DHARAMTAR PORT PVT. LTD.
Regd. Office: JSW Centre,
Bandra Kurla Complex, Bandra (East),
Mumbai – 400 051.
Phone: 022-4286 1000
Fax: 022-4286 3000
CIN: U93030MH2012PTC236083
Website: www.jsw.in
Email Id: infra.mumbai@jsw.in

14th January, 2025

To,
The Director
Ministry of Environment, Forest & Climate Change,
Regional Office,
Ground Floor, East Wing,
New Secretariat Building, Civil Lines,
Nagpur – 440 001

Subject: **Compliance status of Environmental Clearance for Captive jetty at Dharamtar, Dolvi, Raigad, Maharashtra**

Reference: **i. Ministry of Environment & Forest (MoEF) Clearance vide no. J- 16011/6/94-IA.III dated 4th January, 1995**

ii. Ministry of Surface Transport (MoST) Clearance vide no. J-16011/6/94-IA-III/PD.IV dated 12th January, 1997

iii. Ministry of Environment, Forest & Climate Change, Government of India. Letter F.No. 11-79/2013-IA.III dated 26th November, 2015.

iv. Ministry of Environment, Forest & Climate Change, Government of India, Letter F.No. 11-79/2013-IA.III dated 10th January, 2020.

Dear Sir,

You are aware that JSW Dharamtar Port Private Limited is operating the Dharamtar jetty at Dolvi, district Raigad, Maharashtra. The environmental clearance for the same was obtained as per the reference I, II III and IV mentioned above.

We are hereby submitting the six monthly compliance report for the months June 2024 to November 2024

Yours faithfully,

For **JSW Dharamtar Port Private Limited**

(Authorized Signatory)

CC:

1. The Member Secretary, Maharashtra Pollution Control Board, Kalpataru Point, 2nd & 3rd Floor, Sion east, Mumbai 400022
2. Sub Regional Officer, Raigad II, Raigad Bhavan, CBD Belapur, Navi Mumbai
3. The Director, MoEFCC, Paryavaran Bhavan, Jor Bagh, Lodhi Colony, Delhi 110003
4. The Chairman, CPCB, Parivesh Bhavan, CBD cum office complex, east Arjun Nagar Delhi 110032

COMPLIANCE STATUS OF CAPTIVE JETTY AS PER ENVIRONMENTAL CLEARANCE UPTO NOVEMBER, 2024

Ref: Clearance for existing Captive Jetty by M/s. JSW DHARAMTAR PORT PRIVATE LIMITED (Formerly known as M/s Nippon Denro Ispat Ltd.) in Raigad District of Maharashtra.

Ref: MOEF Letter No J-16011 / 6 / 94 - IA - III dated 04-01-1995.

Clause No.	Clearance Condition As per MoEF Letter No. J-16011/6/94-1A.III dated 4th January, 1995	Compliance Status up to Nov 2024
2 - i)	The materials will be carried to and from Sponge Iron Plant by a closed conveyer belt system without causing any dust or spillage to avoid environmental damage. Transfer points must have adequate dust extraction and control systems.	The cross-country conveyer and the conveyor belt is covered from all sides to protect spillage of materials and dust in order to control the pollution. The dust suppression system is provided at the transfer points.
ii)	Dredging operations should be undertaken in consultation with an Expert Institute such as Central Water and Power Research Station (CWPRS) Pune, or any other institute, to ensure that dredging operations do not cause any adverse impact on surface and ground water and marine productivity in the vicinity.	Dredging operation was undertaken in consultation with M/s Maharashtra Maritime Board. (A Govt. of Maharashtra Undertaking). Maintenance dredging is carried out annually with permission from Maharashtra Maritime Board. Adequate mitigation measures are implemented to ensure that there is no adverse impact on surface and ground water. The marine productivity in the vicinity is not impacted.
iii)	The dredged material shall be dumped only at the dumping sites approved by Mumbai Port Trust.	The dredged material is disposed at the site designated by CWPRS. The site is designated by CWPRS through mathematical model studies conducted as a part for obtaining Environmental and CRZ Clearance for the expansion of the jetty.
iv)	During dredging, construction and maintenance stages, the water quality parameters at the bottom level should be inspected and periodic records be maintained. Tests should be carried out to measure water quality parameters viz. Turbidity, Dissolved Oxygen, Ammonical Nitrogen and other parameters which must be maintained within the prescribed standards issued under GSR 422 (E) dated 19-05-1993 as amended on 31-12-1993.	The Jetty water quality monitoring was carried out during dredging & construction activities at Jetty area. Jetty water quality monitoring is done on monthly basis and reports are submitted to MoEF&CC every six months.
v)	The project authority would install a	Jetty water quality monitoring is done

	monitoring system, so that loading / unloading operations at jetty do not cause any damage to the sea water quality and that the water quality should be maintained as per the standards prescribed by Maharashtra Pollution Control Board / Central Pollution Control Board.	on monthly basis and reports are submitted to MoEF&CC and MPCB regularly. Adequate measures are adopted to prevent any fall out into the water bodies during the loading and unloading activities. The reports reveal that the parameters are well within the standards prescribed by Maharashtra Pollution Control Board / Central Pollution Control Board.
vi)	Screening of pollutants in the harbor water should be taken up by the project authorities and periodical monitoring reports on water quality parameters must be forwarded to this Ministry at the six monthly intervals.	Adequate measures are adopted to prevent any run off into the water. Jetty water quality monitoring is done on monthly basis and reports are submitted to MoEF&CC every six months' interval.
vii)	To prevent discharge to sewage, bilge wastes and other liquid wastes into the marine environment, adequate system for collection, treatment and disposal of liquid wastes including shoreline inter sector for receiving liquid wastes from all shore line installations and special hose connection for ships to allow for discharge of sewage must be provided.	No discharge of sewage, bilge wastes and other liquid wastes is done at Jetty area.
viii)	The quality of treated effluent, solid waste, emission and noise level must confirm to the standards laid down by competent authorities including Central / State Pollution Control Boards and under the Environment Protection Act, 1986 whichever are most stringent.	JSW DPPL is engaged in cargo handling at the jetty. No manufacturing is carried out at the jetty, thus no effluents are generated. The sewage is treated in septic tanks and then sent to STP near the jetty area. Solid waste is segregated and disposed as per the norms. The noise level in the Jetty area is maintained as per standards. Wind shields are installed at strategic locations to minimize the impact of the emissions from the cargo handling activities. Trees with thick foliage are maintained along the boundary. Ambient Air Quality monitoring is done on regular basis at Jetty. The reports

		are well within stipulated norms and reports are submitted to MoEF&CC every six months.
ix)	Appropriate devices such as oil water separator, oil monitor, oil skimmer etc. must be provided to remove all floatable material including oil spills while refueling of vessels, because of operations of cargo handling equipments and allied machinery, cranes, tractors etc., to tackle the oil pollution in the port area and marine environment.	Adequate preventive measures are adopted to avoid any oil spill due to jetty operations. An Oil Spill Contingency plan for the Jetty is in place. The jetty is well equipped with requisite equipment to curtail any incidences of oil spill.
x)	Proper fire fighting arrangement must be ensured by providing adequate number of fire hydrants in fire prone areas. The entire fire fighting line must be maintained under pressure through jockey pump and appropriate volume of dead storage water must be ensured for this purpose. The employees must be kept alert and trained to combat fire by conducting regular fire drills to keep this facility in working conditions.	Adequate fire fighting arrangement has been provided at Jetty. Fire hydrant lines are provided at the jetty. Proper training is imparted to the concerned personnel and mock drills are conducted at regular intervals.
xi)	The jetty will not be used for transporting Hazardous Material.	No hazardous material is handled at Jetty.
3	The project authorities must create sufficient in-house capability (Environmental Cell) and full-fledged laboratory to monitor and implement compliance to the prescribed safeguards and programmes related to pollution control and environmental conservation.	An Environment Cell comprising qualified personnel in the fields supervise the environmental aspects of the Jetty.
4	Adequate financial provisions must be made for implementation of the above stipulations.	Adequate financial provisions are ear marked in the annual budget for environmental compliances.
5	In case of any deviation / alterations in the project proposal from those submitted to this Ministry for clearance, these stipulations may be modified and / or new ones imposed or the environmental clearance revoked for ensuring environmental protection.	There is no deviation / alteration in the project proposal as submitted for clearance. JSW Dharamtar Port Private Limited has undertaken the expansion of the jetty. The Environmental and CRZ Clearance for the is accorded by the Ministry of Environment, Forest & Climate Change vide letter dated 26th November, 2015. The consent to establish for the expansion project has also been granted by the Maharashtra Pollution Control Board. The permission for construction of in plant conveyor belt was granted vide MoEFCC letter dated 10th January, 2020

6	These stipulations will be enforced among others under the Water (Prevention & Control of Pollution) Act, 1974, The Air (Prevention & Control of Pollution) Act, 1981 and the Environmental (Protection) Act, 1986.	We Regularly comply with the following Environmental Acts: i) Water (Prevention and Control of Pollution) Act, 1974. ii) Air (Prevention and Control of Pollution) Act, 1981. iii) Environmental (Protection) Act 1986. iv) Other general conditions laid down by Maharashtra Pollution Control Board.

COMPLIANCE STATUS OF CAPTIVE JETTY AS PER ENVIRONMENTAL CLEARANCE UPTO NOVEMBER, 2024

Ref: Clearance for Expansion of Captive Jetty by M/s. JSW Dharamtar Port Private Limited (Formerly known as M/s Nippon Denro Ispat Ltd.) in Raigad District of Maharashtra.

Ref: Ministry of Surface Transport Letter No J-16011 / 6 / 94 - IA - III /PD IV, New Delhi dated 12th January 1997.

Clause No.	Clearance Condition as per MoST Letter No J-16011 / 6 / 94 - IA - III /PD IV, New Delhi dated 12th January 1997.	Compliance Status up to Nov 2024
2 - i)	The materials will be carried to and from Sponge Iron Plant by a closed conveyer belt system without causing any dust or spillage to avoid environmental damage. Transfer points must have adequate dust extraction and control systems.	The cross-country conveyer and the conveyor belt is covered from all sides to protect spillage of materials and dust in order to control the pollution. The dust suppression system is provided at the transfer points.
ii)	Dredging operations should be undertaken in consultation with an Expert Institute such as Central Water and Power Research Station (CWPRS) Pune, or any other institute, to ensure that dredging operations do not cause any adverse impact on surface and ground water and marine productivity in the vicinity.	Dredging operation was undertaken in consultation with M/s Maharashtra Maritime Board. (A Govt. of Maharashtra Undertaking). Adequate mitigation measures are implemented to ensure that there is no adverse impact on surface and ground water. The marine productivity in the vicinity is not impacted.
iii)	The dredged material shall be dumped only at the dumping sites approved by Mumbai Port Trust.	The dredged material is disposed at the site designated by CWPRS. The site is designated by CWPRS through mathematical model studies conducted as a part for obtaining Environmental and CRZ Clearance for the expansion of the jetty.
iv)	During dredging, construction and maintenance stages, the water quality parameters at the bottom level should be inspected and periodic records be maintained. Tests should be carried out to measure water quality parameters viz. Turbidity, Dissolved Oxygen, Ammonical Nitrogen and other parameters which must be maintained within the prescribed standards issued under GSR 422 (E) dated 19-05-1993 as amended on 31-12-1993.	The Jetty water quality monitoring has been carried out during dredging & construction activities at Jetty area. Jetty water quality monitoring is done on monthly basis and reports are submitted to MoEF&CC every six months.
v)	The project authority would install a monitoring system, so that loading /	Jetty water quality monitoring is done on monthly basis and reports are submitted

	unloading operations at jetty do not cause any damage to the sea water quality and that the water quality should be maintained as per the standards prescribed by Maharashtra Pollution Control Board / Central Pollution Control Board.	to MoEF&CC regularly. Adequate measures are adopted to prevent any fall out into the water bodies during the loading and unloading activities. The reports reveal that the parameters are well within the standards prescribed by Maharashtra Pollution Control Board / Central Pollution Control Board.
vi)	Screening of pollutants in the harbor water should be taken up by the project authorities and periodical monitoring reports on water quality parameters must be forwarded to this Ministry at the six monthly intervals.	No pollutants are being discharged in the waters. Jetty water quality monitoring is done on monthly basis and reports are submitted to MoEF&CC every six month's interval.
vii)	To prevent discharge to sewage, bilge wastes and other liquid wastes into the marine environment, adequate system for collection, treatment and disposal of liquid wastes including shoreline inter sector for receiving liquid wastes from all shore line installations and special hose connection for ships to allow for discharge of sewage must be provided.	No discharge of sewage, bilge wastes and other liquid wastes are done at Jetty area. Sewage is treated in the STP
viii)	The quality of treated effluent, solid waste, emission and noise level must confirm to the standards laid down by competent authorities including Central / State Pollution Control Boards and under the Environment Protection Act, 1986 whichever are most stringent.	No effluents are generated at the jetty. The sewage is treated in septic tanks and then sent to STP for further processing. Solid waste is segregated and disposed as per the norms. The noise level in the Jetty area is maintained as per standards. Wind shield are installed at strategic locations to minimize the impact of the emissions from the cargo handling activities. Ambient Air Quality monitoring is done on regular basis at Jetty. The reports are well within stipulated norms and reports are submitted to MoEF&CC every six months.
ix)	Appropriate devices such as oil water separator, oil monitor, oil skimmer etc. must be provided to remove all floatable material including oil spills while refueling of vessels, because of operations of cargo handling equipments and allied machinery, cranes, tractors etc., to tackle the oil pollution in the	Adequate preventive measures are adopted to avoid any oil spill due to jetty operations. An Oil Spill Contingency plan for the Jetty is in place. The jetty is well equipped with requisite equipment to curtail any

	port area and marine environment.	incidences of oil spill.
x)	Proper fire fighting arrangement must be ensured by providing adequate number of fire hydrants in fire prone areas. The entire fire fighting line must be maintained under pressure through jockey pump and appropriate volume of dead storage water must be ensured for this purpose. The employees must be kept alert and trained to combat fire by conducting regular fire drills to keep this facility in working conditions.	Adequate fire-fighting arrangement has been provided at Jetty. Fire hydrant lines are provided at the jetty. Proper training is imparted to the concerned personnel and mock drills are conducted at regular intervals.
xi)	The jetty will not be used for transporting Hazardous Material.	No hazardous material is handled at Jetty.
xii)	The approval is subject to classification of the Dharamtar as CRZ –III on final approval of CZMP of the Maharashtra Govt. If the area is classified as CRZ- I (i) under CZMP the sanction would stand cancelled.	According to the CZMP as obtained from the Town Planning department, the jetty facilities fall in the CRZ I (a permissible activity) and the backshore facilities at Dharamtar fall in the CRZ III.
xiii)	The proponent would ensure that conveyor system and other facilities as provided are in consonant with the activities deemed to be permissible under the law and regulations.	The conveyor system passes through CRZ III and is a permissible activity as per the CRZ Notification.
xiv)	Third party inspection should be ensured during construction and operational phases with adequate Insurance cover. The port authorities should confirm on regular intervals of six months to the Ministry about implementation of the suggested safeguard measures and the data / report should be open for inspection by the team which would be constituted by the Ministry if found necessary.	Sampling and analysis of creek water has been carried out and submitted regularly to the Regional Office of MoEF&CC, Bhopal at six monthly intervals.
xv)	Full support should be extended to the officials of the Regional Office, of the Ministry of Environment and Forests at Bhopal during inspection of the project for monitoring purpose by the project proponents by furnishing full details and action plans including action taken report on mitigative measures.	Will be complied.
3	The project authorities must create sufficient in-house capability (Environmental Cell) and full-fledged laboratory to monitor and implement compliance to the prescribed safeguards and programmes related to pollution control and environmental conservation.	Environment Cell is headed by Head Environment and is manned with qualified people who are looking after the environmental aspects and Jetty. An Environmental laboratory is shared with JSW Steel. Environmental monitoring is carried out through MoEF&CC or NABET accredited laboratories.

