in the findings of Bathymetric survey in respect of volume of sediment deposited, increase in storage capacity due to removal of the stated sediment deposit, the existing storage capacity of Prakasam barrage reservoir in relation to the designed capacity of Prakasam barrage reservoir. On page 27 or page 210 of the report (Annexure – II) it is stated that capacity of Prakasam barrage is 3.071 TMC. On page 4 or page 187 it is stated that due to sediment deposit there is a reduction in storage capacity by approximately 25% which is equivalent to about 0.767 TMC. This is consistent as 25% of 3.071 TMC is 0.767 TMC. On page 29 or page 212 it is reported that existing capacity of Prakasam barrage reservoir is 2.982 TMC and increase in storage capacity after de-silting 1,24,77,704 m^3 (cubic meter) of sediment is 0.441 TMC. The sum of 2,982 and 0.441 is 3.423 TMC which is more than the design capacity of Prakasam barrage reservoir by 0.352 TMC. The difference is quite significant and hence IISc nominated member seeks clarification and explanation for the observed discrepancy.

vi. The cost for removal of sediment from the reservoir bed is quite significant and hence it is a good practice to consider the material removed as a natural resource and to use it for beneficial purposes (if not harmful to human beings and environment). For accomplishing this task, the physical and chemical analyses of the material need to be performed. Based on the outcome of the analysis the material can be utilised for topsoil enhancement and agricultural use, land reclamation and improvement, beach nourishment and shore protection, building construction material etc. The reuse of sediment material will help in recovering cost incurred for removal of the sediment. It is not advisable to dump the sediment removed from the riverbeds on the flood banks.

---------End of the report --------

Follow-up to IISc nominated Expert member KSN's evaluation report on Annexure – II, dated 20 April 2020 as a response to the reply received from the concerned authorities of Irrigation department, Govt. Andhra Pradesh for the queries raised.

Query no.	Query from IISc Expert member	Reply received from the concerned authorities of Irrigation department, Govt. Andhra Pradesh	IISc expert member's observation/s and concluding remarks
1	The methodology adopted for carrying out Bathymetric survey is in conformity with the established and recommended practices. However, there appears to be some discrepancy in the findings of Bathymetric survey in respect of volume of sediment deposited, increase in storage capacity due to removal of the stated sediment deposit, the existing storage capacity of Prakasam barrage reservoir in relation to the designed capacity of Prakasam barrage reservoir. On page 27 or page 210 of the report (Annexure – II) it is stated that capacity of Prakasam barrage is 3.071 TMC. On page 4 or page 187 it is stated that due to sediment deposit there is a reduction in storage capacity by approximately 25% which is equivalent to about 0.767 TMC. This is consistent as 25% of 3.071 TMC is 0.767 TMC. On page 29 or page 212 it is reported that existing capacity of Prakasam barrage reservoir is 2.982 TMC and increase in storage capacity after de-silting 1,24,77,704 m^3 (cubic meter) of sediment is 0.441 TMC. The sum of 2,982 and 0.441 is 3.423 TMC which is more than the design capacity of Prakasam barrage reservoir by 0.352 TMC. The difference is quite significant and hence IISc nominated member seeks clarification and explanation for the observed discrepancy.	During 2016, an approximate assessment of reservoir siltation was conducted using Satellite Imagery, where in it is estimated that the storage capacity of Prakasam Barrage reduced approximately by 25% of the storage capacity (3.071 TMC) i.e., about 0.767 TMC. Further, in 2019 the Krlshna Rlver received heavy floods of more than 8 lakh cusecs for a long duration and the barrage gates were continuously in open condition for about 80 days discharging a total of 798 TMC water into the Bay of Bengal, which was not happened in the past few years. Due to the strong currents of flood water and prolonged flood duration, large depressions were formed below bed level and certain islands and margin lands were eroded as observed in the Bathymetric Survey. Now, after conducting the bathymetric survey in the full scale for the entire reservoir during December 2019 & lan 2020, which is more accurate, the total water storage in Prakasam Barrage reservoir at present is found to be 2.982 TMC at FRL. This total storage of 2.982 TMC includes the dead storage of water below the original bed level in the large depressions formed due to scouring; erosion of riverbed, banks and islands; degradation of riverbed etc. As per Bathymetry survey data, the probable increase in Water storage capacity after conducting de-siltation of 1,24,77,704 cum deposits above original bed level would be 0.441 TMC. And The Storage	The basic objective of assessing and managing reservoir sedimentation is to estimate the loss of storage capacity and to restore the storage capacity by removal of sediments/desiltation. In this context according to the findings of the Bathymetric survey conducted during December 2019 and January 2020, the present water storage capacity of Prakasam Barrage reservoir is 2.982 TMC. The design water storage capacity of Prakasam Barrage reservoir is 3.071 TMC. Therefore, the loss in storage capacity is (3.071 - 2.982 = 0.089) 0.089 TMC. In order to restore the lost water capacity of 0.089 TMC due to sediment deposition, it can be concluded that the volume of sediments to be removed or desilted will be 25,20,200 m3 (cubic meter) which is equivalent to 0.09 TMC. **Concluding Remarks:** **In the opinion of IISc nominated expert member, sediment to the extent of 25,20,200 m^3 (cubic meter) which is equivalent to 0.09 TMC should be removed or desilted.**

		capacity is 3.432 TMC (The sum of 2.982 TMC and 0.441 TMC).	

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

Respected madam,

With reference to the clarification sought by the Committee, the point wise clarification obtained from the concerned authorities is furnishing here with for kind perusal and necessary action in the matter.

Dated: 13.04.2020

Bathymetric Survey Report:

1. The need for de-siltation arose due to heavy deposition of silt coupled with increased demand of water in the region. A study by Irrigation department assessed 71 Lakh m^3 of silt deposit in the Krishna River upto 13.5 Km upstream of Prakasam Barrage. It is observed that quantities for 5 to 10 Km have been shown as zero without mentioning any reason. Further, data relating to 11 Km and 12 Km are exactly same. Similarly, for 13 Km and 14 Km, figures are same. It is not clear if it is coincidence or based on certain assumptions.

The clarification given by the River Conservator / Executive Engineer, K.C. Division, Vijayawada is herewith enclosed in ANNEXURE-I.

Ecological Assessment Report:

2. The above study was limited to only 9 locations which included all the 8 locations alleged in NGT Case OA 935/2018. But, in the report submitted by Water Resource Department, it has been stated that de-siltation by motorized boats was carried out in 7 locations in Guntur District and 5 locations in Krishna District apart from 3 locations where de-siltation was done by dredging operation.

It is informed that, it is a fact that, the the River Conservator / Executive Engineer, K.C. Division, Vijayawada vide his Letter No: Camp-1, & Letter No: Camp-2, dated: 18.01.2016 (ANNEXURE-II & ANNEXURE-III) has requested the Joint Collectors & Chairman, District Level Sand

Committee, Guntur & Krishna for issuing permission for de-siltation of the sand accumulated in 7 locations in Guntur District & 5 Locations in Krishna District. Out of 7 locations in Guntur district, the District Collector, Guntur vide Gazette No: 36, dated: 24.03.2016 (ANNEXURE-IV) has permitted de-siltation operations in 6 locations only and out of 5 locations in Krishna district 2 locations (Bhavnipuram and Gollapudi) stopped operations from long back. That is why the study was taken up in 9locations.

3. In the study report, Undavalli (from Km 2.00 to Km 3.200 of KRF bank) has been assumed as non-de-siltation area and chosen as reference site to compare the impacts. However, in the report of Water Resource Department, de-silted quantity from the same location i.e. Undavalli (from Km 2.00 to Km 3.200 of KRF bank) has been mentioned as 2 Lakh m^3. The reason for same may be brought about.

it is informed that, it is a fact that, the River Conservator / Executive Engineer, K.C. Division, Vijayawada vide his Letter No: Camp-1, dated: 18.01.2016 has requested the Joint Collector & Chairman, District Level Sand Committee, Guntur for issuing permission for de-siltation of the sand accumulated in the 7 locations including Undavalli (from Km 2.00 to Km 3.200 of KRF bank) in Guntur District.