4	Adequate financial provisions must be made for implementation of the above stipulations.	Adequate financial provisions are ear marked in the annual budget.
5	In case of any deviation / alterations in the project proposal from those submitted to this Ministry for clearance, these stipulations may be modified and / or new ones imposed or the environmental clearance revoked for ensuring environmental protection.	There is no deviation / alteration in the project proposal as submitted for clearance. JSW Dharamtar Port Private Limited has undertaken expansion of the jetty. The Environmental and CRZ Clearance for the is accorded by the Ministry of Environment, Forest & Climate Change vide letter dated 26th November, 2015. The consent to establish for the expansion project has also been granted by the Maharashtra Pollution Control Board. The EC dated 26th November, 2015 is amended vide MoEFCC letter dated 10th January 2020 granting permission for laying in plant conveyor belt.
6	These stipulations will be enforced among others under the Water (Prevention & Control of Pollution) Act, 1974, The Air (Prevention & Control of Pollution) Act, 1981 and the Environmental (Protection) Act, 1986.	We are regularly complying with the following Environmental Acts: i) Water (Prevention and Control of Pollution) Act, 1974. ii) Air (Prevention and Control of Pollution) Act, 1981. iii) Environmental (Protection) Act 1986. iv) Other general conditions laid down by Maharashtra Pollution Control Board.

COMPLIANCE STATUS OF CAPTIVE JETTY AS PER ENVIRONMENTAL CLEARANCE UPTO NOVEMBER, 2024

Ref: Clearance for Expansion of Dharamtar Jetty facility in Village Dolvi of district Raigad (Maharashtra) by M/s. JSW Dharamtar Port Private Limited – Environmental and CRZ Clearance – Reg

Ref: Ministry of Environment, Forest & Climate Change, Government of India. Letter F.No. 11-79/2013-IA.III dated 26th November, 2015.

Clause No.	Clearance Condition as per MoEF&CC Letter F.No. 11-79/2013-IA.III dated 26th November, 2015.	Compliance Status up to Nov, 2024
4 A.	**SPECIFIC CONDITIONS**	
i.	'Consent to Establish' shall be obtained from Pollution Control Board under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974.	Maharashtra Pollution Control Board has accorded 'Consent to Establish' for the Expansion of the jetty from 331.5m to 1750m under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974 vide their consent order no. Format 1.0/BO/CAC-cell/EICno.RD-2792-14/E(amendment)/ CAC-10000 dated 30th October, 2014. The expansion work is still under process. Thereby, the Consent to Establish was revalidated through MPCB vide Consent no: Format1.0/BO/CAC-Cell/UAN No. 23048/CAC-1905000980 dated 16th May, 2019. The CTE is revalidated by MPCB vide their letter dated 25th Nov, 2022.
ii.	No mangroves shall be cut during project implementation and utmost care shall be taken to conserve them. Also, in view of the likely impact of the proposed construction methodology, National Centre for Sustainable Coastal Management (NCSCM) may carry out a study for suggesting measures for mangrove protection.	The project does not envisage any mangrove cutting. Mangrove exist along the shore along the jetty area. NCSCM has submitted the report. Report annexed along as **Annexure I**
iii.	There shall be no disposal of dredged material into the sea, but to be reused for reclamation and for shore enrichment based on its characteristics, as committed.	The condition of the EC has been amended vide MoEF&CC letter dated FNo.11-79/2013-IA.III dated 26th March, 2016. The letter is annexed along as **Annexure II**.

		The amendment pertains to reuse of dredged material for reclamation and shore enrichment. According granular and rocky materials shall be used for landfilling and grading. The remaining material shall be disposed at the grounds designated by CWPRS and accepted by EAC, MoEF&CC.
iv.	Total water requirement of 800KLD after the proposed expansion, shall be met from the existing source of K.T. Bandhara, MIDC. There shall not be any abstraction from any other surface water body or ground water to avoid depletion of the existing local water resources. The wastewater from washing and other construction activities shall be treated to meet the prescribed norms and shall be reused. There shall be no discharge of untreated effluents into the marine environment.	The water requirement shall be met through existing source of K.T. Bandhara, MIDC. The project does not envisage any abstraction from surface water body or ground water. The local water resources will not be altered. The waste water is treated in the soak pit and the treated water is used for sprinkling and gardening. No effluents are generated at the jetty area and no waste water is discharged into the marine environment.
v.	Adequate scour protection shall be applied to prevent damage due to scouring and bathymetric survey will be carried out to ensure that any accretion creates no risk to navigation/sediment transport of the jetty.	Shall be complied Bathymetric survey for the region is carried out. Mathematical model studies for the rate of accretion is done by Central Water and Power Research Station, Pune. The bottom is rocky and hence scour protection is not necessary.
vi.	The PP shall undertake the environmental monitoring programme, as committed in the EIA study. This shall also include continuous measurements of underwater vibration and noise levels by installing appropriate measuring instruments immediately at Piles and thereafter at a distance of 2 km from that Piles.	The environmental monitoring programme is being implemented. The survey for carrying out Underwater vibration and noise level is undertaken. The report is annexed along as **Annexure III**.
vii.	As committed under the EIA study, necessary arrangements for the treatment of effluents and solid wastes shall be made and it shall be ensured that the untreated effluents and solid wastes are not discharged into the water/CRZ area.	Adequate mitigation measures as mentioned in the EIA study is being taken. The project is cargo handling at the jetty facilities in which no effluents are generated. The solid waste generated at the premises is segregated and disposed as per the norms/ guidelines of the CPCB. No solid waste is discharged into the water/CRZ area.

viii.	Ships/ barges shall not be allowed to release any oily bilge waste or ballast water in the sea. Any effluents from the jetty which have leachable characteristics shall be segregated and recycled/disposed as per MPCB guidelines.	Only barges and mini bulker carriers of 6000 to 8000 DWT enter to the jetty area. Release of oily bilge waste or ballast water from these barges is not be permitted. Only cargo handling is carried out at the jetty. The process does not involve any manufacturing process that generate effluents. Thus, no effluents are generated at the jetty.
ix.	Location of DG sets and other emission generating equipment shall be decided keeping in view the predominant wind direction so that emissions do not effect nearby residential areas. Installation and operation of DG sets shall comply with the guidelines of CPCB.	Shall be complied. The port has a continuous power supply. DG is used only in case of emergency for office lights only. The DG set is placed in acoustic enclosure.
x.	All the mechanized handling systems and other associated equipments such as hoppers, belt conveyors, stacker cum reclaimers shall have integrated dust suppression systems. Dust suppression systems shall be provided at all transfer points.	Shall be complied. All the mechanized handling systems and other associated equipments such as hoppers, belt conveyors, stacker cum reclaimers installed at the jetty as a part of jetty expansion have integrated dust suppression systems. Dust suppression systems are also provided at all transfer points. Other measures for dust suppression are also implemented.
xi.	A windshield of appropriate height shall be provided around the coal/other bulk stack yard for control of wind generated dust.	Windshields of appropriate height is provided around the coal/other bulk stack yard. Bulk cargo like coal and iron ore is stored in covered sheds.
xii.	All the conditions stipulated by the MCZMA vide their letter no. CRZ-2014/CR-41/TC-4 dated 24.02.2015, shall be strictly complied with.	Is being complied.
xiii.	No product other than permitted under the CRZ Notification, 2011 shall be stored in CRZ area.	Is adhered. No products except the ones permitted are stored in CRZ area.
xiv.	The project affected people, if any, due to the land acquisition shall be rehabilitated or compensated as per the norms laid down by the concerned agency of State/Central Government.	No R & R involved. Land will be purchased from private owners as per the prevailing rate.

xv.	The quality of treated effluents, solid wastes, emissions and noise levels and the like, from the project area must conform to the standards laid down by the competent authorities including the Central or State Pollution Control Board and under the Environment (Protection) Act, 1986.	Ambient air quality and noise level are within the permissible limits. The monitoring is carried out by MoEFCC recognized laboratory
xvi.	All the mitigation measures suggested in the EIA report and the marine environment study of CWPRS, Pune shall be implemented. The compliance for each of those measures shall be submitted to concerned SPCB and R.O. of this Ministry along with six monthly compliance reports.	Shall be adhered. The compliance report is regularly submitted to MPCB and RO, Nagpur along with the six monthly compliance reports.
xvii.	There shall be no drawal of ground water in CRZ area.	No ground water is drawn from the CRZ area. The water requirement at the jetty is met from the supply by KT Bandhara.
xviii.	Periodical study on shoreline changes shall be conducted and mitigation carried out, if necessary. The details shall be submitted along with the six monthly monitoring report.	No shoreline changes are envisaged. The study for shoreline changes have been carried out through National Coastal for Sustainable Coastal Management. The report submitted in August 2022 is attached as **Annexure IV**
xix.	It shall be ensured by the Project Proponent that the activities do not cause any disturbance to the fishing activity, movements of fishing boats and destruction of mangroves during construction and operation phase.	The barges navigate only through the demarcated channel. Fishing activities will not be affected. The project development does not envisage any mangrove cutting.
xx.	All the recommendation of the EMP including dust control at storage and handling of cargos shall be complied with letter and spirit. The Project Proponent may be asked to submit all the EMPs mentioned in the EIA report and during the subsequent presentations made before the EAC shall be submitted in a tabular format with budgetary provisions and the same shall be submitted to Ministry and with a copy to R.O., MoEF&CC within two months.	The recommendation of the Environmental Management Plan suggested in the EIA is implemented. The dust control measures are installed at all the strategic points to control emissions. Environment Management Plan (EMP) • EMP includes regular monitoring of the air, noise and creek water quality. • Covered shed for storage to minimize fugitive emissions • Covered conveying system • Dust suppression measures adopted at all transfer points • Sewage treated in STP at the site

<table>
<tr><td>xxi.</td><td>The project Proponent shall take up and earmark adequate fund for socio-economic development and welfare measures as proposed under the CSR Programme. This shall be taken up on priority.</td><td>The funds are earmarked. JSW Dharamtar Port is actively involved in CSR activities like supplying water tankers to the villages, holding cultural activities in the vicinity, sports development, women empowerment etc.

The CSR proposed during the year 2024-25 is as below:

<table><tr><th>sr</th><th></th><th>Expenditure (in lakhs)</th></tr><tr><td>1</td><td>Community Development</td><td>5.0</td></tr><tr><td>2</td><td>Rural Infrastructure</td><td>50.0</td></tr><tr><td></td><td>Total</td><td>55.0</td></tr></table></td></tr>
<tr><td>xxii.</td><td>The Project Proponent shall set up separate environmental management cell for effective implementation of the stipulated environmental safeguards under the supervision of a Senior Executive.</td><td>An Environment Cell comprising qualified personnel is formed at the site for monitoring the stipulated environmental safeguards.</td></tr>
<tr><td>xxiii.</td><td>The funds earmarked for environment management plan shall be included in the budget and this shall not be diverted for any other purposes.</td><td>Funds for environment management plan is included in the annual budget.

The annual budget of 62.88 lakh was earmarked for the year 2024-25.
The details of expense are as below:<table><tr><th>sr</th><th></th><th>Expenditure (in lakhs)</th></tr><tr><td>1</td><td>Environment monitoring</td><td>12.10</td></tr><tr><td>2</td><td>Sweeping machine operation</td><td>19.00</td></tr><tr><td>3</td><td>O&M of STP</td><td>13.86</td></tr><tr><td>4</td><td>Water tanker</td><td>07.92</td></tr><tr><td>5</td><td>Others</td><td>10.00</td></tr><tr><td></td><td>Total</td><td>62.88</td></tr></table></td></tr>
<tr><td>xxiv.</td><td>The responses/commitments made to the issues raised during public hearing shall be complied with in letter and spirit. A hard copy of the action taken shall be submitted to the Ministry.</td><td>Shall be complied as committed.
JSW proactively provides water tankers to the nearby villages. Also other activities like aids in educational facilities, aid in acquiring technical qualification to the youth, women empowerment is implemented.</td></tr>
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xxv.	The proponent shall abide by all the commitments and recommendations made in the EIA/EMP report so also during their presentations	Shall be complied
xxvi.	The PP shall engage NCSCM, Chennai to carry out the monitoring at their own cost to ensure proper implementation of the construction methodology and construction of the Jetty without disturbing the existing mangroves, natural resources and other environmental safeguards.	NCSCM is carrying out the study for proper implementation of the construction methodology. No mangroves are disturbed/ cut for project development.
xxvii.	Corporate Social Responsibility; a. The Company shall have a well laid down Environment Policy approved by the Board of Directors. b. The Environment Policy shall prescribe for standard operating process/ procedures to bring into focus any infringements/ deviation/ violation of the environmental or forest norms/conditions. c. The hierarchical system or Administrative Order of the company to deal with environmental issues and for ensuring compliance with the environmental clearance conditions shall be furnished. d. To have proper checks and balances, the company shall have a well laid down system of reporting of non-compliances/violations of environmental norms to the Board of Directors of the company and/or shareholders or stakeholders at large.	The Safety, Health and Environment Policy is in place. Considering the proposed expansion, the policy shall be updated. The copy of the Environment Policy is enclosed along as **Annexure V**
4 B	**GENERAL CONDITIONS**	
i.	Appropriate measures must be taken while undertaking digging activities to avoid any likely degradation of water quality	The dredging is carried out with permission from Maharashtra Maritime Board. We have deployed grab type dredgers. The dredged material was disposed at the sites designated by CWPRS through model studies. No spoil is allowed to slip in the water. Water quality is monitored regularly its chemical properties.
ii.	Full support shall be extended to the officers of this Ministry/Regional Office at Nagpur by the project proponent during inspection of the project for monitoring purposes by furnishing full details and action plan including action	Noted and shall be adhered to during the visit of the official during the site inspection.

	taken reports in respect of mitigation measures and other environmental protection activities.	
iii.	A six monthly monitoring report shall need to be submitted by the project proponents to the Regional Office of this Ministry at Nagpur regarding the implementation of the stipulated conditions.	Is being complied regularly. The last report from Dec 2024 to May 2024 was submitted to MoEF&CC, Regional Office Nagpur
iv.	Ministry of Environment, Forest and Climate Change or any other competent authority may stipulate any additional conditions or modify the existing ones, if necessary in the interest of environment and the same shall be complied with.	Noted
v.	The Ministry reserves the right to revoke this clearance if any of the conditions stipulated are not complied with satisfaction of the Ministry.	Noted
vi.	In the event of a change in project profile or change in the implementation agency, a fresh reference shall be made to the Ministry of Environment, Forest and Climate Change	Noted and shall be complied to.
vii.	The project proponents shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the date of start of land development work	The project is expansion of the existing jetty.
viii.	A copy of the clearance letter shall be marked to concerned Panchayat/local NGO, if any, from whom any suggestion/representation has been made received while processing the proposal.	Noted
ix.	A copy of the environmental clearance letter shall also be displayed on the website of the concerned State Pollution Control Board. The EC letter shall also be displayed at the Regional office/ Tehsildar's office for 30 days.	Not in JSW scope. A copy of the environmental clearance was submitted to Maharashtra Pollution Control Board.
5	These stipulations would be enforced among others under the provisions of Water (Prevention and Control of Pollution) Act 1974, the Air (Prevention and Control of Pollution) Act 1981, the Environment (Protection) Act, 1986, the Public Liability (Insurance) Act, 1991 and EIA Notification 1994, including the amendments and rules made thereafter.	Consent from the MPCB is obtained time to time under the Water (Prevention and Control of Pollution) Act 1974 and the Air (Prevention and Control of Pollution) Act 1981. The latest Consent to Operate is accorded by MPCB vide letter no. Format1.0/BO/CAC-CELL/UAN no.75788/CAC-2002001100 dated 25th February, 2020.

		The insurance under the Public Liability (Insurance) Act 1991 is renewed timely. The latest PLI is valid up to 30th June 2025.
6	All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Civil Aviation Department, Forest Conservation Act, 1980 and Wildlife (Protection) Act, 1972 etc. shall be obtained, as applicable by project proponents from the respective competent authorities.	The jetty does not handle any Petroleum products.
7	The project proponent shall advertise in at least two local Newspapers widely circulated in the region, one of which shall be in the vernacular language informing that the project has been accorded Environmental and CRZ Clearance and copies of clearance letters are available with the State Pollution Control Board and may also be seen on the website of the Ministry of Environment, Forest and Climate Change at http://www.envfor.nic.in. The advertisement should be made within Seven days from the date of receipt of the Clearance letter and a copy of the same should be forwarded to the Regional office of this Ministry at Nagpur.	Advertisement were published in Krushival (Marathi newspaper) and Raigad Times (English newspaper)
8	This Clearance is subject to final order of the Hon'ble Supreme Court of India in the matter of Goa Foundation Vs Union of India in Writ Petition (Civil)No.460 of 2004 as may be applicable to this project.	Noted
9	Status of compliance to the various stipulated environmental conditions and environmental safeguards will be uploaded by the project proponent in its website.	The copy of compliance report is uploaded on the DPPL website
10	Any Appeal against this clearance shall lie with National Green Tribunal, if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.	An appeal no. 30 of 2016 was filed against the EC and CRZ Clearance. Hon'ble NGT (Western Bench) Pune disposed the appeal vide order dated 23rd May, 2017 as the appeal was barred by limitation.
11	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zilla Parisad/Municipal Corporation, Urban Local Body and the Local NGO, if any, from whom suggestions/representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the company by the proponent.	The copy of the EC is uploaded on the DPPL website,
12	The proponent shall upload the status of compliance of the stipulated EC conditions,	The compliance status is uploaded on the DPPL website.

	including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MoEFCC, the respective Zonal Office of CPCB and the SPCB.	The compliance reports are submitted regularly.
13	The environmental statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the company along with the status of compliance of EC conditions and shall also be sent to the respective Regional Offices of MoEFCC bye-mail.	Form V is submitted to MPCB regularly. The copy of the Form V is uploaded on the DPPL website.

4 COMPLIANCE STATUS OF CAPTIVE JETTY AS PER ENVIRONMENTAL CLEARANCE UPTO NOVEMBER, 2024

Ref: Clearance for Expansion of Dharamtar Jetty facility in Village Dolvi of district Raigad (Maharashtra) by M/s. JSW Dharamtar Port Private Limited – Amendment in Environmental and CRZ Clearance – Reg

Ref: Ministry of Environment, Forest & Climate Change, Government of India. Letter F.No. 11-79/2013-IA.III dated 10th January, 2020.

A. SPECIFIC CONDITIONS

<table>
<tr><th>Clause No.</th><th>Clearance Condition as per MoEF&CC Letter F. No. 11-79/2013-IA.III dated 10th January 2020</th><th>Compliance Status up to Nov 2024</th></tr>
<tr><td>i.</td><td>All the recommendations and conditions specified by the Maharashtra Coastal Zone Management Authority (MCZMA) vide letter no. CRZ 2018/CR-293/TC-4 dated 16.02.2019 shall be complied with.</td><td>All the Conditions of the MCZMA are complied with and followed.</td></tr>
<tr><td>ii.</td><td>The company shall draw up and implement corporate social Responsibility plan as per the Company's Act of 2013. As per the Ministry's Office Memorandum F No. 2265/2017IA.III dated 01.05.2018 and proposed by the project proponent, an amount of Rs 3.0 crore @ 0.75% of Amended cost) shall be earmarked under Corporate Environment Responsibility (CER) for the activities such as health, water, infrastructure, skill development, agriculture and scientific support and plantation. The activities proposed under CER shall be restricted to the affected area around the project. The entire activities proposed under the CER shall be treated as project and shall be monitored.</td><td>CSR activity is carried out as committed.

<table><tr><td>CER component</td><td>Amount Rs Lacs</td></tr><tr><td>Health & Nutrition's – Support to Nursing College</td><td>30.20</td></tr><tr><td>Education-School infra</td><td>41.63</td></tr><tr><td>Environment</td><td>4.13</td></tr><tr><td>Rural Development</td><td>95.40</td></tr><tr><td>Admin cost</td><td>0.25</td></tr><tr><td>Total</td><td>171</td></tr></table>
About 171 lakhs have been spent on Health & Nutrition's, Education, Plantation & Rural development during the last 2 years.</td></tr>
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Report on

Monitoring - Expansion of Dharamtar Jetty facility at Dolvi, Raigad, Maharashtra

National Centre for Sustainable Coastal Management
Ministry of Environment, Forest & Climate Change

August 2018

Contents

1. Background

The JSW Steel Limited, Dolvi Works, Maharashtra, JSWSL produces about 3.3 MTPA of steel and generates 55 MW of power, involving about 9.69 MTPA of raw materials. The raw material is received at the existing 331.5 m jetty, owned and operated by JSW Dharamtar Port Private Limited (JSWDPPL). This jetty is located on the right bank of Amba River, 22km from its mouth (Fig 1.1). The jetty is located equidistant about 33 km nautical miles from Jawaharlal Nehru Port and Mumbai Port. Another port in vicinity is PNP port located opposite to the JSW port on the left bank of Amba River. The jetty is accessible by road and is 80 km from Mumbai. It is well connected to national highway NH-17 that joins the coastal highway.

A simple logistic chain is followed at the JSW Dharamtar facility. During fair weather conditions, mother vessels are moored at the Mumbai Offshore anchorage whereas during monsoon, the inner anchorage is used. The load from the mother ships is transferred into the barges using ship's gears. The barges travel to the JSW berth through the creek where it gets unloaded. The unloaded materials are sent to the plant storage through the jetty and the cross country conveyors. Currently, there is no storage at the berth. JSWSL has proposed to increase the plant capacity to 10 MTPA which will trigger expansion of the captive port to handle the increased raw material requirements. The volume of total cargo is expected to increase from present 9.69 MTPA to 33.95 MTPA.

The existing barge handling facility at Dharamtar was originally designed for barge sizes of 2500 DWT and presently is handling barges up to 3700 DWT. Hence, JSWDPPL has planned to increase the existing 331.5 m long berth to 1750 m in three developmental phases (Fig 1.2).

Existing Operations (Phase – I): The present jetty is about 331.5 m long and is designated as berth 1 to 4 (Fig 1.2). The raw material at present is handled using 2 barge unloaders on rail and two static Mobile Harbour Cranes. Present handling capacity is 8.24 MTPA of raw materials annually.

Phase -II (On-going Expansions): In phase II, which is the on-going expansion phase (Fig 1.2-), a new berth of 718.5 m long is being constructed, taking the total length of the berth to 1050 m. The phase II operation is expected to increase the imported raw material volume from present 8.24 MTPA to 14.2 MTPA and finished product to be exported from 1.45 MTPA to 2.6 MTPA. Accordingly, about 53 ha back up storage area would be required for the same in this phase.

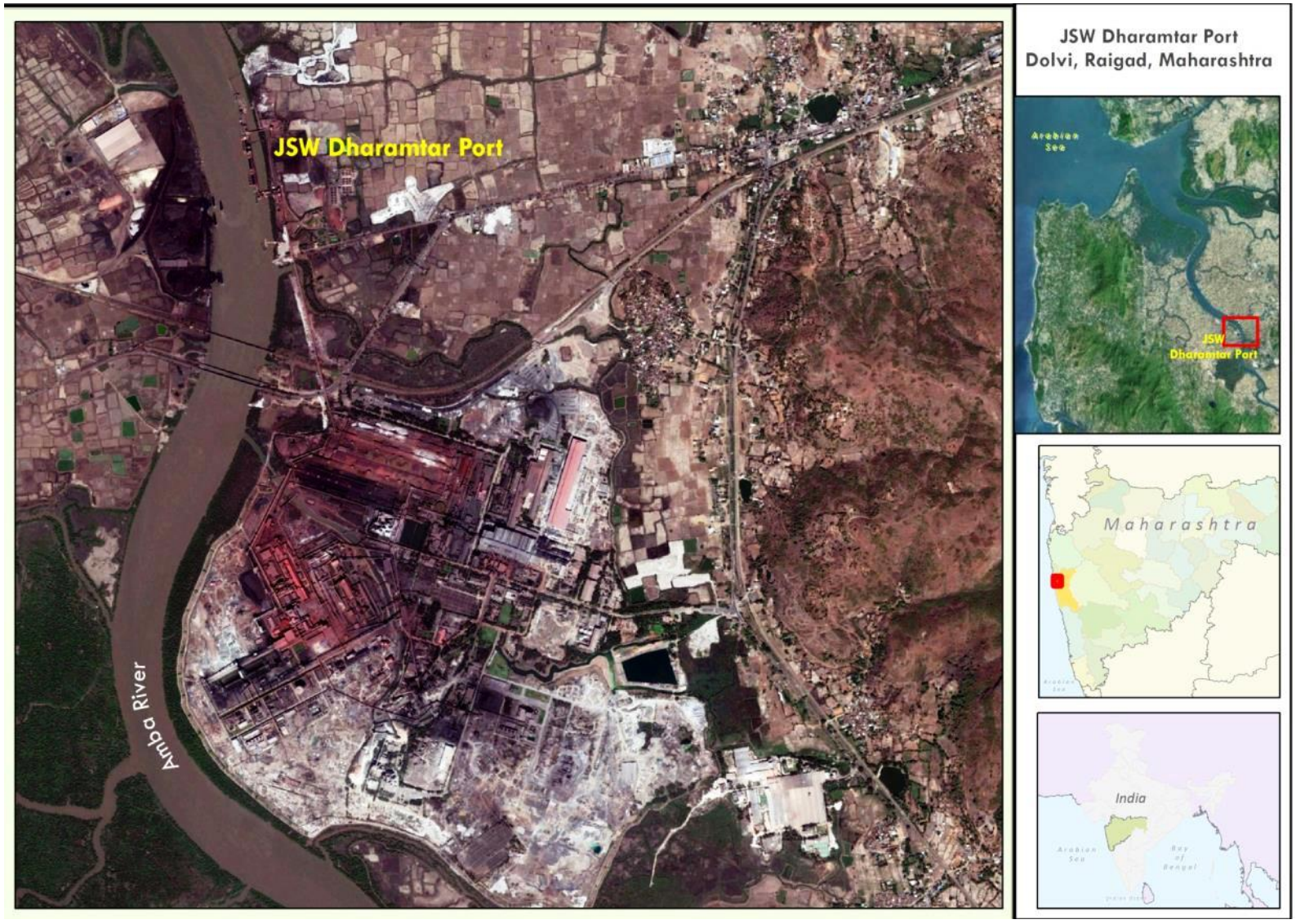


Fig 1.1: Location map of JSW Dharamtar Port

Phase – III Operations

In this phase, it is expected that approximately 33.95 MTPA of cargo would be required to be handled. It is proposed to construct 700 m of berth in this phase, taking the total length of the berth to 1750 m. In tandem, the backup area requirement would go up to 84 ha from the 53 ha required in phase II.

Cargo Handling

The imported cargo includes Iron Bearing Raw Materials (IBRM), Coal Bearing Raw Materials (CBRM), container and clinker. The exported cargo will include HR coils, container, cement and slag. In the existing phase, the raw materials are directly fed through conveyer belts from the port. In the process of expansion, a port backup containing bulk stockyard for the raw materials will be provided behind the berths to increase the efficiency and operational flexibility of raw material handling at the port.

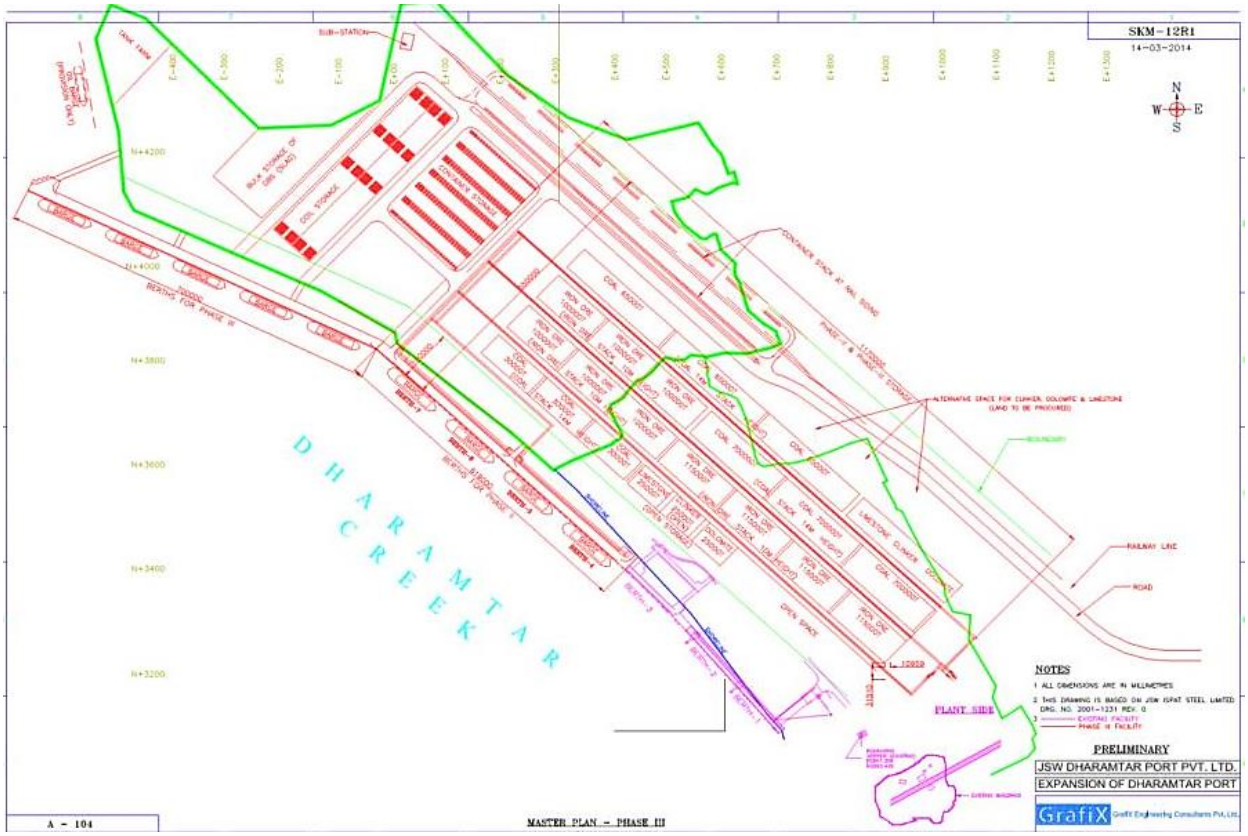


Fig. 1.2: Proposed Layout of the Dharamtar Facility

2. ToR for Environmental Monitoring

As per the recommendations of Environment Appraisal Committee (EAC), the Ministry of Environment, Forest& Climate Change hereby accorded Environmental and CRZ Clearance to the project 'Expansion of Dharamtar Jetty facility in Village Dolvi of District Raigad (Maharashtra) by M/s JSW Dharamtar Port Pvt Ltd, vide MoEF&CC letter No. F. No. 11 - 79 / 2013 - IA.III dated 26/11/2015.

It was specified that NCSCM shall carry out the study for suggesting measures for mangrove protection, in the view of impact of proposed construction methodology as well as to carry out monitoring to ensure proper implementation of the construction methodology and construction of the Jetty without disturbing the existing mangroves, natural resources and other environmental safeguards, as stipulated in MoEF&CC's EC letter cited as above.

EC Conditions for Environmental Monitoring

The Special Conditions of the EC state "*The PP shall engage NCSCM, Chennai to carry out the monitoring at their own cost to ensure proper implementation of the construction methodology and construction of the Jetty without disturbing the existing mangroves, natural resources and other environmental safeguards*".

Accordingly, NCSCM has undertaken the task of period monitoring of construction activities during Phase-II with the following tasks as mentioned in the Terms of Reference:

(a) Monitoring of site during construction phase and
(b) Suggest measures for mangrove protection and other environmental safeguards during the construction phase

Monitoring of site during construction phase:

It was proposed that environmental monitoring of the stations during Phase-II construction will be carried out with increased number of locations (at least 6), the rationale being that the distance from the project site to River mouth and upstream needs to be covered.

Following components were proposed for monitoring with a frequency of once in three months

A. Water:
   - *Physico-Chemical Parameters* (pH, Salinity, Conductivity, TDS, Turbidity, DO, BOD, Phosphates, Nitrates, Sulphate, Chloride)

- *Biological Variables* (Transparency, Chlorophyll, Phytoplankton (density, diversity), Zooplankton (density, diversity)

B. Marine Sediment Analysis:
   - *Physico-Chemical* parameters
   - *Biological (Phytoplankton, Zooplankton,* Benthic meiofauna, Benthic macrofauna)

C. Air quality (PM_{10}, $PM_{2.5}$, SO2, NOx)

D. Noise

E. Greenbelt development

Suggested measures for mangrove protection

This activity involves mapping of the mangroves in the locality up to 10 km from project site boundary as well as mapping of flow conditions in the Amba River, modelling changed flow patterns due to dredging, and assessing the potential impacts on the mangroves due to the changed flow regime.