But the District Collector, Guntur vide Gazette No: 36, dated: 24.03.2016 (ANNEXURE-IV) has given permission for de-siltation of sand in KRF side of Prakasam Barrage in other locations excluding Undavalli (from Km 2.00 to Km 3.200 of KRF bank) of Guntur District. The de-siltation in Undavalli (from Km 2.00 to Km 3.200 of KRF bank) was not permitted on safety grounds as the location was very nearer to the then Hon'ble Chief Minister of Andhra Pradesh Residency.

Dated: 20.04.2020

Clarifications sought from Bathymetric Survey report:

1. The methodology adopted for carrying out Bathymetric survey is in conformity with the established and recommended practices. However, there appears to be some discrepancy in the findings of Bathymetric survey in respect of volume of sediment deposited, increase in storage capacity due to removal of the stated sediment deposit, the existing storage capacity of Prakasam barrage reservoir in

relation to the designed capacity of Prakasam barrage reservoir. On page 27 or page 210 of the report (Annexure – II) it is stated that capacity of Prakasam barrage is 3.071 TMC. On page 4 or page 187 it is stated that due to sediment deposit there is a reduction in storage capacity by approximately 25% which is equivalent to about 0.767 TMC. This is consistent as 25% of 3.071 TMC is 0.767 TMC. On page 29 or page 212 it is reported that existing capacity of Prakasam barrage reservoir is 2.982 TMC and increase in storage capacity after de-silting 1,24,77,704 m3 (cubic meter) of sediment is 0.441 TMC. The sum of 2,982 and 0.441 is 3.423 TMC which is more than the design capacity of Prakasam barrage reservoir by 0.352 TMC. The difference is quite significant and hence clarification and explanation for the observed discrepancy is sought.

2. The cost for removal of sediment from the reservoir bed is quite significant and hence it is a good practice to consider the material removed as a natural resource and to use it for beneficial purposes (if not harmful to human beings and environment). For accomplishing this task, the physical and chemical analyses of the material need to be performed. Based on the outcome of the analysis the material can be utilised for topsoil enhancement and agricultural use, land reclamation and improvement, beach nourishment and shore protection, building construction material etc. The reuse of sediment material will help in recovering cost incurred for removal of the sediment. It is not advisable to dump the sediment removed from the riverbeds on the flood banks. Why was the sediments dumped in river bed?

The clarification given by the River Conservator / Executive Engineer, K.C. Division, Vijayawada is herewith enclosed in ANNEXURE-I.

Clarifications on Ecological Study:

TSS has an important role in maintaining favourable flora and fauna environment for sustainable ecological balance in the river system. The report submitted by AcharyaNagarjuna University will benefit if clarifications to queries 1-9 detailed below is provided by the Investigators.

Section V a Investigators state that "Water samples were collected from nine different study sites. From each site six samples from different depths at different times were collected (Page 6).

1. *At what depth intervals, were the water samples collected at each site.*

2. *What method was followed to collect water samples from different depths of a site.*

3. *What was the time interval between field sampling and determination of TSS and Turbidity of water samples in the laboratory?*

4. *What volume of water sample was used in the Gravimetric method (TSS determination)*

5. *How was it ensured that the sample condition, representative of field condition, was used in Gravimetric and Turbidity measurements in the laboratory?*

6. *Was relevant Bureau of Indian Standards Procedures adopted in laboratory determination of TSS and Turbidity parameters?*

7. *Were replicates performed for TSS and turbidity measurements. If yes, what was the percent variation from average for each triplicate set of measurements. Give data for both TSS and turbidity*.Section Vi a The investigators state that "The estimated TSS and turbidity values of water samples collected from Undavalli area, non-desilatation sampling site, found in the ranges of 125- I 45 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 (Pages 8-9).

8. *Can the variations of TSS with depth and turbidity with depth be provided for the eight desiltation sites and 1 reference site?*

9. Section V a The investigators state that "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 (Page 7).

10. *Turbidity can serve as a rough index of a sample's true sediment load (Carlson 2005; Amanda et al, 2018; Hannouche et al., 2011). The data for Shitalakhya river, Dhaka city, Bangladesh (Md. Serajuddin et al., 2019), Piranga river, Brazil (Amanda et al., 2018), Arkansas rivers, USA (West and Scott, 2016) indicate a positive correlation between TSS and turbidity (Figure 1). The data of Krishna river reported by the Investigators (Page 8, maximum values from Table 1 of Annex III are used in Figure 1) indicate that turbidity is independent of TSS concentration (Figure 1). Could the investigators explain their observed trend between turbidity and TSS of Krishna river water samples tested in the study (Figure 1). 6 Figure 1: Relations between TSS and turbidity of river water samples.*

The clarification given by the Professors of Acharya Nagarjuna University is herewith enclosed in ANNEXURE-V.

09/05/2020

ANNEXURE -I

Explanation on the Clarifications sought by Smt T.Mahima of CPCB, on the report submitted by WRD, AP.

The Pointwise explanations for the clarifications sought are as follows

Bathymetric survey report:

I. **Clarification Sought: The need for de-siltation arose due to heavy deposition of silt coupled with increased demand of water in the region. A study by Irrigation department assessed 71 Lakh m³ of silt deposit in the Krishna River up to 13.5 Km upstream of Prakasam Barrage. It is observed that quantities for 5 to 10 Km have been shown as zero without mentioning any reason. Further, data relating to 11 Km and 12 Km are exactly same. Similarly, for 13 Km and 14 Km, figures are same. It is not clear if it is coincidence or based on certain assumptions.**

Reply:

The total quantity of deposited silt was ascertained by considering the accumulated shoals wherever the shoal average depth is more than 2m, while calculating the amount of silt in the foreshore of Prakasam Barrage i.e from Km 0.00 to Km 13.50 on upstream of Barrage. Since the average depth of accumulation is less than 2m from Km 5.00 to Km 10.00, at Km 12.00 and at Km 14.00, these reaches have not been considered for de-siltation.

Clarification sought on 20.04.2020 from Bathymetric Survey report:

II. **Clarification Sought: The methodology adopted for carrying out Bathymetric survey is in conformity with the established and recommended practices. However, there appears to be some discrepancy in the findings of Bathymetric survey in respect of volume of sediment deposited, increase in storage capacity due to removal of the stated sediment deposit, the existing storage capacity of Prakasam barrage reservoir in relation to the designed capacity of Prakasam barrage reservoir. On page 27 or page 210 of the report (Annexure – II) it is stated that capacity of Prakasam barrage is 3.071 TMC. On page 4 or page 187 it is stated that due to sediment deposit there is a reduction in storage capacity by approximately 25% which is equivalent to about 0.767 TMC. This is consistent as 25% of 3.071 TMC is 0.767 TMC. On page 29 or page 212 it is reported that existing capacity of Prakasam barrage reservoir is 2.982 TMC and increase in storage capacity after de-silting 1,24,77,704 m3 (cubic meter) of sediment is 0.441 TMC. The sum of 2,982 and 0.441 is 3.423 TMC which is more than the design capacity of Prakasam barrage reservoir by 0.352 TMC. The difference is quite significant.**

08/5/20

Reply:

During 2016, an approximate assessment of reservoir siltation was conducted using Satellite Imagery, where in it was estimated that the storage capacity of Prakasam Barrage reduced approximately by 25% of the storage capacity (3.071 TMC) i.e., about 0.767 TMC.