A detailed survey with respect to health and status of the mangrove was carried out during April 2017 to propose necessary measures for management of the mangrove vegetation located in vicinity of JSW port. Present survey (March 2018) focuses on assessing the status of environmental quality.

3. Field Survey

A field visit to JSW Dharamtar Port Private Limited was carried out from 22nd March 2018 to 25th March 2018 by a team of scientists from NCSCM. The team included:

(1). Dr. Maria Fernandes
(2). Mr. Arumugam K
(3). Ms. Armoury Kazip Y S
(4). Mr. Anandavelu I
(5). Mr. Darwin Devidas Ramteke

The objectives of the survey were to undertake environmental monitoring

The officials from JSW Dharamtar assisted the team.

4. Environmental Monitoring

The team made a detailed survey (4th Quarterly) at existing jetty facility as well as of the on-going construction work. The team carried out a spatial survey for environmental parameters in the Amba River. Following first-hand observations were made during the visit:

- The project site is located at 18°42'520" N and 73°1'620" E, located at the right bank of Amba River, at a distance of 22 km from its mouth.
- On the other side of the bank of Amba River, PNP Port is located. Length of the existing Jetty is 331.5 m. In Phase-II, expansion of jetty to the north by 718.5 m is under progress.
- The construction of the jetty is being carried out by self-supported Cantilever Gantry Construction method, which is known to cause minimal disturbance to environmentally sensitive areas, and does not require load-out facilities a smaller assembly zone.
- Previously selected 10 stations covering the upstream, port and downstream regions of Amba River were sampled (Fig .4.1).

Fig. 4.1: Sampling locations for periodic monitoring in Amba River

Fig. 4.2: Sample collection in the Amba River

Air Quality

Particulate matter (PM) in addition to few anthropogenic gases (e.g. NOx, SOx, CO etc.) present in ambient air is a prime concern in ports and harbours. In addition to the emissions of SOx, NOx and fine-particle from ship, dust emissions at different intensities also arise during various regular port–related activities such as loading, un-loading, transportation and storage of cargo materials such as coal, ores etc. Particulate matter consists of both Suspended Particulate Matter (>10µm; PM_{10}) and Respirable Suspended Particulate Matter (<2.5 µm; $PM_{2.5}$). It acts as an irritant and even penetrate into the human respiratory system, causing serious health hazards.

At present, over 600 million people living in urban areas worldwide are being exposed to dangerous levels of traffic–generated air pollutants. About 30% of the respiratory diseases are related to personal exposure to high level ambient PM concentrations (WHO, 2000). In developed countries, PM emissions are mainly responsible for respiratory health problems. The main sources for ambient PM concentrations in urban roadways are vehicle exhausts, emissions from tyre and brake wear and re–suspension of road dust. Therefore, the monitoring for PM_{10} (<10 µm) is considered as a good technique of determining the

community's exposure to potentially harmful dust. Recently these measurements have been shifted from PM_{10} (<10 µm) to finer particles ($PM_{2.5}$; <2.5 µm) based on the relevance in direct health consequences. This was significantly noted in the inclusion of PM_{10} (2000) and $PM_{2.5}$ (2009) in the National Ambient Air Quality Standards (NAAQS). About 60 % of the country's mean $PM_{2.5}$ concentrations (population-weighted) come from anthropogenic source sectors, while the remainder are from "other" sources, such as windblown dust and extra-regional sources. Power plants, industrial coal combustion and anthropogenic dust (including coal fly ash, fugitive road dust and waste burning) are the few potential sources of atmospheric dust particles. Total dust (windblown and anthropogenic together) contributed 39 % of $PM_{2.5}$, while transportation, brick production.

In order to ensure sustainable port activities, concentration of the following air quality parameters in the ambient air should not be allowed to exceed the levels mentioned in revised National Ambient Air Quality Standards (NAAQS) [NAAQS Notification dated 18th November, 2009]. As per NAAQS Central Pollution Control Board Notification (2009), the permissible limit of PM_{10} is 100 µg/m^3 and $PM_{2.5}$ is 60 µg/m^3 on a 24-hour basis for industrial areas/ports and harbours. In addition, the concentration of gaseous pollutants like sulphur dioxide and nitrogen dioxide in ambient air were measured by absorbing a known volume of air at a regulated flow rate in the respective absorbing solutions followed by colorimetric analyses (National Ambient Air Quality Series:NAAQMS/36/2012-13)

Measurements of air quality (suspended particles, PM) were made within the port premises at the new jetty construction site using laser sensor, calibrated for Indian conditions against BAM (Beta attenuation Monitor-most advanced system for measuring ambient air quality). For the measurement of ambient SO_x and NO_x concentrations, improved West and Gaeke method and Jacob & Hochheiser modified (Na-Arsenite) methods were followed, respectively.

Following observations were made during air quality monitoring at the site:

- Major pollutant sources inside the port area were identified as follows:
  - Vehicular emissions from tanker and truck traffic
  - Transport of dust particle from adjacent industries
  - Dust(coal/ore) from adjacent ports
  - Occasional spill from closed conveyor belt etc.
- During the study period, the wind speed ranged between 0.7 to 3.2 m/s. The wind was predominantly from the south west direction.

- Prominent pollutant sources included emissions from construction activities and regular loading/ unloading of coal materials from the ports were identified
- Although Dharamtar Port has sealed conveyor belt system for the transport of coal, frequent monitoring for the detection of any spillage/dispersion from the closed conveyor belt is essential for pollution free operation.
- Dust generating activities may be stopped for two hours, if sustained wind speed exceeds 36 km/hr (or 10m/s). It can again be started once the it is demonstrated that the work site is sufficiently protected so that wind will not generate dust.

Table 4.1: Assessment of temporal variation in air Quality at Dharamtar Port near the berth construction site in the month of March, 2018

Air quality stations	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_X (µg/m³)	NO_x (µg/m³)
National Ambient Air Quality Standards				
Annual	60	40	50	40
24 hrs average	100	60	80	80
Observation at Dharamtar Port (construction site): January 2017				
Minimum	65	34	9.8	11.1
Maximum	132	88	17.4	22.4
Average	95	53	14.8	16.3
Observation at Dharamtar Port (construction site): April 2017				
Minimum	76	47	11.6	16.4
Maximum	167	106	23.4	31.6
Average	112	69	18.6	19.1
Observation at Dharamtar Port (construction site): October 2017				
Minimum	55	30	7.6	9.4
Maximum	122	82	15.1	18.4
Average	92	49	11.8	14.3
Observation at Dharamtar Port (construction site): March 2018 (*22 to 25th March*)				
Minimum	59	36	15.6	12
Maximum	141	80	23.8	16.8
Average	97	48	13	15

- Depositions of fine dust on the leaves of vegetation and dispersion of coal dust from the surrounding areas were observed, similar to earlier surveys.
- The concentration of particulate matter was time dependent with high concentrations were observed during morning hours
- PM concentrations also strongly correlate with vehicular emission rates i.e., PM_{10} levels increase with increase in traffic flow and it decreases at night time due to reduction in source emission rate.

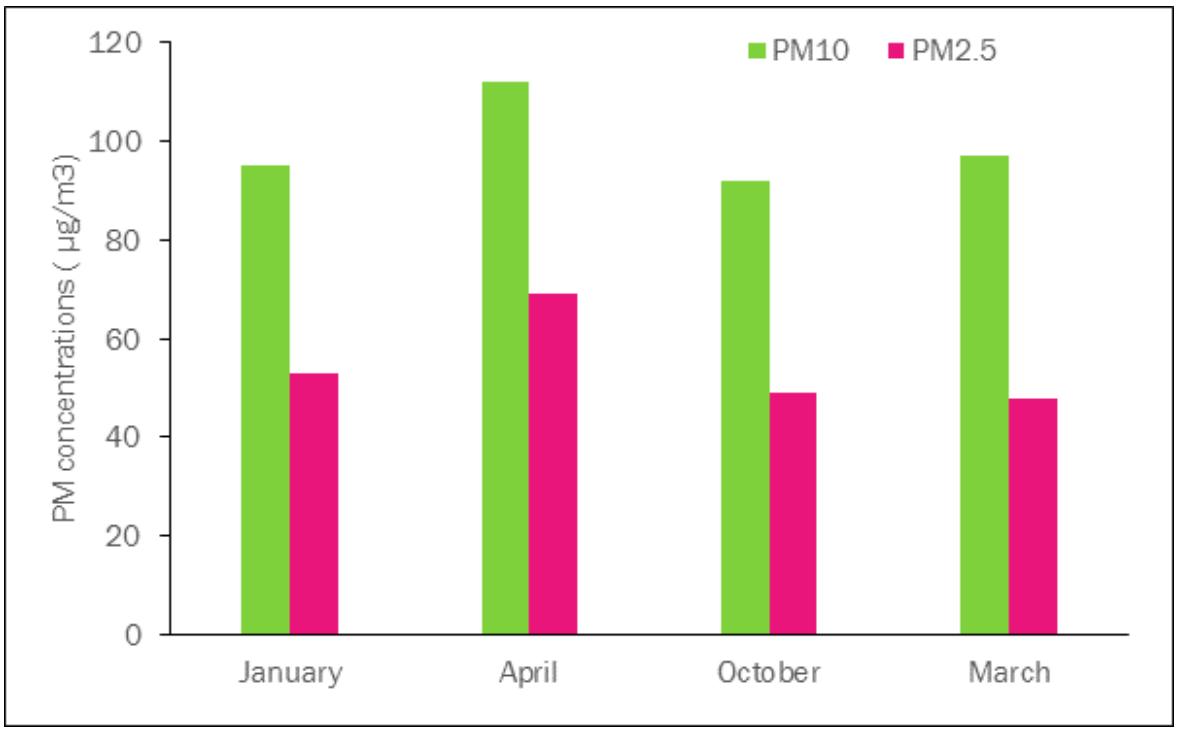


Fig. 4.3: Concentration of Particulate Matter (mean) during the survey period (January, April, October, 2017 and March 2018).

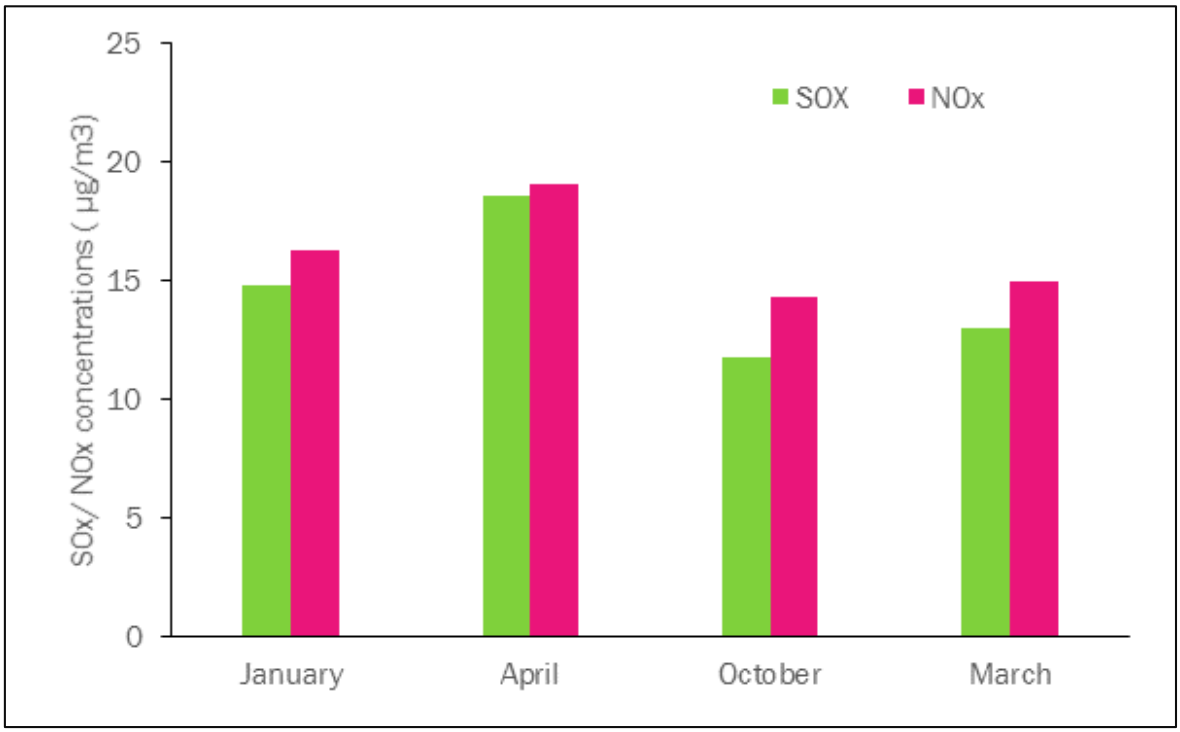


Fig. 4.4: Temporal variation in SOx and NOX during the survey period (January, April, October, 2017 and March 2018).

- The mean value for PM_{10} and $PM_{2.5}$ concentrations were marginally higher than the permissible limits prescribed for the industrial areas defined by CPCB (Table 4.1).
- All the air quality parameters including suspended material showed lower ambient concentration in October compared to January and April 2017 and March 2018 (Fig 4.3 & 4.4).

Significant results for Air Quality:

Mean concentrations of ambient PM_{10}, $PM_{2.5}$, SO_x and NO_x were measured during January, April, October, 2017 and March, 2018. The ambient concentrations were well within the permissible limits for the industrial areas as prescribed by Central Pollution Control Board, Government of India. Occasional fluctuation and spikes in concentrations in the ambient air were subjected to specific port activities. The high concentrations were observed mostly during day time. Lowest PM_{10} and $PM_{2.5}$ concentrations were observed during October compared to the other months. Wet deposition in addition to strong wind from the south west direction (seaside) may have contributed in the reduction in PM and trace gas concentrations in this area. However, deposition of a layer of fine black dust was observed at the leaves of mangroves and other terrestrial vegetation near the jetty.

Noise level

Noise measurement is one of the most important diagnostic tools that allow monitoring and comparing different noise levels for the assessment of adverse impacts of noise and implementing suitable measures for noise reduction. The intensity of sound is measured in sound pressure levels and common unit of measurement is decibel (dB) (Fig.4.5).

Day time monitoring of noise intensities was carried out on the third week of March, 2018. The measurements were carried out by installing sound level meter (Optimus, G066918, CR:162C) near the predetermined new berth construction site (18° 42.598'N, 73°1.642'E). The results were compared to standards defined by CPCB for industrial category (Table 4.2). Comparisons of the present data were also made with the other results collected during the previous surveys in January, April and October 2017 and March 2018.

Table 4.2: Ambient Noise Quality Standards in respect of Noise (Noise pollution (regulation and control) rules, 2000)

Area Code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

The following observations were made and the Projected Exposure estimated from the collected data during March, 2018 are given in Table 4.3.

- The energy mean of the noise level (LA_{eq}) over the specified period was found to be 58.6 dB with the peak value (LC_{Peak}) of 114.1 dB (Table 4.4 & 4.5).
- These results indicated that during the sampling period the noise pollution level was within permissible limits for industrial areas, as prescribed by the CPCB.
- Summary of results collected at Dharamtar Site on 22nd March -25th March 2018 is given in table 4.4. Calibration Offset 1.97 dB

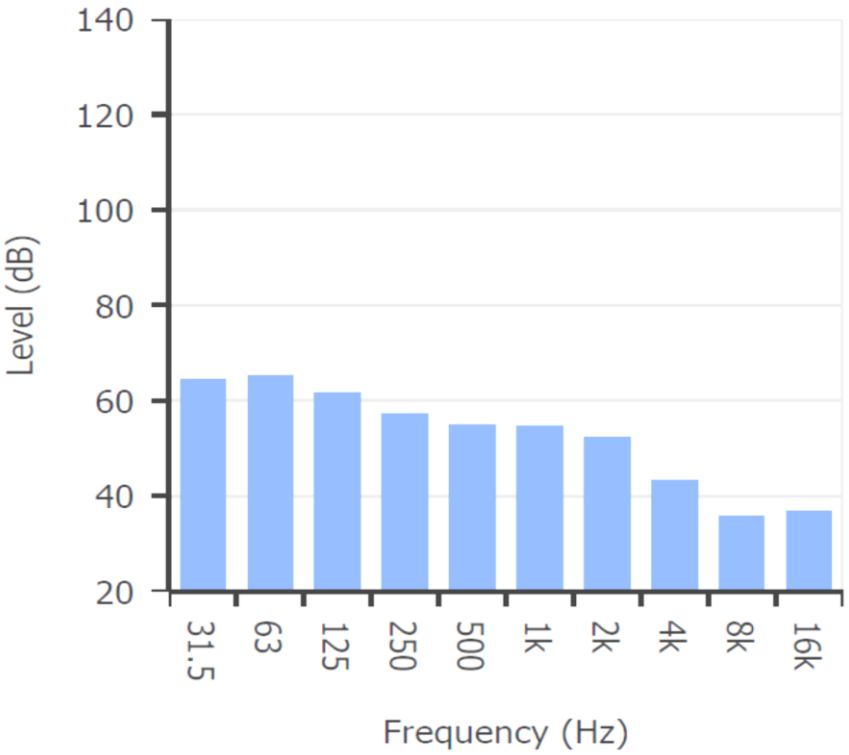
Time	Noise (dB)
30 Minutes	46.6
1 Hour	49.6
2 Hours	52.6
4 Hours	55.6
6 Hours	57.4
8 Hours	58.6
10 Hours	59.6
12 Hours	60.4

Table 4.3: Projected exposure estimated from the collected data.

Fig .4.5: Sound level meter (Optimus, G066918, CR:162C) installed at the construction site

Table 4.4: Mean noise values at the port region.

Basic Values	Indices
LAeq	58.6 dB
LCPeak	114.1 dB
C-A	9.7 dB
LEX8	58.2 dB
LAFMax	85.6 dB



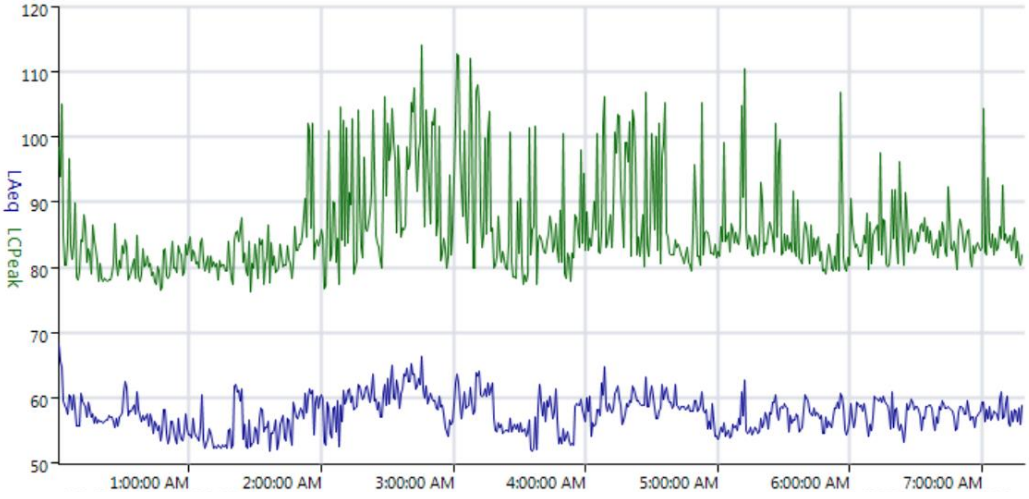


Fig. 4.6. Frequency (Hz) of different Noise level and temporal variations of noise level during the study

Table 4.5: Noise values observed from the construction site at Dharamtar Jetty during January, April, October, 2017 and March, 2018.

	LA_{eq}	LC_{Peak}	LEX8
January 2017	58.6 dB	98.5 dB	57.3 dB
April 2017	67.1 dB	109.2 dB	66.3 dB
October 2017	64.6 dB	103.8 dB	61.9 dB
March 2018	58.6 dB	114.1 dB	58.2 dB

LAeq = Equivalent Continuous Level;
LC_{Peak}= peak sound pressure level;
LEX8: L_{eq}- Equivalent Continuous Sound Level corrected for 8 hour;

Significant result for Noise Quality:
The amount of noise generated at the site of construction was well within the prescribed standard given by CPCB and were considered to be satisfactory.

Water Quality

A water quality impact assessment provides a broad overview of the water quality situation and the trend, and to determine how this could be affected by the planned project. A survey was undertaken during March 2018 to define the nature and scale of potential environmental impacts associated with the Project specifically in terms of the effects in the vicinity of sensitive receivers like the estuary and the mangroves. Both construction and operational phase impacts have been assessed continuously.
The major source of water to the JSW port is Amba River, which flows through 22 km and finally meets the Arabian Sea. We observed that the estuarine water quality varies seasonally and was also influenced by tidal action, vertical mixing and other anthropogenic sources. Ten strategic sampling locations were fixed to obtain a complete gradient of water quality from i) upstream of the river, ii) the port area and iii) downstream river up to the Arabian Sea. The water quality is assessed in terms of a few physico-chemical properties such as surface water temperature, salinity, dissolved oxygen (DO), total dissolved solids (TDS), turbidity, pH and specific conductivity (SpC), which can potentially affect the fate of any contaminant in the water. Distribution of dissolved or particulate fractions of inorganic salts was used to indicate the pollution levels of the water body. Water quality data were assessed according to a fitness for use range (water quality criteria), which is based on the Central Pollution Control Board's Water Quality Guidelines.

Table 4.6: Water Quality variation (in average ± standard deviation) in Amba River

Parameters	UPSTREAM	PORT	DOWNSTREAM
Water Temperature (°C)	27.73 ± 0.43	27.69 ± 0.62	27.86 ± 0.08
Salinity	27.2 ± 1.3	28.8 ± 1.2	31.7 ± 1.2
pH	7.41 ± 0.64	7.73 ± 0.12	8.07 ± 0.10
ORP (mV)	361 ± 31	364 ± 18	327 ± 56
DO (mg L^{-1})	6.1 ± 0.3	6.2 ± 0.2	6.9 ± 0.9
Specific Conductivity (mS cm^{-1})	42.3 ± 1.8	44.7 ± 1.7	48.7 ± 1.7
TDS (g L^{-1})	27.1 ± 1.3	28.6 ± 1.1	31.1 ± 1.1
NO_3 (µM L^{-1})	53.0 ± 8.3	47.3 ± 5.5	50.3 ± 5.8
NO_2 (µM L^{-1})	1.8 ± 1.5	3.0 ± 1.8	1.2 ± 0.7
NH_4 (µM L^{-1})	5.2 ± 3.3	9.4 ± 7.6	4.4 ± 2.7
DIP (µM L^{-1})	0.68 ± 0.08	0.68 ± 0.09	0.69 ± 0.04
DSi (µM L^{-1})	82.6 ± 7.9	74.1 ± 2.8	59.2 ± 9.7

*ORP = Oxidation Reduction Potential; DO = Dissolved Oxygen; TDS = Total Dissolved Solid; NO_3 = Nitrate; NO_2 = Nitrite; NH_4 = Ammonium; DIP = Dissolved Inorganic Phosphate; DSi = Dissolved Inorganic Silicate

During the periodic survey in March 2018 (pre-monsoon), i*n-situ* water quality (water temperature, salinity, pH, ORP, dissolved oxygen, conductivity, total dissolved solids) measurements were made using Hydrolab® sonde, and measurement of other parameters (nitrate, nitrite, ammonium, phosphate, silicate) were carried out using standard procedures as mentioned in "Standard methods for the examination of water and wastewater" American Public Health Association (APHA): Washington, DC, USA (2005) using an automated continuous flow nutrient analyzer system (Skalar San^{++}®) in lab.

Water Temperature

Water temperatures in tropical estuaries are usually higher (24°to 32°C) than temperate estuaries (3°to 16°C), which plays a major role in the biological activity in the system. The surface water temperature remained almost stable from upstream to coastal waters with insignificant spatial fluctuations between 27ºC to 28º C. The negligible difference observed in the surface water temperature at different locations, could be attributed to the well mixing nature of the Amba estuary.

Salinity

Salinity, is a conservative factor and an important parameter in regulating the water column dynamics. Any fluctuation in its value affects both biotic and abiotic processes. The salinity of the upstream estuary was found to be 27 and gradually

increased towards the sea, where a typical salinity of ~32 was recorded. Salinity distribution was typically of an estuary.

pH

During the sampling, the observed range of pH in surface waters was 7.41 – 8.07 (Table 4.6), indicating that the water was marginally above neutral. In the upstream river, the transported humic materials are frequently slightly acidic, and when sea water influences are greater, the colloidal particles become coagulated and the pH shifts towards alkalinity. Hence, the values were found higher towards downstream. The pH was within the range as perscribed by CPCB.

Oxidation Reduction Potential (ORP)

ORP is typically measured to determine the oxidation-reduction potential of surface waters. The mean ORP of the Amba estuary was observed to be 361 mV in upstream and reduced to 327 mV in the Arabian sea. The ORP values in the current study are similar as in most of the rivers, which typically are always positive.

Dissolved Oxygen (DO)

Dissolved Oxygen (DO), is used as an indicator in most water quality studies as any change in biological activities as well as physical properties such as temperature, salinity, are directly reflected in DO concentration. Oxygen has limited solubility in water, usually ranging from 6 to 14 mg L^{-1} in coastal waters. DO concentration was found to be stable from 6.1 to 6.9 mg L^{-1}. Entire estuary DO content was found within the prescribed limits of CPCB (Table 4.6 and 4.7). As there was continuous movement of barges in the water, the water column was mixed resulting in near saturation values for dissolved oxygen.

Total Dissolved Solid

Total dissolved solid (TDS) measures both inorganic salts and dissolved materials. In natural waters, salts are chemical compounds of anions such as carbonates, chlorides (Cl_2), sulphates (SO_4), nitrates (NO_4) and cations such as potassium (K), magnesium (Mg), calcium (Ca) and sodium (Na). Dissolved solid concentrations in natural waters are the result of weathering and dissolution of minerals from local soil and bedrock. The average TDS obtained from the Amba estuary was ~30 g L^{-1}. TDS level is very low could be due to the low inflow of fresh water.

Nutrients

Nutrients - especially nitrogen and phosphorus, are key water quality parameters in estuaries as their availability regulates primary productivity in estuarine and coastal waters. Nutrient concentrations vary according to surrounding land use, season, and geology. Nitrogen is supplied in elemental and combined forms into the estuaries and among these, the main form of combined nitrogen is dissolved nitrate and nitrite. Both these nutrients are present in low concentrations in the

estuarine waters either as an intermediate product of microbial reduction of nitrate or through the oxidation of ammonia and as an excretory product of plankton.

In the Amba estuary, in the total dissolved DIN pool, ~88% of the nitrogen is in oxidised form as NO_3^-, followed by ~9% as in the reduced form (i.e. NH_4^+) and the remaining 3% as NO_2^-. The concentration of nitrate was found to be considerably higher (47 – 53 µM l^{-1}), above the ambient levels (<16 µM L^{-1}) which is received through the agriculture runoff in the catchment areas. Another reason of nitrate enrichment could be due to well mixed conditions due to continuous barge movement, as contributions from point sources could be greater relative to the streamflow, and dilution is less. In the port region ammonium was ~9 µM L^{-1}. The variability of NH_4^+ along the estuary gradient was probably related to variations in water column and bottom sediment nitrogen regeneration and release/uptake in the estuary.

All phosphorus (P) in the system can be considered to be in either the dissolved or the particulate phase, and P reactions involve transfers between these phases. P is an indicator of contamination from activities in the catchment such as waste water discharge and fertilisers from agricultural activities. Elevated concentrations of phosphate can lead to algal blooms in standing water, which affect the aquatic ecosystem negatively. Dissolution of mineral phosphate also depends on physico-chemical characteristics such as pH, available sulphides, alkalinity and the redox state. Dissolved inorganic phosphate (DIP) values were found to be very low with an average 0.68 µM L^{-1} (Table 4.6 & 4.7). This clearly showed during lean flow season, input of phosphate from watershed reduced drastically.

Variability in N to P atomic ratios (N:P) have an important biogeochemical implication, as P is commonly the "limiting" nutrient for photosynthesis in aquatic systems because of its low solubility, and N is limiting in coastal and marine surface waters. In the Amba estuary, N:P atomic ratios were observed to be significantly high with respect to Refield ratio (N:P = 16:1), in upstream (69), Port (85) and downstream waters (63). Increased N:P ratio in waters, shows dominance of primary productivity. Phytoplankton is more efficient of uptaking P over N, hence the biological consumption in the estuary, lowered the DIP concentration and led to increase nitrate content in the waters.

Rivers are the primary source of silicon (Si) to the oceans, essentially coming from rock weathering, and is a crucial factor in the eventual occurrence of eutrophication problems in the coastal zone. Mean dissolved silicate (H_4SiO_4) concentrations in upstream waters were found to be ~83 µM L^{-1} and it's gradually reduced to ~59 µM L^{-1} towards the sea, as the distribution of silicate largely governed by freshwater discharge.

Table 4.7: The water quality of Amba River and estuary compared with CPCB norms for surface water

	pH	DO (mg L^{-1})	5-day BOD (mg L^{-1})	Total Coliform	Free NH_4^+ (mg L^{-1})
Standards					
Class A	6.5-8.5	6	2	50	
Class B	6.5-8.5	5	3	500	
Class C	6.5-9.0	4	3	5000	
Class D	6.5-8.5	4			1.2
Class E	6.5-8.5				
Field Observations					
Upstream	7.41	6.1	4.3	-	0.09
Near Port	7.73	6.2	3.2	-	0.17
Downstream	8.07	6.9	2.8	-	0.07

Sediment Quality

Physical characteristics of sediments were delineated through specific parameters, viz. particle size distribution. Particle size has a significant effect on environmental quality as nutrients and heavy metals (chemically reactive pollutants) become appreciably associated with fine particles. Grain size parameters have been used to characterize the sediments in coastal environments; moreover, the bottom topography of any modern environment is affected by the distribution and transport processes of the sediments present in the area. Particle size distributions in Amba estuary during both seasons are shown in the Table 4.8 and Figure 4.8.

Table 4.8: Particle size distribution (in %) in Amba River and estuarine sediments

No.	Sampling Stations	Apr-17			Oct-17			Mar-18		
		Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay
1	S1	63.9	35.2	0.9	23.5	75.8	0.7	87.2	11.8	1.0
2	S2	34.9	64.7	0.4	13.4	86.3	0.3	36.2	63	0.8
3	S3	40.4	58.9	0.7	16	83.4	0.6	45.4	54	0.6
4	S4	0.0	99.3	0.7	50.9	46.2	2.9	3.6	95.6	0.8
5	S5	0.1	95.2	4.7	53.8	45.4	0.8	2.4	97.3	0.3
6	S6	10.5	85.3	4.2	29.9	66.1	4.0	20.4	76.2	3.4
7	S7	0.0	99.2	0.8	9.1	90.2	0.7	0.1	99.2	0.7
8	S8	12	87.6	0.4	64.9	34.3	0.8	20.7	77.8	1.5
9	S9	10.9	86.7	2.4	46.2	52.1	1.7	18.4	79.6	2.0
10	S10	22.8	76.0	1.1	40.6	58.4	1.0	24.1	75.3	0.6

Fig. 4.7: Collection of bulk sediments using Van Veen Sediment Grab

Generally, sand and silt content varies from 0 to 87.2 (%) and 11.8 to 99.3 (%), respectively; with clay values <5 (%) from the collected sediment samples during all seasons. The sediments were mainly dominated by silt, at all the stations. Mean sand content values during October 2017 shows higher 34.8 ± 19.2% compared to the dry seasons 19.6 ± 21.1% & 25.9 ± 26.0%. Wider variations in sand percentage were observed among the stations of the Amba estuary. Sandy nature is generally higher towards the upstream area of Amba estuary. Sediment variable textural facies for all the seasons are plotted in the Folk ternary plot (Figure 4.8). The sediments textural classes from the Amba estuary fall in mainly three groups sandy silt, silty, and silty sand. Overall majority of Amba estuary sediments (66%) is sandy silt, while the silty sand and silt represent 16.5% each.