Further, in 2019 the Krishna River received heavy floods of more than 8 lakh cusecs for a long duration and the barrage gates were continuously in open condition for about 80 days discharging a total of 798 TMC water into the Bay of Bengal, which was not happened in the past few years. Due to the strong currents of flood water and prolonged flood duration, large depressions were formed below bed level and certain islands and margin lands were eroded as observed in the Bathymetric Survey.

Now, after conducting the bathymetric survey in the full scale for the entire reservoir during December 2019 & Jan 2020, which is more accurate, the total water storage in Prakasam Barrage reservoir at present is found to be 2.982 TMC at FRL. This total storage of 2.982 TMC includes the dead storage of water below the original bed level in the large depressions formed due to scouring; erosion of river bed, banks and islands; degradation of river bed etc. As per Bathymetry survey data, the probable increase in Water storage capacity after conducting de-siltation of 1,24,77,704 cum deposits above original bed level would be 0.441TMC. And The Storage capacity is 3.432 TMC (The sum of 2.982 TMC and 0.441TMC).

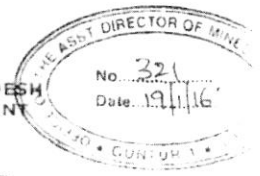
III. **Clarification Sought: The cost for removal of sediment from the reservoir bed is quite significant and hence it is a good practice to consider the material removed as a natural resource and to use it for beneficial purposes (if not harmful to human beings and environment). For accomplishing this task, the physical and chemical analyses of the material need to be performed. Based on the outcome of the analysis the material can be utilised for topsoil enhancement and agricultural use, land reclamation and improvement, beach nourishment and shore protection, building construction material etc. The reuse of sediment material will help in recovering cost incurred for removal of the sediment. It is not advisable to dump the sediment removed from the riverbeds on the flood banks. Why was the sediments dumped in river bed?**

Reply:

Clarifications on the above point and Ecological report may be obtained from the concern through Deputy Director, Mine & Geology Department.

Executive Engineer
KC Division, Vijayawada

ANNEXURE -II



GOVERNMENT OF ANDHRA PRADESH
IRRIGATION & CAD DEPARTMENT

From
Sri. K[illegible] M.Tech.
Executive Engineer,
Krishna Central Division,
Vijayawada.

To
The Joint Collector,
Chairman, District Level
Sand Committee,
Guntur District.

Letter No. C[illegible]p-I, Date: 18.01.2016.

Sir,

Sub - Desilting Operations for Sand in Krishna River in KRF Bank towards upstream side of Prakasam Barrage in Guntur District - Proposals submitted for De-Silting Operations - Regarding.

Ref: G.O.Ms.No: 20, Industries & Commerce (M.II) Department, dated: 15.01.2015.

****

I have the kind attention to the subject and reference cited. I submit that, the Government vide G.O. cited pronounced the New Sand Policy. As per the Rule 9- of APMMC Rules 1966 the Irrigation Department has to submit the proposals for de-silting of Major, Medium & Minor Reservoirs to the District Level Sand Committee.

In this connection it is submitted that, huge Quantities of sand is accumulated in the Krishna Reservoir area up to 13.50 Kms from Prakasam Barrage on KRF Bank in Guntur District. The accumulated sand has to be de-silted to increase the storage capacity of the Reservoir.

Hence in view of the above Rule it is requested to initiate necessary action for de-siltation of the sand accumulated in the specified areas of Reservoir. The details of the proposed de-silting points are enclosed herewith for taking necessary action in the matter.

Yours Faithfully

18/1/16

Executive Engineer,
K.C.Division, Vijayawada

Copy to Member Convener, DLSC & Asst. Director of Mines & Geology, Guntur for information.

PROPOSED LOCATIONS FOR THE DESILTING OPERATIONS ABOVE PRAKASAM BARRAGE IN THE GUNTUR DISTRICT

SL NO	NAME OF THE RESERVOIR	LOCATION OF THE PROPOSED AREA ABOVE BARRAGE	ESTIMATED RESERVES OF SAND (Cu.Mts.)	DETAILS OF RAMP POINT
1	PRAKASAM BARRAGE	UNDAVALLI FROM KM 2.000 TO KM 3.200 OF KRF BANK	200000	AT 3.200 KM
2	PRAKASAM BARRAGE	PENUMAKA FROM KM 3.200 TO KM 4.400 OF KRF BANK	300000	AT 4.200 KM
3	PRAKASAM BARRAGE	VENKATAYAPALEM FROM KM 5.000 TO KM 6.400 OF KRF BANK	600000	AT 6.400 KM
4	PRAKASAM BARRAGE	UDDANDARAYAPALEM FROM KM 9.000 TO KM 10.800 OF KRF BANK	200000	AT 10.800 KM
5	PRAKASAM BARRAGE	LINGAYAPALEM FROM KM 10.800 TO KM 12.000 OF KRF BANK	400000	B/W 10.800 KM to 12.000 KM
6	PRAKASAM BARRAGE	RAYAPUDI - 1 FROM KM 12.000 TO KM 12.750 OF KRF BANK	400000	B/W 12.000 KM to 12.750 KM
7	PRAKASAM BARRAGE	RAYAPUDI - 2 FROM KM 12.750 TO KM 13.500 OF KRF BANK	300000	B/W 12.750 KM to 13.500 KM
TOTAL QUANTITY OF SAND AVAILABLE IN THE RESERVOIR IN Cu.Mts			2400000	

NOTE1 : RAMP POINTS SUBJECTED TO MODIFICATION BASED ON THE SITE CONDITIONS.

NOTE2 : RAMP PERMISSION MAY BE OBTAINED BY THE RIVER CONSERVATOR , KRISHNA RIVER BEFORE ENTERING THE SAND REACH .

EXECUTIVE ENGINEER
KRISHNA CENTRAL DIVISION
VIJAYAWADA

ANNEXURE-III

GOVERNMENT OF ANDHRA PRADESH
IRRIGATION & CAD DEPARTMENT

Krishna Central Division,
Sri. K.Ravi M.Tech.
Executive Engineer,
Krishna Central Division,
Vijayawada

To
The Joint Collector,
Chairman, District Level
Sand Committee,
Krishna District.

Letter No. Camp-I, Date: 18.01.2016.

Sir,

Sub:- Desilting Operations for Sand in Krishna River in KLF Bank towards upstream side of Prakasam Barrage in Krishna District – Proposals submitted for De-Silting Operations – Regarding.

Ref:- G.O.Ms.No: 20, Industries & Commerce (M.II) Department, dated: 15.01.2015.

****

I invite kind attention to the subject and reference cited. I submit that, the Government vide G.O. cited pronounced the New Sand Policy. As per the Rule 9-1 (2) of APMMC Rules 1966 the Irrigation Department has to submit the proposal of de-silting of Major, Medium & Minor Reservoirs to the District Level Sand Committee.

In this connection it is submitted that, huge Quantities of sand is accumulated in the Krishna Reservoir area up to 13.50 Kms from Prakasam Barrage in KLF Bank of Krishna District. The accumulated sand has to be de-silted to increase the storage capacity of the Reservoir.

Keeping in view of the above Rule it is requested to initiate necessary action for de-siltation of the sand accumulated in the specified areas of Reservoir. The details of the proposed de-silting points are enclosed herewith for taking necessary action in the matter.

Yours Faithfully

18/1/16.

Executive Engineer,
K.C.Division, Vijayawada

Copy to the Member Convener, DLSC & Asst. Director of Mines & Geology, Vijayawada for favor of information.