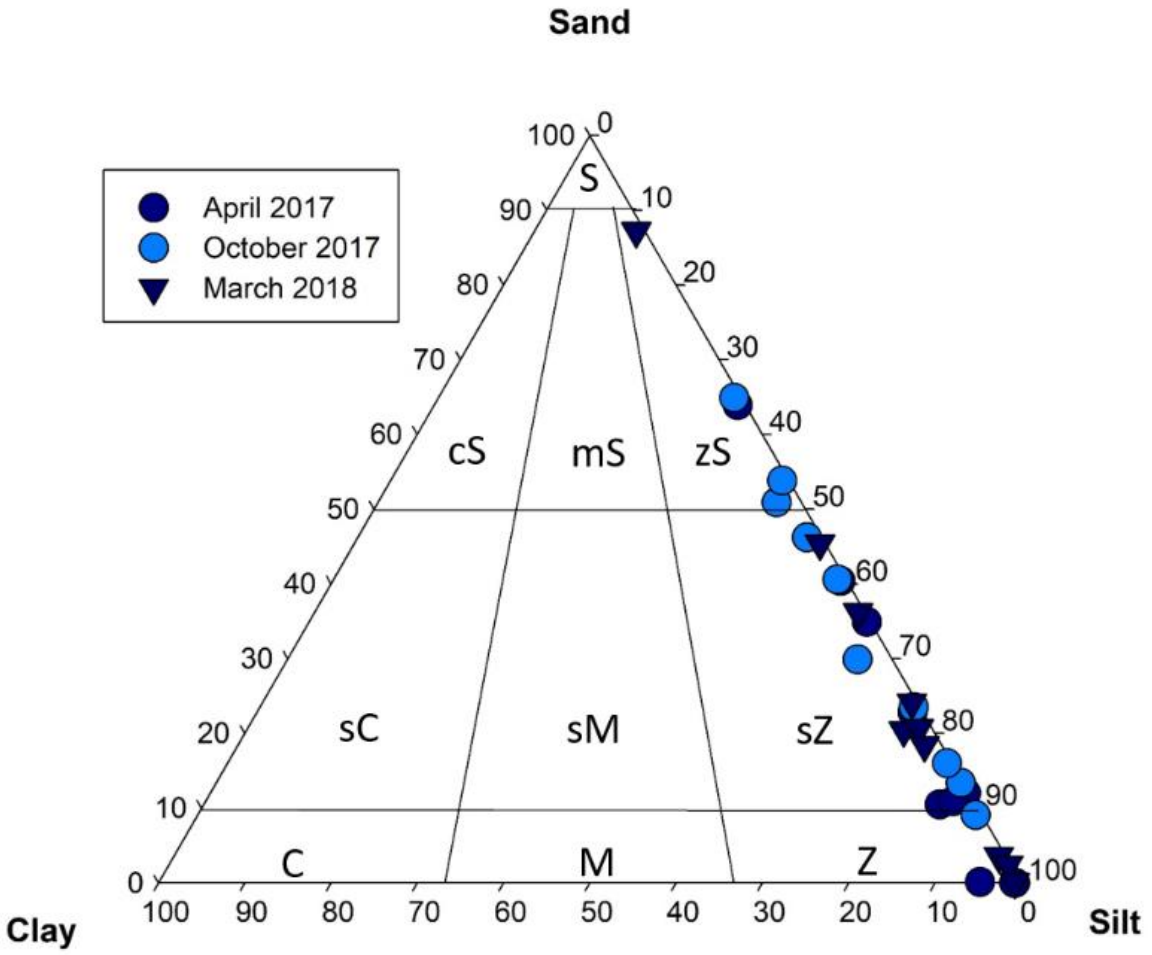
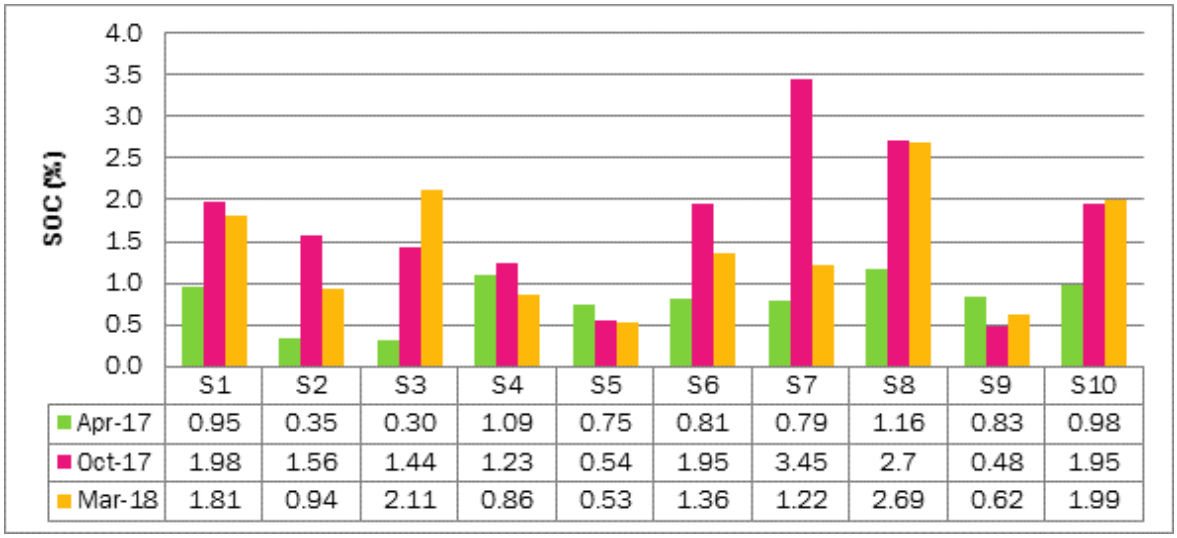


Fig. 4.8: Folk ternary plot of bed sediments from Amba estuary

The collected sediment samples were analysed for various chemical parameters, viz. pH, organic carbon and TKN. pH is controlled by both biogenic and abiogenic reactions; and greatly affects the solubility of metal ions and regulates nutrient availability. In this survey during both seasons, the sediments ranged between acidic to marginally alkaline in all the stations (6.50 -7.96) with very insignificant variation in pH between different stations. In October 2017, the pH of sediments showed marginally higher values 7.32 ± 0.28 compared to the dry seasons 7.13 ± 0.23.

Organic matter in sediments has highly variable sources, including plankton production, terrestrial components, matter of plant origin and sewage residue, etc. Higher SOC level can lead to the depletion of oxygen in the sediments and overlying water, which can have a deleterious effect on the benthic and fish communities. Organic carbon distribution in Amba estuary during all the seasons is given in Figure 4.9.



	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Apr-17	0.95	0.35	0.30	1.09	0.75	0.81	0.79	1.16	0.83	0.98
Oct-17	1.98	1.56	1.44	1.23	0.54	1.95	3.45	2.7	0.48	1.95
Mar-18	1.81	0.94	2.11	0.86	0.53	1.36	1.22	2.69	0.62	1.99

Fig 4.9: Temporal and spatial variation of Sediment Organic Carbon in Amba sediments

Sediment Organic Carbon in the Amba river and estuary were in general low, varying from 0.30 to 2.69% during dry season and from 0.47 to 3.40% during wet season. Mean values during wet season was found to be higher (1.70 ± 0.89%) compared to dry season (1.11 ± 0.62%). Surface runoff from watershed regions during wet season may be attributed to the increase in organic carbon content in the Amba river.. Higher SOC values at stations S7 and S8 indicate the probable influence of mangroves in these locations, as mangrove ecosystems are recognized to contain high OC stocks, which is supplied and transported to the surrounding waters during the tidal cycles.

Total Kjeldahl Nitrogen (TKN), which has both inorganic and organic sources is of vital importance for establishing mass balances in aquatic systems. TKN values in Amba estuary during wet season varied between 0.07 - 0.35% with mean value 0.23 ± 0.09%. During dry season, the values ranged between 0.12 – 0.44% with relatively similar mean value of 0.27 ± 0.12%. Figure 4.10 reveals higher values of TKN were observed in downstream compared to upstream stations. There are no guideline levels for TKN in sediments; however, the levels were in the range as observed in coastal sediments in India. The spatial variability of N is dominated by the sediment texture, N input and site specific geochemical processes. Similar fluctuations in sediment properties during different seasons in Amba estuary were reported earlier; due to the movement of sediments in shallow estuaries with unconsolidated substratum, experiencing strong currents. Important factors responsible for the spatial variation in nutrients from the Amba River and estuary are primarily the grain size distribution pattern and anthropogenic inputs such as domestic sewage, urban and industrial wastes.

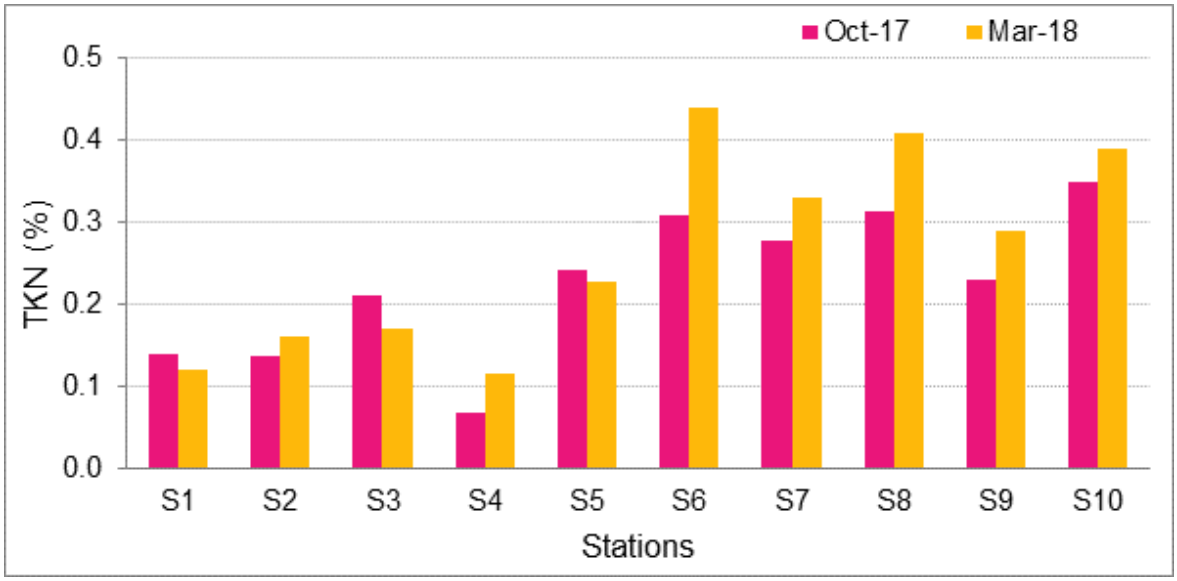


Fig. 4.10: TKN variation in Amba sediments during wet (October 2017) and dry (March 2018) seasons

Biological Observations

The diversity and population density of the phytoplankton, zooplankton and benthic community was assessed to understand the health of the Amba estuary.

Phytoplankton Community

Species Composition, Abundance & Diversity

Plankton abundance and species composition provide information on environmental variability in coastal waters. Specifically, studies that correlate abundance of lower trophic level plankton with atmospheric, estuarine and oceanographic conditions provide important insight into ecosystem productivity. Of particular interest and the focus of many time series are copepods; these zooplankton are abundant, have short life spans (thus responding to seasonal and intra-seasonal variability), and are not harvested for commercial purpose. This makes the community as ideal indicators of environmental changes in the coastal waters. In addition, plankton are primary producers (phytoplankton) and primary consumers or secondary producers (zooplankton), providing the critical first step in the transfer of carbon to tertiary level (fishes and mammals). Time series data on abundance and species composition plankton are key to understanding ecosystem dynamics within, and differences along the Amba River.

A total of 23 species belonging to 16 genera were identified during the study period. Phytoplankters were represented by two main groups namely diatom (centric and pennate diatom) and Cyanophyceae. The most dominating group

was diatoms which comprised 22 species belonging to 15 genera (Centric diatom 12 species belonging to 8 genera and Pennate diatom 10 species belonging to 7 genera). The second most dominating group was Cyanophyceae (Table 4.10). During the present study (March 2018), phytoplankton population and abundance was very less compared to previous field observations (Table 4.9). The most dominated species was *Coscinodiscus sp.* observed in all sampling locations. During previous observations, diatoms and dinoflagellates were equally abundant, however in this survey, the presence of dinoflagellates was minimal indicating good health of the estuary. In terms of percentage of species diversity, 94% of the phytoplankton were diatoms followed by Cyanophyceae (Fig. 4.11). Diatoms such as *Cocinodiscus* sp., *Ditylum brightwellii, Odontella mobiliensis, Pseudo-nitzschia* sp, and *Thalassiosira eccentric* were the most dominant species. A few species of microzooplankton species such as *Metacylis* sp. and *Tintinnopsis* sp. were also observed.

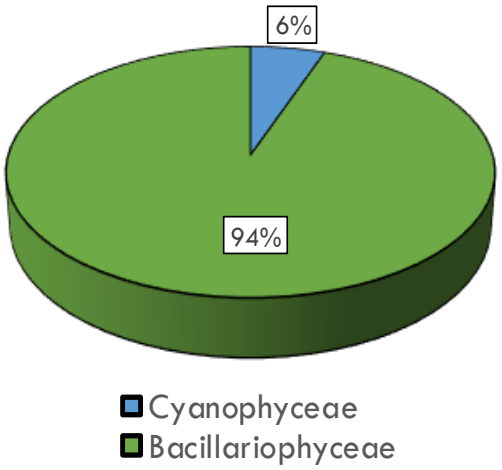


Fig. 4.11: Percentage composition of phytoplankton in Amba River

Table 4.9 Seasonal variation of average phytoplankton density and composition in Amba River

Class	January 2017	May 2017	September 2017	March 2018
Average Cell density cells/L^{-1}				
Diatom	91429	230.8	1897.3	99
Dinoflagellates	23.3	19	415.7	--
Cyanophyceae	--	101	--	129
Dominated species	*Coscinodiscus oculus-iridis*	*Coscinodiscus oculus-iridis*	*Coscinodiscus oculus-iridis*	*Coscinodiscus centralis*
Species composition				
Diatom	14 species & 9 genera	23 species 16 & 9 genera	37 species & 27 genera	22 species & 15 genera
Dinoflagellates	5 species & 4 genera	2 species & 2 genera	7 species & 6 genera	1 species & 1 genera
Cyanophyceae	--	1 species & 1 genera	--	--

Phytoplankton density

The phytoplankton density varied from 1200 to 5530 cells. L^{-1} in the estuary. In the upstream, population density ranged from 1300 to 1850 cells. L^{-1} with maximum (1850 cells. L^{-1}) at St.1 and minimum (1300 cells. L^{-1}) at St.3. At port region (middle of the estuary) population density ranged from 1200 to 2220 cells/L^{-1}. The density was highest at the estuary mouth (2740-5530 cells/L^{-1}) (Fig. 4.12).

Phytoplankton diversity index

Biodiversity indices (Shannon diversity (H'), Simpson dominance (λ), Margalef species richness (d) and Pielou's evenness (J')) were measured to explain the variability in zooplankton distribution at different regions. The number of species (S) ranged from 11 to 20. Highest diversity was observed at the estuary mouth (20; St.10) and lowest at near the port area (11; St-5). Number of individuals ranged from (1200-5530 cells. L^{-1}). Species richness (d) ranged from 2.8 to 5.1. Maximum values for species richness (d=4.0) was observed at St-2 (Sector I). Evenness (J') ranged from 1.41 to 2.21 with peak values at estuary mouth and minimum at port (Tables 4.9 and 10).

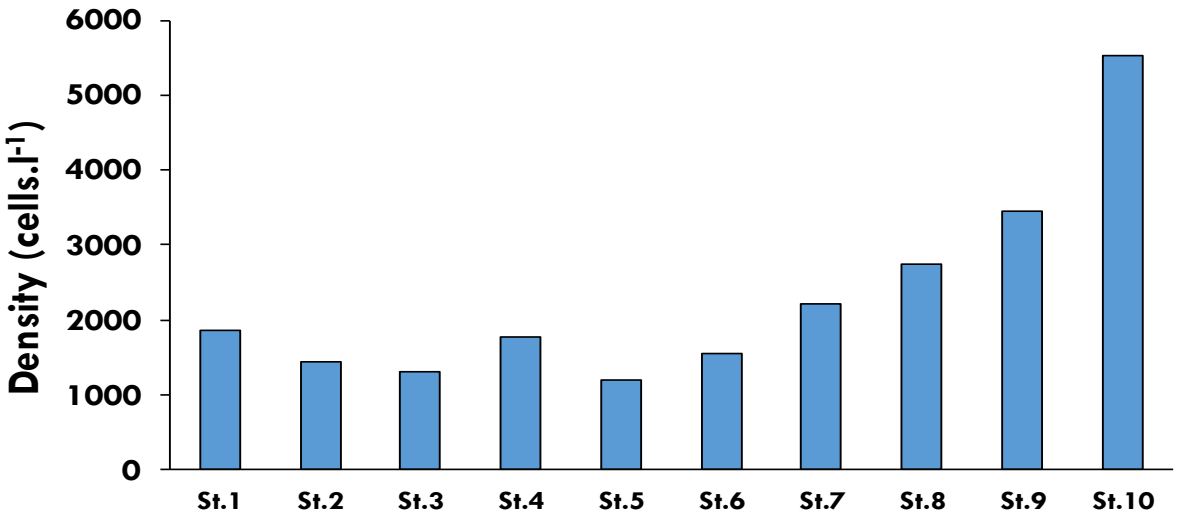


Fig. 4.12: Population density of phytoplankton in the Amba River

Cluster and nMDS

Two separate assemblages of species were observed in the Amba River and estuary. The upper estuary and port area formed the first cluster with 75% similarity among the diatom species. The estuary mouth formed the second cluster suggesting 80% similarity (Fig. 4.13a). Samples are overlaid with the dendogram similarity result 70% similarity. Upstream region forms one group and is entirely different from the other sampling locations.

The population density of phytoplankton is comparatively lower than the downstream. The second group/cluster included sampling locations from downstream/ estuary mouth with high phytoplankton density. The high abundance of diatom indicated the good health of the estuary and port area as these phytoplankton forms an essential part of the food web and are an important contributors to the water column productivity. (Fig. 4.13b).

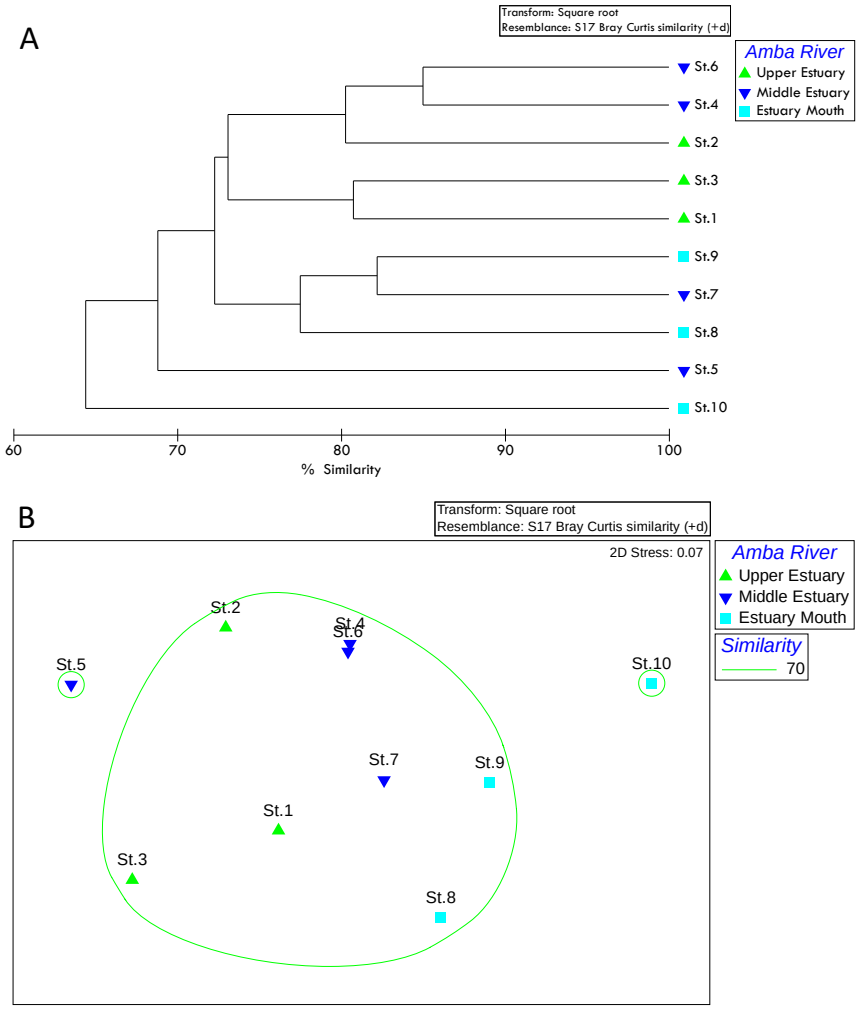


Fig. 4.13: a-b: Station-wise Cluster and nMDS analysis to identify the similarity

Table 4.10: Biological diversity indices for the phytoplankton from Amba River

Station	S	N	d	J'	H'(loge)
St.1	15	1850	1.86	0.80	2.17
St.2	13	1430	1.65	0.90	2.30
St.3	13	1300	1.67	0.85	2.18
St.4	13	1780	1.60	0.91	2.33
St.5	11	1200	1.41	0.91	2.18
St.6	17	1550	2.18	0.88	2.49
St.7	14	2220	1.69	0.85	2.24
St.8	14	2680	1.65	0.87	2.30
St.9	16	3460	1.84	0.86	2.37
St.10	20	5530	2.21	0.77	2.29

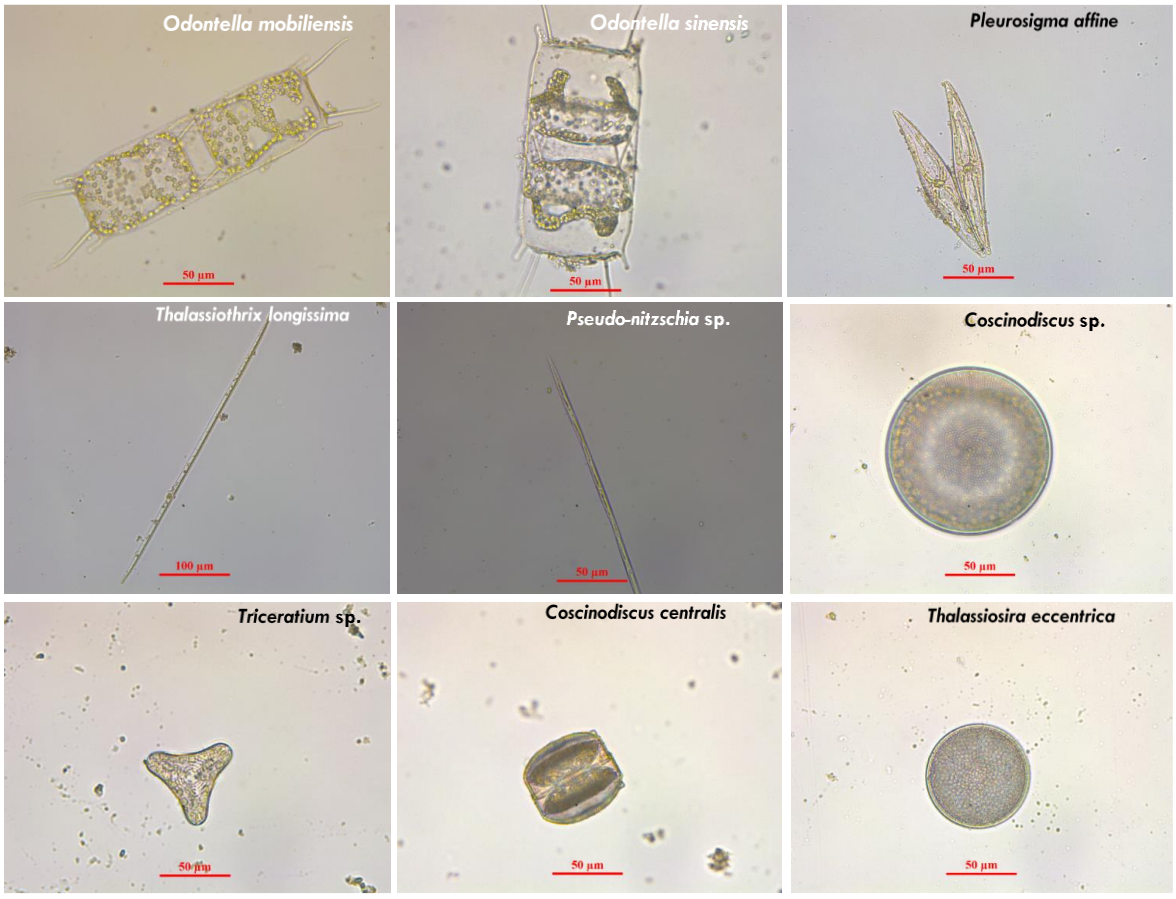


Fig. 4.14: Check list of phytoplankton in Amba River and estuary

Mesozooplankton

Composition and diversity

Mesozooplankton comprised of 25 taxa dominated by copepods; other groups included decapod larvae, cheatognaths, gastropod veliger and fish larvae. The bulk of abundance was contributed primarily by *Parvocalanus* sp., *Acartia tropica,* and nauplii. The density of copepods was found to be higher at middle zone (station 4 and 5) with 469 ind. m^{-3} and 296 ind. m^{-3} respectively and were least at estuarine mouth (4.44 ind. m^{-3}) (Fig. 4.15). The relative abundance of major groups in the region is given in Fig. 4.16. *Parvocalanus* sp., was the most common and dominant species occurring in all 9 stations. Second most dominant species was *Acartia spinicauda* which was observed *at* 8 stations. Over all, the copepods comprising of 12 species namely *Acartia spinicauda*., *Acartia tropica*, *Acartiella erythraea, Bestiolina* sp., *Parvocalanus* sp., *Pseudodiaptomus sewelli*, *Pseudodiaptomus annandalei*, *Pseudodiaptomus ardjuna*, and copepodids of *Labidocera androsoni*, *Labidocera pectinate,* and *Tortanus forcipatus Metis* sp. was found in this region (Annex 2). The species *Parvocalanus* sp. (31.02%) numerically dominated the total mesozooplankton community with density ranging from 3.33 ind. m^{-3} to 244.43 ind. m^{-3}. The occurrence of demersal organisms such as cummaceans and benthic copepods (Harpacticoida) in the upstream and port area indicates the shallow depth of the estuarine area.

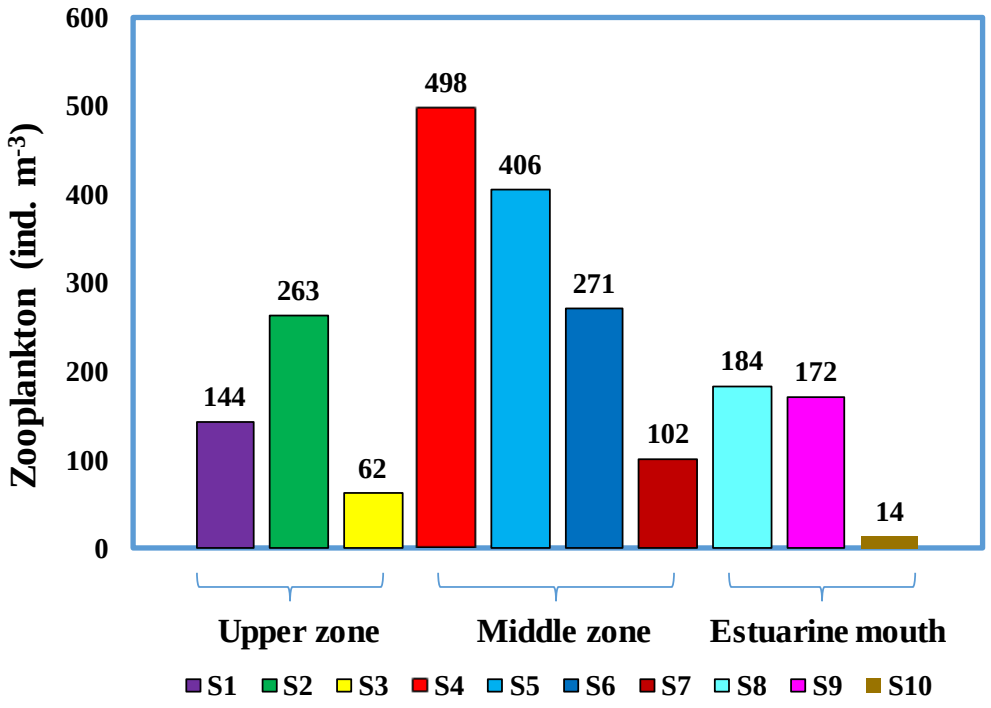


Fig. 4.15: Total abundance of zooplankton in Amba estuary during the study

The dominance of *Parvocalanus* sp. (31.02%), *Acartia tropica* and *Bestiolina* sp., in the survey area may have been due to the increase in nutrient supply. During ebb tides, the decapod larvae are exported from estuaries to adjacent coastal waters, resulting in the higher densities (168.58 ind. m^{-3}). One of the main trophic functions of these larvae is to transfer energy to higher links of the food chain including economically important fishes. The survival of the young shellfishes such as *Mysidacea, Cummacea* and shrimps may indicate the availability of abundant littoral zooplankton and benthos aided by omnivore and high ecological efficiencies.

The dendrogram of Bray Curtis Similarity index revealed that the samples upstream and port region formed a cluster indicating the similarity in abundance and species composition of zooplankton. Table 4.11 presents the biological diversity indices for the zooplankton from Amba River and estuary. The number of species (S) ranged between 7 and 15 with maximum species observed at St.4 followed by St. 1, 7, 8 and 9 each with 14 species and minimum at St.10 (14 species). Similarly, the evenness in distribution ranged between 0.535 to 0.89 and the average diversity was maximum towards the coastal side compared to other zones (Table 4.11).