PROPOSED LOCATIONS FOR THE DESILTING OPERATIONS ABOVE PRAKASAM BARRAGE IN THE KRISHNA DISTRICT

SL NO	NAME OF THE RESERVOIR	LOCATION OF THE PROPOSED AREA ABOVE BARRAGE	ESTIMATED RESERVES OF SAND (Cu.Mts.)	DETAILS OF RAMP POINT
1	PRAKASAM BARRAGE	BHAVANIPURAM FROM KM 1.00 TO KM 2.50 OF KLF BANK	100000	AT 1.136 KM
2	PRAKASAM BARRAGE	GOLLAPUDI FROM KM 3.00 TO KM 4.50 OF KLF BANK	200000	AT 3.443 KM
3	PRAKASAM BARRAGE	SURAYAPALEM FROM KM 6.00 TO KM 7.00 OF KLF BANK	200000	AT 6.015 KM
4	PRAKASAM BARRAGE	GUNTUPALLI FROM KM 7.00 TO KM 9.00 OF KLF BANK	200000	AT 7.450 KM
5	PRAKASAM BARRAGE	IBRAHIMPATNAM FROM KM 10.00 TO KM 13.50 OF KLF BANK	200000	AT 13.500 KM
TOTAL QUANTITY OF SAND AVAILABLE IN THE RESERVOIR IN Cu.Mts			900000	

NOTE1 : RAMP POINTS SUBJECTED TO MODIFIED BASED ON THE SITE CONDITIONS.

NOTE2 : RAMP PERMISSION MAY BE OBTAINED BY THE RELEVANT DEPARTMENT BEFORE ENTERING THE SAND REACH .

RIVER CONSERVATOR &
EXECUTIVE ENGINEER
K.C.DIVISION, VIJAYAWADA

ANNEXURE-IV

గుంటూరు జిల్లా రాజ పత్రము

GUNTUR DISTRICT GAZETTE

EXTRAORDINARY PUBLISHED BY AUTHORITY

GAZETTE No: 36 GUNTUR Thursday, 24th March, 2016

GOVERNMENT OF ANDHRA PRADESH
COLLECTOR AND DISTRICT MAGISTRATE, GUNTUR

NOTIFICATION

In obedience to the Revised Sand Policy pronounced by the Government vide Memo No: 3066/M.II(1)/2016-3, dated: 04.03.2016 it is hereby declared that, **Ordinary Sand** in the areas detailed in the Notification are available to the public for excavation / transportation without charging any fee from **24th March, 2016**.

I. DE-SILTING POINTS :

Sl No	Name of the area	Location	Ramp point	Qty in M^3 Permitted
1	Penumaka, Tadepalli Mandal	From KM 3.20 to KM 4.40 of KRF Bank	At 4.20 KM KRF Penumaka	3,00,000
2	Rayapudi-I Thulluru Mandal	From KM 12.000 to KM 12.750 of KRF Bank	At 12.00 KM KRF Rayapudi	4,00,000
3	Rayapudi-II Thulluru Mandal	From KM 12.750 to KM 13.500 of KRF Bank	At 12.75 KM KRF Rayapudi	3,00,000
4	Venkatapalem Thulluru Mandal	From KM 5.000 to KM 6.400 of KRF Bank	At 6.400 KM KRF Venkatapalem	6,00,000
5	Uddandarayuni-palem, Thulluru	From KM 9.000 to KM 10.800 of KRF Bank	At 10.800 KM KRF Uddandarayuni palem	2,00,000
6	Lingayapalem Thulluru Mandal	From KM 10.800 to KM 12.000 of KRF Bank		4,00,000
7	K.V.Palem, H/o Munugodu	Atchampet Mandal	At 55.00 KM of KRF Bank	50,000
8	Penumudi Repalle Mandal	From 62.500 KM to KM 71.00 of KRF Bank	At 64.45 KM KRF Penumudi	2,00,000

II. OPEN REACHES :

Sl. No	Name of the Reach	Geo co-ordinates	Ramp point	Extent (Hect)	Qty in M^3 Permitted
1	Konuru-I Atchampet M	16°37' 27.1"N 80°11' 22.5"E 16°37' 22.4"N 80°11' 28.2"E 16°37' 18.6"N 80°11' 26.2"E 16°37' 17.7"N 80°11' 20.5"E 16°37' 20.7"N 80°11' 19.0"E	49.50KM of KRF Bank	4.800	48,000
2	Konuru-II Atchampet M	16°37' 17.7" N 80°11' 20.5"E 16°37' 18.6"N 80°11' 26.6"E 16°37' 12.6"N 80°11' 31.4"E 16°37' 09.7"N 80°11' 24.7"E		4.900	49,000
3	Konuru-III Atchampet M	16°37' 12.6"N 80°11' 31.4"E 16°37' 10.0"N 80°11' 33.5"E 16°37' 07.2"N 80°11' 36.5"E 16°37' 03.9"N 80°11' 31.2"E 16°37' 03.2"N 80°11' 31.9"E		4.900	49,000

4	Konuru-IV Atchampet M	16° 37' 03.2"N, 80° 11' 31.9"E 16° 37' 07.2"N, 80° 12' 36.5"E 16° 37' 05.2"N, 80° 12' 38.5"E 16° 37' 02.6"N, 80° 11' 42.1"E 16° 36' 57.6"N, 80° 11' 40.8"E 16° 37' 00.6"N, 80° 11' 34.8"E	49.50KM of KRF Bank	4.900	49,000
5	Kastala-I Atchampet M	16° 36' 31.9"N, 80° 12' 32.4"E 16° 36' 30.3"N, 80° 12' 37.8"E 16° 36' 19.7"N, 80° 12' 35.3"E 16° 36' 22.8"N, 80° 11' 31.0"E		4.900	49,000
6	Kastala-II Atchampet M	16° 36' 30.3"N, 80° 12' 37.8"E 16° 36' 28.9"N, 80° 12' 42.6"E 16° 36' 17.2"N, 80° 12' 38.8"E 16° 36' 19.7"N, 80° 11' 35.3"E		4.800	48,000
7	Kastala-III Atchampet M	16° 36' 28.9"N, 80° 12' 42.6"E 16° 36' 28.0"N, 80° 12' 45.7"E 16° 36' 14.7"N, 80° 12' 42.4"E 16° 36' 17.2"N, 80° 11' 38.8"E	46.40KM of KRF Bank	4.400	44,000
8	Kastala-IV Atchampet M	16° 36' 28.0"N, 80° 12' 45.7"E 16° 36' 26.7"N, 80° 12' 50.1"E 16° 36' 13.0"N, 80° 12' 44.8"E 16° 36' 14.7"N, 80° 11' 42.4"E		4.900	49,000
9	Kastala-V Atchampet M	16° 36' 26.7"N, 80° 12' 50.1"E 16° 36' 17.1"N, 80° 12' 54.3"E 16° 36' 13.0"N, 80° 12' 44.8"E		4.837	48,370
10	Malladi Amaravathi M	De Siltation in Balusupadu Lift Irrigation Scheme	At 37.50 KM of KRF Bank		71,172
11	Didugu Amaravathi M	16° 35' 46.3"N, 80° 17' 15.5"E 16° 35' 43.6"N, 80° 17' 14.2"E 16° 35' 39.0"N, 80° 17' 25.3"E 16° 35' 44.3"N, 80° 11' 25.4"E		4.047	40,470
12	Prathuru Tadepalli M	16° 27' 40.5"N, 80° 39' 29.8"E 16° 27' 40.8"N, 80° 39' 32.0"E 16° 27' 31.3"N, 80° 39' 37.5"E 16° 27' 33.9"N, 80° 39' 45.6"E	5.600 KM of KRF Bank	4.900	49,000
13	Gundimeda-I Tadepalli M	16° 27' 25.90"N 80° 39' 40.60"E 16° 27' 29.29"N 80° 39' 43.29"E 16° 27' 25.30"N 80° 39' 54.19"E 16° 27' 21.61"N 80° 39' 46.68"E		4.690	46,900
14	Gundimeda-II Tadepalli M	16° 27' 15.76"N 80° 39' 48.14"E 16° 27' 21.61"N 80° 39' 46.68"E 16° 27' 25.50"N 80° 39' 54.19"E 16° 27' 19.51"N 80° 39' 56.30"E	7.400 KM of KRF Bank	4.839	48,390
15	Gundimeda-III Tadepalli M	16° 27' 15.76"N 80° 39' 48.14"E 16° 27' 19.51"N 80° 39' 56.30"E 16° 27' 05.61"N 80° 39' 50.69"E		4.208	42,800
16	Vallabhapuram-I Kollipara M	16° 20' 37.3"N, 80° 43' 58.1"E 16° 20' 37.1"N, 80° 44' 00.6"E 16° 20' 24.5"N, 80° 44' 03.7"E 16° 20' 23.3"N, 80° 43' 59.5"E		4.200	42,000
17	Vallabhapuram-II Kollipara M	16° 20' 37.1"N, 80° 44' 00.6"E 16° 20' 36.7"N, 80° 44' 04.4"E 16° 20' 25.4"N, 80° 44' 07.8"E 16° 20' 24.5"N, 80° 43' 03.7"E	22.500 KM of KRF Bank	4.400	44,000
18	Vallabhapuram-III Kollipara M	16° 20' 36.7"N, 80° 44' 04.4"E 16° 20' 25.4"N, 80° 44' 07.8"E 16° 20' 26.4"N, 80° 44' 11.7"E 16° 20' 36.2"N, 80° 43' 09.0"E		4.200	42,000
19	Vallabhapuram-IV Kollipara M	16° 20' 36.2"N, 80° 44' 09.0"E 16° 20' 35.3"N, 80° 44' 15.1"E 16° 20' 27.6"N, 80° 44' 15.7"E 16° 20' 26.4"N, 80° 43' 11.7"E		4.076	40,760

20	Munnangi Kollipara M	16° 20' 09.5"N, 80° 44' 08.4"E 16° 20' 07.6"N, 80° 44' 07.1"E 16° 19' 56.1"N, 80° 44' 31.9"E 16° 19' 58.5"N, 80° 43' 32.9"E 16° 20' 00.3"N, 80° 44' 29.1"E 16° 20' 01.2"N, 80° 44' 26.4"E 16° 20' 02.5"N, 80° 44' 21.6"E 16° 20' 03.8"N, 80° 44' 19.1"E 16° 20' 05.1"N, 80° 44' 16.9"E		4.900	49,000
21	Bommuvnipalem Kollipara M	16° 17' 35.4"N 80° 46' 35.5" E 16° 17' 22.8"N 80° 46' 45.0" E 16° 17' 20.1"N 80° 46' 41.1" E 16° 17' 28.8"N 80° 46' 36.5" E 16° 17' 30.1"N 80° 46' 37.6" E 16° 17' 30.5"N 80° 46' 36.9" E 16° 17' 31.6"N 80° 46' 36.4" E 16° 17' 32.0"N 80° 46' 36.7" E 16° 17' 32.7"N 80° 46' 36.1" E 16° 17' 31.4"N 80° 46' 32.7" E 16° 17' 32.3" N 80° 46' 31.6" E	At 30.500 KM of KRF Bank	4.900	49,000
22	Gajullanka Kolluru M	16° 11` 26.4"N 80° 49` 38.4"E 16° 11` 28.6"N 80° 49` 41.4"E 16° 11` 34.2"N 80° 49` 38.9"E 16° 11` 37.8"N 80° 49` 35.7"E 16° 11` 33.3"N 80° 49` 34.2"E	At 42.850 KM of KRF bank	4.047	40,470
23	Potharlanka-I Kolluru M	16° 09' 47.1"N 80° 50' 21.0"E 16° 09' 48.0"N, 80° 50' 31.9"E 16° 09' 43.4"N, 80° 50' 31.6"E 16° 09' 42.1"N, 80° 50' 22.4"E	At 42.850 KM of KRF bank	4.500	45,000
24	Potharlanka-II Kolluru M	16° 09' 42.1"N, 80° 50' 22.4"E 16° 09' 43.4"N, 80° 50' 31.6"E 16° 09' 37.1"N, 80° 50' 31.2"E 16° 09' 36.7"N, 80° 50' 24.1"E	At 42.850 KM of KRF bank	4.400	44,000
25	Potharlanka-III Kolluru M	16° 09' 36.7"N, 80° 50' 24.1"E 16° 09' 37.1"N, 80° 50' 31.2"E 16° 09' 29.1"N, 80° 50' 30.6"E 16° 09' 26.8"N, 80° 50' 26.9"E	At 42.850 KM of KRF bank	4.657	46,570
26	Juvvalapalem-I Kolluru M	16° 08' 12.4"N, 80° 51' 18.3"E 16° 08' 11.3" N, 80° 51' 19.0"E 16° 08' 11.7"N, 80° 51' 23.2"E 16° 08' 08.4"N 80° 51' 25.9"E 16° 08' 06.3"N, 80° 51' 12.2"E 16° 08' 09.9"N, 80° 51' 11.4"E	At 51.800 KM on KRF Bank	4.930	49,300
27	Juvvalapalem-II Kolluru M	16° 08' 06.3"N, 80° 51' 12.2"E 16° 08' 08.4" N, 80° 51' 25.9"E 16° 08' 05.0"N, 80° 51' 26.6"E 16° 08' 02.1"N 80° 51' 15.1"E	At 51.800 KM on KRF Bank	4.930	49,300
28	Juvvalapalem-III Kolluru M	16° 08' 02.1"N, 80° 51' 15.1"E 16° 08' 05.0" N, 80° 51' 26.6"E 16° 07' 59.9"N, 80° 51' 27.8"E 16° 07' 58.0"N 80° 51' 17.9"E	At 51.800 KM on KRF Bank	4.930	49,300
29	Juvvalapalem-IV Kolluru M	16° 07' 58.0"N, 80° 51' 17.9"E 16° 07' 59.9"N, 80° 51' 27.8"E 16° 07' 55.4"N, 80° 51' 28.9"E 16° 07' 51.0"N 80° 51' 22.7"E	At 51.800 KM on KRF Bank	4.959	49,590

III ORDER STREAMS :

Besides the above, all the sand bearing areas in the III Order streams of Gundlakamma, Naguleru, Ogeru and Chandravanka are permitted for extraction of Sand by local public.

PROVISIONS:

- Any consumer is permitted to take Ordinary Sand from the above authorized Reaches only.
- The District Administration provided poclains for loading the Ordinary Sand in all the reaches. These permitted poclain owners / operators shall not collect more than Rs: 30/- per Cubic Meter towards loading charges from the consumer. If it is Manual loading, the labors shall not collect more than Rs: 100/- per Cubic Meter towards loading charges from the consumer.

- If the excavation & transportation of Ordinary Sand is by means of Boats. The Boatsman not collect more than Rs: 120/- per Cubic Meter towards from the consumer plus for loading the Sand from Boats to respective vehicles, the permitted poclain owners / operators shall not collect more than Rs: 30/- per Cubic Meter from the consumer.

- Ramps and Access Roads shall be maintained by the Panchayat Raj Department dovetailing NREGP funds or Department's budget.

CONDITIONS:

- No Sale of Sand is permitted.

- The excavation of Sand in these areas shall be limited to one meter thickness only.

- If the excavation of Sand reaches the permitted Quantity, the Reach will be automatically closed.

- No stocking of Sand more than the requirement of own construction is permitted.

- Sand shall not be permitted to use filling purpose or any other purpose other than the building constructions, laying of Roads.

- Transportation of sand to any other State by any entity is strictly prohibited and treats as serious offence.

- Sand Quarrying is prohibited in the District Other than above authorized reaches.

- Sand Quarrying is prohibited within 500 meters distance from bridges, culverts, ground water structures, tube wells, drinking water bore wells, Irrigation structures, State & National High Ways, Railway Lines as per APWALTA & E.C. conditions. Respective Departments should protect their structures from excavating the sand in the prohibited areas of 500 meters and maintain sign boards at the periphery of Safety Zone.

- No machinery shall be used without the permission of the District Collector, Guntur.

PENALTIES:

- In the case of the vehicles engaged in illegal / unauthorized excavation in the prohibited areas (i.e., within 500 mts from the Groundwater structures, Bridges, Dams, Railway lines and cross drainage structures etc.), transportation of sand outside the State, shall be penalized as follows:

Vehicle Type	Punishment for the offence
Tractor	Penalty of Rs.1,00,000/- and confiscation of the vehicle and Imprisonment of vehicle operator as well as owner for upto two years.
Lorry upto 10 Tons Capacity	
Lorry above 10 Tons Capacity	

- Whenever any person extracts sand or has extracted sand in the areas other than those notified for lawful excavation, the officer authorized in this behalf by the District Collector and District Magistrate shall assess such quantity of sand and levy and collect @ Rs.2,000/- per cubic metre of sand or Rs.2.00 lakhs whichever is higher, as penalty. This is in addition to the penalties described above.

- If any stocking of more than the required quantity of sand for construction purposes is found, such stocks of sand shall be seized by the officer authorized in this behalf by the District Collector and District Magistrate. Such seized sand stocks shall be allotted for any Government works. The person responsible for such illegal stocks of sand shall be punishable with imprisonment up to 2 years and a fine of Rupees Two Lakhs.

- If a person or groups or entity monopolizes sand reaches, prevents others from accessing the sand reach, such offences shall be treated as cognizable offence under section 379 of CrPC and shall be punishable with imprisonment of up to two years and fine of Rupees Two Lakhs.

- If a person or groups or entity utilizes sand for filling purpose or any purpose other than in mortar for construction, such offences shall be treated as cognizable offence under section 379 of CrPC and shall be punishable with imprisonment of up to two years and fine of Rupees Two Lakhs.

- The Collector and District Magistrate, Guntur vide Proceedings No: 1218/Sand/2016, dated: 22.03.2016 has designated the following Officers to exercise the powers mentioned above:

a. Joint Collector, Guntur - at District Level.

b. Revenue Divisional Officers - at Divisional Level.
Guntur, Tenali, N.S.Pet, Gurazala

c. All Tahasildars of Guntur District - at Mandal Level.

o/c

COLLECTOR & DISTRICT MAGISTRATE
GUNTUR

24/3/16 24/3/16 24/3/16

ANNEXURE - V

TSS has an important role in maintaining favourable flora and fauna environment for sustainable ecological balance in the river system. The report submitted by Acharya Nagarjuna University will benefit if clarifications to queries 1-9 detailed below is provided by the Investigators.

Section V a Investigators state that "Water samples were collected from nine different study sites. From each site six samples from different depths at different times were collected (Page 6).

1. *At what depth intervals, were the water samples collected at each site.*

   Water samples were collected at a single depth only of either 1.5 or 2 meters based on the depth of river bed at the collection point. At 9 stations, samples were collected twice in a month during the study period of three months i.e. 9 X 2 X 3 = 54 samples.

2. *What method was followed to collect water samples from different depths of a site*

   Water samples were collected by Grab method.

3. *What was the time interval between field sampling and determination of TSS and Turbidity of water samples in the laboratory?*

   TSS and TURBIDITY analyses were made within 24 hours from the time of sample collection.

4. *What volume of water sample was used in the Gravimetric method (TSS determination)*

   100 ml of water sample was used in the gravimetric method as per the procedure.

5. *How was it ensured that the sample condition, representative of field condition, was used in Gravimetric and Turbidity measurements in the laboratory?*

   The sample condition was ensured by determining the TSS and turbidity of samples within 24 hours.

6. *Was relevant Bureau of Indian Standards Procedures adopted in laboratory determination of TSS and Turbidity parameters?*

Yes, standard procedures of BIS 3025 (Part- 17) for TSS and 3025 (part-10) for turbidity were followed.

7. *Were replicates performed for TSS and turbidity measurements. If yes, what was the percent variation from average for each triplicate set of measurements. Give data for both TSS and turbidity*. Section Vi a The investigators state that "The estimated TSS and turbidity values of water samples collected from Undavalli area, non-desilatation sampling site, found in the ranges of 125- I 45 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 (Pages 8-9).

The values of TSS and turbidity given in our study are the mean values of triplicates. For the TSS, percent variation from the average value was found in the range of 1.8 to 3.2.
For the turbidity, percent variation is very less and between 0.15 and 0.28 as the nephlometer will be calibrated frequently during the analysis of samples.

8. *Can the variations of TSS with depth and turbidity with depth be provided for the eight desiltation sites and 1 reference site?*

Only single depth of sample collection was made at all stations.

9. Section V a The investigators state that "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 (Page 7).

During desiltation, TSS and associated turbidity may likely increase. But in our study, the TSS and turbidity values of reference site and other study sites are almost in the same range without much variation. This may be because of that there is no desiltation activity in the study sites during the entire period of study. Infact, desiltation activity was stopped in the study sites from six months prior to the commencement of our study.

10. *Turbidity can serve as a rough index of a sample's true sediment load (Carlson 2005; Amanda et al, 2018; Hannouche et al., 2011). The data for Shitalakhya river, Dhaka city, Bangladesh (Md. Serajuddin et al., 2019), Piranga river, Brazil (Amanda et al., 2018), Arkansas rivers, USA (West and Scott, 2016) indicate a positive correlation between TSS and turbidity (Figure 1). The data of Krishna river reported by the Investigators (Page 8, maximum values from Table 1 of Annex III are used in Figure 1) indicate that turbidity is independent of TSS concentration (Figure 1). Could the investigators explain their observed trend between turbidity and TSS of Krishna river water samples tested in the study (Figure 1). 6 Figure 1: Relations between TSS and turbidity of river water samples.*

In our study, direct proportional trend between TSS and turbidity was observed at each and individual study site level.

Evaluation report on "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" (Annexure – III) carried out by Acharya Nagarjuna University in the matter of O.A No. 935/2018 of Hon'ble NGT

By

Professor Sudhakar Rao

Department of Civil Engineering

Indian Institute of Science

Bengaluru 560012

April 2020

1. Introduction

The Additional Director & Divisional Head – IPC -II, Central Pollution Control Board, Delhi approached the Director, Indian Institute of Science (IISc), Bengaluru vide letter No. CPCB/IPC-II/Mining (OA-935/2018)/2020 dated January 19, 2020 requesting him to nominate a representative to the expert committee constituted in compliance of Hon'ble NGT order in OA No. 935/2018 dated 14-02-2020. The Director, Indian Institute of Science, Bengaluru vide letter No. DIR: N13/DO No. 419 dated 3rd March 2020 informed Shri Nazimuddin, Additional Director & Divisional Head – IPC -II, Central Pollution Control Board, Delhi that he has nominated (1) Professor Sudhakar Rao, and (2) Dr. K S Nanjunda Rao both from the Department of Civil Engineering, IISc, Bangalore as members of the expert committee. Both Professor Sudhakar Rao, and Dr K S Nanjunda Rao received emails on 18 March 2020 from Smt. Mahima T Gowda, Senior Environmental Engineer, Central Pollution Control Board, Regional Directorate (South), 1st & 2nd floors, Nisarga Bhawan, 7th D cross, Thimmaiah Road, Shivajinagar, Bengaluru-560079, enclosing the following files (1) Annexure – I NGT order dated 14-02-2020, (2) Annexure – II Report of water resources department including findings of bathymetric survey (3) Annexure - III Report on 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 and (4) Background Information in compliance to Hon'ble NGT order dated 14.02.2020 in the matter of O.A No. 935/2018. The sections to follow presents the evaluation of "Report on 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".

2. Summary of Report contents

An investigation was undertaken during October to December 2019 by four departments of Acharya Nagarjuna University; Dept. of Zoology & Aquaculture, Dept. of Botany & Microbiology, Dept. of Environmental Sciences and Dept. of Sociology & Social Work (hereafter referred as Investigators) to study the ecological impact on flora and fauna and socio-economic condition of dependent people due to desiltation of river Krishna (upstream of Prakasam barrage, up to 13.5 km), with the following objectives assigned by Dept. of Mines, Govt. of A.P.

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

The Undavalli site from 2.0 km to 3.2 km of KRF Bank was selected as reference site for the study by the Investigators. This was done as there was no baseline data available; hence a site with similar geological characteristics where no dredging activity has taken place was chosen as reference site by the Investigators to understand the impact of desiltation.

The following sites of river Krishna upstream of Prakasm barrage both on Guntur and Krishna districts side of desiltation locations (hereafter referred as desiltation sites) were taken into consideration for their study by the Investigators: Penumaka, Venkatapalem , Uddandarayunipalem, Lingayapalem and Rayapudi of Guntur district side and Surayapalem, Guntupally and lbrahimpatnam on Krishna District side.

Suitable methodology appropriate to the proposed studies was followed by the Investigators. Water quality parameters (total suspended solids and turbidity), Plankton and Benthic fauna survey, Riparian vegetation, Fish and Avian fauna survey was performed by the Investigators based on field and laboratory investigations.

Basing on the field and laboratory observations, the Investigators arrive at following conclusions:

I. The TSS and turbidity in reference site and desilting locations are almost in the same range, which implies that the desiltation has not impacted the water quality w.r.t TSS and turbidity, since desiltation is stopped since more than 6 months (Page 9). These findings are found to be supportive and favourable for flora and fauna towards the sustainability of ecological balance (Page 69).
II. In comparison with the Undavalli (Reference) site, the phytoplankton observed at other different desiltation sites viz., Penumaka, Venkatayapalem, Uddandarayunipalem, Lingayapalem and Rayapudi on Guntur district side, and Surayapalem, Guntupalli and lbrahimpatnam 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 (Page 46). 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 (Page 69).
III. From the qualitative analysis, it was observed that riparian vegetation in reference site and desil tation areas are similar implying that the desiltation and dredging do not have serious impact on vegetation (Page 47). The Investigators further conclude that “The riparian vegetation at all the study sites, both of 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” (Page 69).
IV. The good distribution and abundance of benthic fauna recorded in river Krishna upstream waters indicating that desiltation activity has no effect on the benthic community. The benthic community were dominated by crustaceans followed by ostrocodes at desiltation and non-desiltation sites (Page 48). Qualitatively the number of genera and species of different taxa found in desiltation area of river Krishna, upstream water showed abundant and uniform species diversity, clearly indicating that ecosystem is more or less homogenous (Page 70)
V. The abundance of Cyprinidae members (55 species) indicated that fish community in river Krishna has not been disturbed by disilatation activity (Page 50).
VI. The Investigators observed and identified 28 avian species belonging to 12 families of 11 orders. The Investigators opine that Krishna upstream having good vegetation and algae at riverbank

sides and islands seems to be most favourable feeding grounds for avian fauna (Page 52). The types and occurrence of avian fauna including the migratory category noticed at the upstream of river Krishna indicated that the habitat environment of river Krishna is favourable to the livelihood for birds in all aspects (Page 70).

VII. The socio-economic study due to disiltation in river Krishna indicated the following. Traditionally, the community was into fishing activity. During 2015, when the de- siltation work started, in addition to fishing the people native to the region have taken debt and invested in dredging machinery like boats etc. The Investigators were informed by the public that before the debts taken for dredging machinery is cleared, the desiltation activity was stopped due to which the economic condition of the people has deteriorated (Page 59).

3. Comments on the Report

TSS is good indicator of physical and aesthetic degradation of surface water quality. Large TSS concentrations lead to reduction in photosynthetic activity due to the impediment of the passage of sunlight; further, transport of pollutants such as phosphorus, mercury and hydrophobic organic compounds are associated with large TSS concentrations in water (Amanda et al, 2018; Rügner et al., 2013). Large amounts of suspended solids (SS) can affect procreation of fish and invertebrates due to obstruction on breeding habitat (Amanda et al, 2018; Naveedullah et al., 2016). In addition, TSS can shelter pathogenic microorganisms and may be associated to bacterial contamination (Bakan et al., 2010). US EPA (2015) lists river sediment as the second-most common cause of impairment in U.S. rivers and streams.

TSS has an important role in maintaining favorable flora and fauna environment for sustainable ecological balance in the river system. In the opinion of the IISc nominated member, the report submitted by Acharya Nagarjuna University will benefit if clarifications to queries 1-9 detailed below is provided by the Investigators.

Section V a

Investigators state that “Water samples were collected from nine different study sites. From each site six samples from different depths at different times were collected (Page 6).”

Query

1. At what depth intervals, were the water samples collected at each site.
2. What method was followed to collect water samples from different depths of a site.

Section V a

Investigators state that “The total suspended solids (TSS) was estimated using Gravimetric method and nephelometric (in terms of Nephelo Turbidity Unit) respectively (Pages 6-7).”

Query

3. What was the time interval between field sampling and determination of TSS and Turbidity of water samples in the laboratory?
4. What volume of water sample was used in the Gravimetric method (TSS determination)?

5. How was it ensured that the sample condition, representative of field condition, were used in Gravimetric and Turbidity measurements in the laboratory?
6. Was relevant Bureau of Indian Standards Procedures adopted in laboratory determination of TSS and Turbidity parameters?
7. Were replicates performed for TSS and turbidity measurements. If yes, what was the percent variation from average for each triplicate set of measurements. Give data for both TSS and turbidity.

Section Vi a

The investigators state that "The estimated TSS and turbidity values of water samples collected from Undavalli area, non-desilatation sampling site, found in the ranges of 125- I 45 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 (Pages 8-9)."

Query

8. Can the variations of TSS with depth and turbidity with depth be provided for the eight desiltation sites and 1 reference site?

Section V a

The investigators state that "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 (Page 7). "

Query

9. Turbidity can serve as a rough index of a sample's true sediment load (Carlson 2005; Amanda et al, 2018; Hannouche et al., 2011). The data for Shitalakhya river, Dhaka city, Bangladesh (Md. Serajuddin et al., 2019), Piranga river, Brazil (Amanda et al., 2018), Arkansas rivers, USA (West and Scott, 2016) indicate a positive correlation between TSS and turbidity (Figure 1). The data of Krishna river reported by the Investigators (Page 8, maximum values from Table 1 of Annex III are used in Figure 1) indicate that turbidity is independent of TSS concentration (Figure 1). Could the investigators explain their observed trend between turbidity and TSS of Krishna river water samples tested in the study (Figure 1).

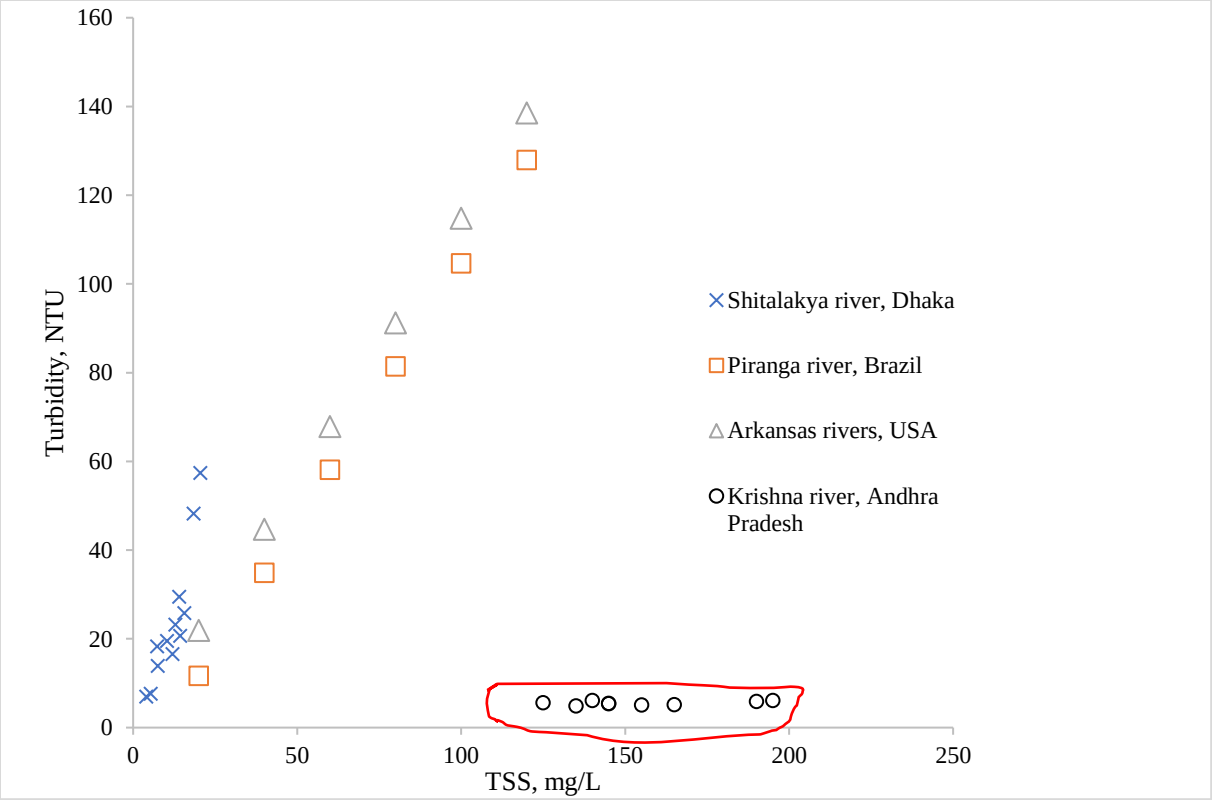


Figure 1: Relations between TSS and turbidity of river water samples: Data for Shitalakya river, Piranga river, Arkansas rivers and Krishna river from Md. Serajuddin et al., 2019, Amanda et al., 2018, West and Scott, 2016, Annex III respectively

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20th April 2020

---------End of the report --------

Clarifications given by ANU on Queries raised by IISc on Ecological Assessment study

TSS has an important role in maintaining favourable flora and fauna environment for sustainable ecological balance in the river system. The report submitted by Acharya Nagarjuna University will benefit if clarifications to queries 1-9 detailed below is provided by the Investigators.

Section V a Investigators state that "Water samples were collected from nine different study sites. From each site six samples from different depths at different times were collected (Page 6).

1. *At what depth intervals, were the water samples collected at each site.*

   Water samples were collected at a single depth only of either 1.5 or 2 meters based on the depth of river bed at the collection point. At 9 stations, samples were collected twice in a month during the study period of three months i.e. 9 X 2 X 3 = 54 samples.

2. *What method was followed to collect water samples from different depths of a site*

   Water samples were collected by Grab method.

3. *What was the time interval between field sampling and determination of TSS and Turbidity of water samples in the laboratory?*

   TSS and TURBIDITY analyses were made within 24 hours from the time of sample collection.

4. *What volume of water sample was used in the Gravimetric method (TSS determination)*

   100 ml of water sample was used in the gravimetric method as per the procedure.

5. *How was it ensured that the sample condition, representative of field condition, was used in Gravimetric and Turbidity measurements in the laboratory?*

   The sample condition was ensured by determining the TSS and turbidity of samples within 24 hours.

6. *Was relevant Bureau of Indian Standards Procedures adopted in laboratory determination of TSS and Turbidity parameters?*

Yes, standard procedures of BIS 3025 (Part- 17) for TSS and 3025 (part-10) for turbidity were followed.

7. *Were replicates performed for TSS and turbidity measurements. If yes, what was the percent variation from average for each triplicate set of measurements. Give data for both TSS and turbidity*. Section Vi a The investigators state that "The estimated TSS and turbidity values of water samples collected from Undavalli area, non-desilatation sampling site, found in the ranges of 125- I 45 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 (Pages 8-9).

The values of TSS and turbidity given in our study are the mean values of triplicates. For the TSS, percent variation from the average value was found in the range of 1.8 to 3.2.
For the turbidity, percent variation is very less and between 0.15 and 0.28 as the nephlometer will be calibrated frequently during the analysis of samples.

8. *Can the variations of TSS with depth and turbidity with depth be provided for the eight desiltation sites and 1 reference site?*

Only single depth of sample collection was made at all stations.

9. Section V a The investigators state that "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 (Page 7).

During desiltation, TSS and associated turbidity may likely increase. But in our study, the TSS and turbidity values of reference site and other study sites are almost in the same range without much variation. This may be because of that there is no desiltation activity in the study sites during the entire period of study. Infact, desiltation activity was stopped in the study sites from six months prior to the commencement of our study.

10. *Turbidity can serve as a rough index of a sample's true sediment load (Carlson 2005; Amanda et al, 2018; Hannouche et al., 2011). The data for Shitalakhya river, Dhaka city, Bangladesh (Md. Serajuddin et al., 2019), Piranga river, Brazil (Amanda et al., 2018), Arkansas rivers, USA (West and Scott, 2016) indicate a positive correlation between TSS and turbidity (Figure 1). The data of Krishna river reported by the Investigators (Page 8, maximum values from Table 1 of Annex III are used in Figure 1) indicate that turbidity is independent of TSS concentration (Figure 1). Could the investigators explain their observed trend between turbidity and TSS of Krishna river water samples tested in the study (Figure 1). 6 Figure 1: Relations between TSS and turbidity of river water samples.*

In our study, direct proportional trend between TSS and turbidity was observed at each and individual study site level.

Final Comments based on Evaluation of Annex 3 by IISc Expert member and Responses of ANU to queries raised by IISc Expert member (Also see Follow-Up Report on ANU Clarifications by IISc Expert member)

I. The Evaluation Report of IISc Expert Member, ANU Clarifications on the Evaluation Report of IISc Expert Member and Follow-Up Report on ANU Clarifications by IISc Expert member be included as Addendum A, B and C respectively in Annex 3 Report prepared by ANU

II. Section Va of the report (Annex 3) indicates that samples were collected at two depths (1.5 and 2m) at each site, while, the ANU clarification states that samples were collected at one depth only (1.5 m or 2 m) from each site.

III. Following from point ii, there is inconsistency in number of samples collected in Annex 3 Report (108 samples) and ANU Clarifications (54 samples).

IV. Volume of water used in TSS measurement is not consistent with BIS: 3025 (Part 11) – 1984, Section 4.2 Sample Volume requirement for water samples with turbidity less than 50 units.

V. Annex 3 or ANU Clarifications, does not state that the river water samples were vigorously shaken or stirred with Teflon coated magnetic stirrer, before filtration as per BIS : 3025 (Part 11) – 1984 requirement. Lack of sample homogenization affects the TSS and turbidity values.

VI. Compliance of relevant BIS codes to determine TSS and turbidity in laboratory is not stated in Section Va of the report (Annex 3).

VII. Use of triplicates along with percent variation from the average for TSS and turbidity measurements is not stated in Section Va of the report (Annex 3).