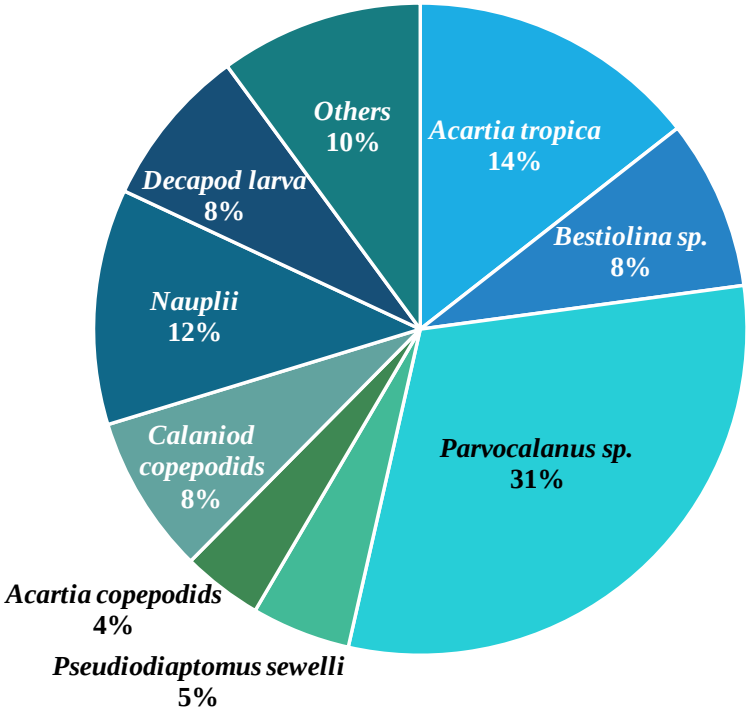


Fig. 4.16: Relative abundance of zooplankton and copepod species in Amba River and estuary

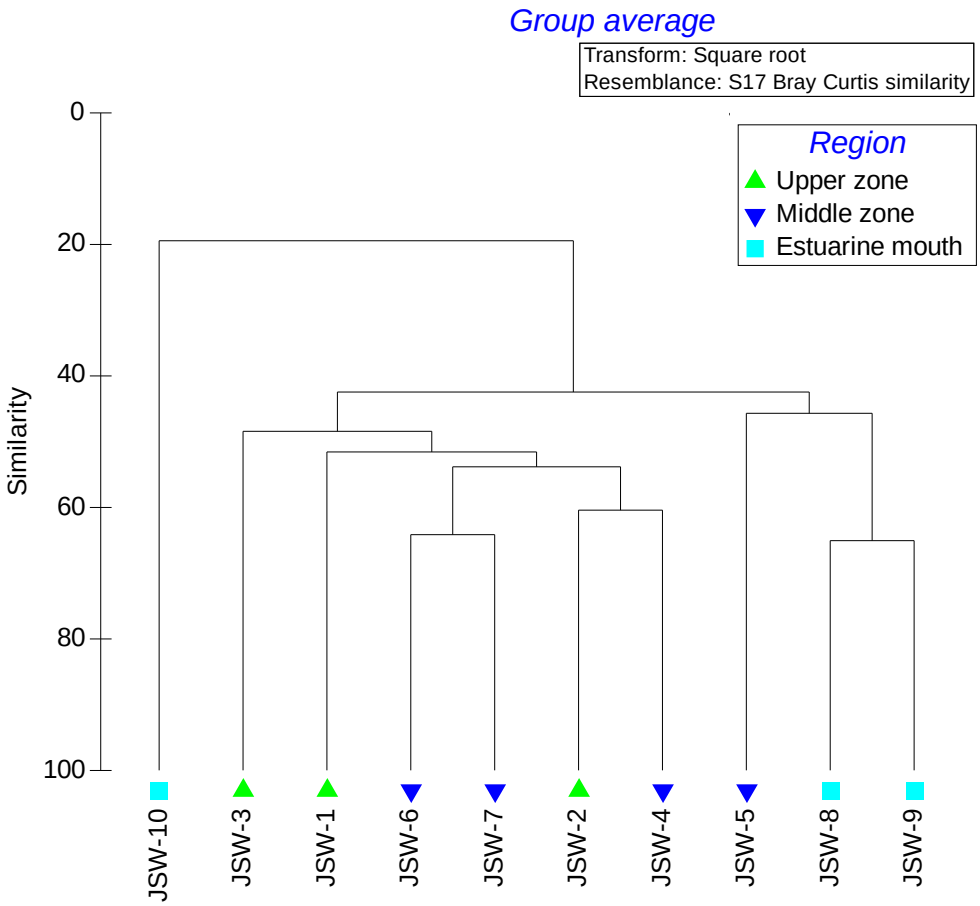


Fig. 4.17: Cluster Bray Curtis percentage Similarity analysis station wise

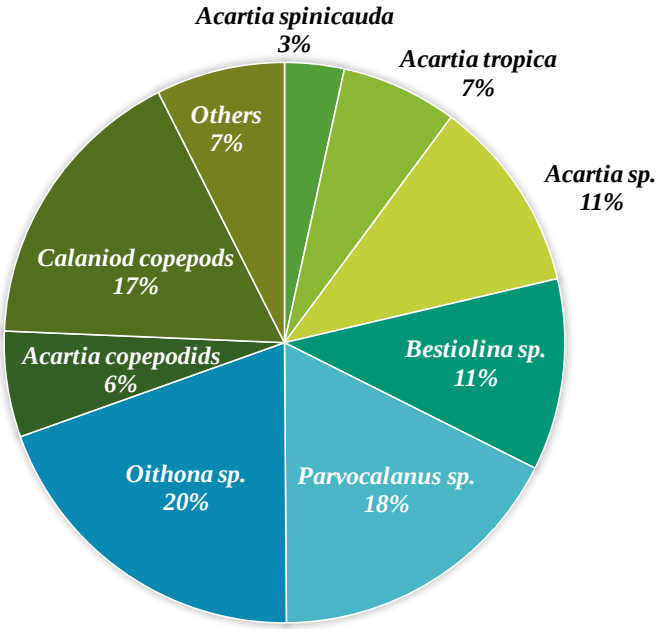


Fig. 4.18: Percent mean abundance of zooplankton and copepod species in Amba River and estuary in post monsoon and summer

Table 4.11: Biological diversity indices for the zooplankton from Amba River during the study S: Number of species; N: Number of individuals; d: Margalef richness; J': Pielou's evenness; H': Shannon diversity; λ: Simpson dominance

Sample	S	N	d	J'	H'(log$_2$)	λ
St-1	14	143	2.621	0.5352	2.038	0.3623
ST-2	11	263	1.795	0.824	2.851	0.1565
ST-3	13	62	2.913	0.7698	2.848	0.1863
ST-4	15	498	2.254	0.6731	2.63	0.1972
ST-5	11	386	1.679	0.5377	1.86	0.435
ST-6	10	271	1.606	0.739	2.455	0.2538
ST-7	14	101	2.819	0.7792	2.967	0.1801
ST-8	14	184	2.493	0.7055	2.686	0.2152
ST-9	14	172	2.526	0.7008	2.668	0.1973
ST-10	7	12	2.38	0.8982	2.522	0.2041

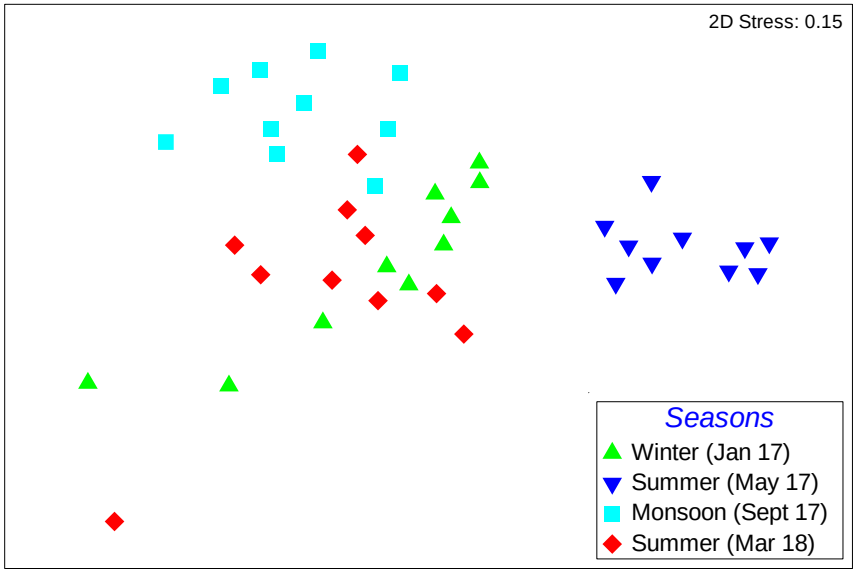


Fig. 4.19: nMDS orientation showing the clustering of stations at various seasons covered during the study from Amba River.

Seasonal variation in Mesozooplankton composition

During the period of study, *Oithona* sp., (20%) was most abundant however absent in early summer. Whereas other taxa such as, *Bestiolina* sp. (18%), *Parvocalanus* sp. (11%), Calaniod copepods (17%), Chaetognaths (0.72%), *Oikopleura* sp. (0.53%), Nauplii (14.03%), Decapod larva (3.01%), Fish larva (0.37%), Foraminifera (0.28%) occurred all along the seasons studied. The relative abundance of major

groups presented in the Fig. 4.18. *Parvocalanus* sp. is one of the major constituents of shallow water estuaries and co-occurred with *Bestiolina* sp. This species is predominantly found in temperature above 20°C and 32 salinity. Calanoid copepods and nauplii were also high due to favorable environmental conditions (temperature and salinity) in both the seasons. *Acartia copepodids* were regular in all the seasons except January (2017), while adult copepods (*Acartia spinicauda*) were found abundant in present survey indicating the period of maturity favoured by the environmental conditions.

Table 4.12: Seasonal variation in the density and species composition of zooplankton and copepods species in Amba River and estuary

Class	January 2017	May 2017	September 2017	March 2018
Zooplankton (Avg. ind. m^{-3})				
Copepods	285.77	2887.72	295.9	155.87
Zooplankton	79.55	1426.25	20.9	53.24
Dominant Copepod	*Acatia* sp., *Parvocalanus* sp. & *Pseudodiaptomus* sp.	*Oithona* sp. & *Parvocalanus* sp.	*Bestiolina similis, Acartia spinicauda* & *Acartia tropica*	*Parvocalanus* sp., *Acartia tropica* & *Bestiolina similis*
Dominant zooplankton	Nauplii, Gastropod veliger & Decapod larva	Nauplii, Heteropoda & Polychaete larvae	Nauplii, Decapod larvae & *Oikopleura* sp.	Nauplii, Decapod larva & Gastropod veliger
Species Composition				
Copepods	10 species & 10 genera	8 species & 8 genera	13 species & 11 genera	12 species & 8 genera
Zooplankton	19 taxa	14 taxa	10 taxa	20 taxa

Ctenophores are exclusively marine and were observed in the downstream of the Amba River indicating dominance of seawater. The mean density of zooplankton varied in a descending order (93 ind.m^{-3}, 78 ind.m^{-3}, 74 ind.m^{-3} and 67 ind.m^{-3}) from post monsoon to summer. Based on non-metric multidimensional scaling (nMDS) orientation, the temporal variation in the zooplankton community structure is evident with stress value of 0.15. The nMDS orientation shows the clustering of May 2017 samples separated from other seasons could be due to less fresh water influx and peak summer in the locality (Fig. 4.19). Table 4.12 describes the average density, abundant species and zooplankton taxa from different seasons studied from the Amba River.

Figure 4.20: Some commonly found zooplankton species in Amba River. (a,b,c,d)-Fish larva; (e,f)-Amphipod; (g)- Unidentified insect; (h)- Megalopa; (i)-Cummacea; (j,k)- Decapod larva; (l)- Lucifer sp.; (m)- Mycidacea; (n)- Gastropod veliger; (o)-Acartia spinicauda; (p)- Labidocera androsoni; (q)- Pseudodiaptomus sewelli; (r)-Metis sp.

Usually copepods are key component of zooplankton in the coastal and estuarine region, However, in Amba River, the species diversity was less in all season ranging from 8 to 13 species. The diversity was always high in the estuarine (near mouth) region. However, the diversity index based on the richness and evenness of the species in the study area indicated a balanced aquatic ecosystem.

The availability of larval mollusc, fish eggs and larvae and considerable abundance of decapod larvae in the estuaries and mangroves region indicate the survival of abundant meroplankton (littoral and nektonic forms). Nevertheless, the frequent occurrences of demersal fauna, e.g. cummaceans in the surface water attribute to the bottom disturbance caused by dredging, sand mining and other activities.

Zooplankton like. ctenophores are exclusively marine and were observed in the estuary mouth indicating seawater intrusion and decreased flux of fresh water during March 2018. In addition, the multivariate statistical analysis (nMDS) showed a significant temporal variation in the zooplankton community structure could be due to seasonal salinity fluctuations and water temperature in the Amba River.

Benthos

Benthos is a community of organisms that live in, on or near the sediments. Benthic organisms are important part of the marine ecosystem and play a critical role in maintaining ecological balance. They are not only a major food source for many fish species but humans also consume some of the large sized bivalves and crustaceans. Due to their natural sediment reworking capabilities, they play a very significant role in nutrient recycling in the sediment water-interface. Hence their role is critical in the biogeochemical processes. Benthic invertebrates are sedentary in nature and are sensitive towards environmental changes. Hence they have been used as environmental indicators and are commonly used in the environmental impact assessment study as well as assessing health of marine environment. Based on their body size benthic communities are subdivided in the following size groups:

- Microfauna- 25-63µm
- Meiofauna- 45- < 500µm
- Macrofauna- 500 µm-1cm

Macrobenthic community in sediments play an important role such as mineralization, mixing of sediments through burrowing activity, flux of oxygen into deep sediments, nutrients cycling, dispersion and burial and secondary production. It is an important component of food chain as it provides a key linkage between primary producers and higher tropic levels like larger consumers such as crabs, fish and seabirds.Most of the macrobenthic species usually have long life cycle and

stable community composition and therefore their populations can be used as monitoring index for any disturbance. Some of the dominant forms such as polychaetes are active bioturbators and hence termed as conveyor-belt organisms.

The meiobenthos enhances the rate of carbon mineralisation by stimulating microbial activity through predation, and/or consumption of detritus by larger deposit-feeding invertebrates. They act as potential microbioturbators and could considerably increase the transport of solutes and reaction rates in sediments. Meiobenthic fauna through their mucus secretion helps in stabilization the sediment. Typically, they are very active organisms and the dominant are usually nematodes (Nematode) and harpacticoid copepods (Crustacea Copepoda). The meiobenthic nematode communities are known to amplify energy flow, organic matter mineralization rates, enhance the recirculation of nutrients and have significant influence on the productivity of shallow waters.

Meiofaunal samples were collected from the same stations where macrobenthic sample collection was done. Meiobenthos were collected using a 10cm^2 size PVC corer and samples were the transferred in the zip-lock plastic bags and were properly labelled. 5% formalin stained with Rose Bengal solution was added. Identification was done up to the lowest possible level following standard taxonomic keys. The total count (no. of organisms per sample) of fauna was determined from each station

Faunal composition

The total macrobenthic community were represented by 19 taxa belonging to 11 major groups. Macobenthic community from the study area was dominated by Brachyura (46%) followed by *Nephtys sp*. (31%), *Nereis sp*. (15%), Ampeliscidae (8%). The total macrofaunal density was found around 1,711 ind/m^2. Macrofaunal composition and density from the study area was shown in Table 4.13

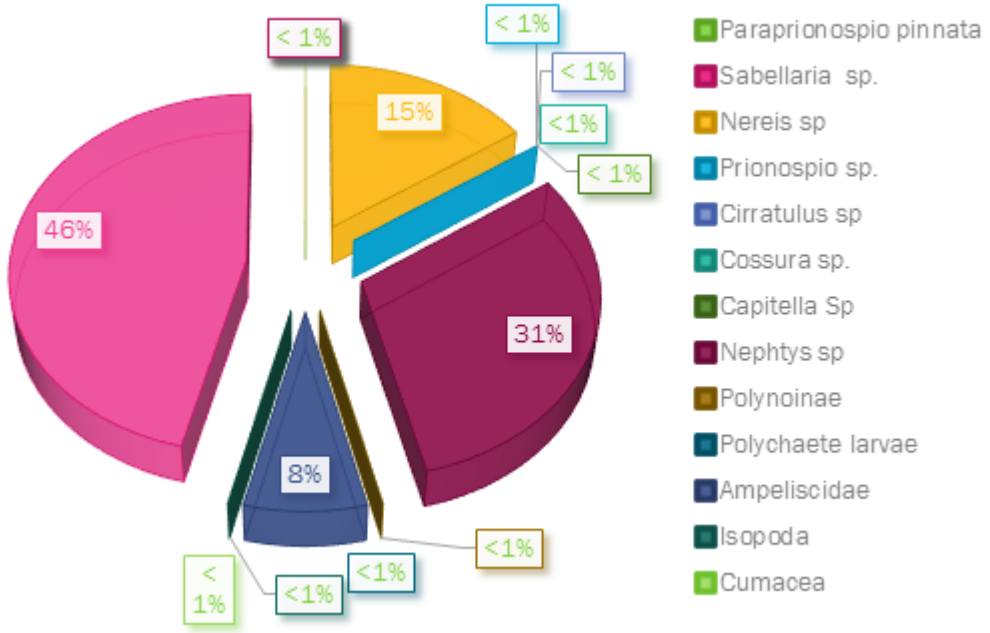


Fig. 4.21. Percent composition of total macrofauna in Amba River and estuary

Meiofauna

Meiofaunal density was found about 919 ind/10 cm^2. Meiobenthic community from the study area was dominated by Crustacean larvae (55%) followed by Harpacticoida (31%), and Nematoda (14%). Meiofaunal composition and the density from the study area is given in Table 4.14

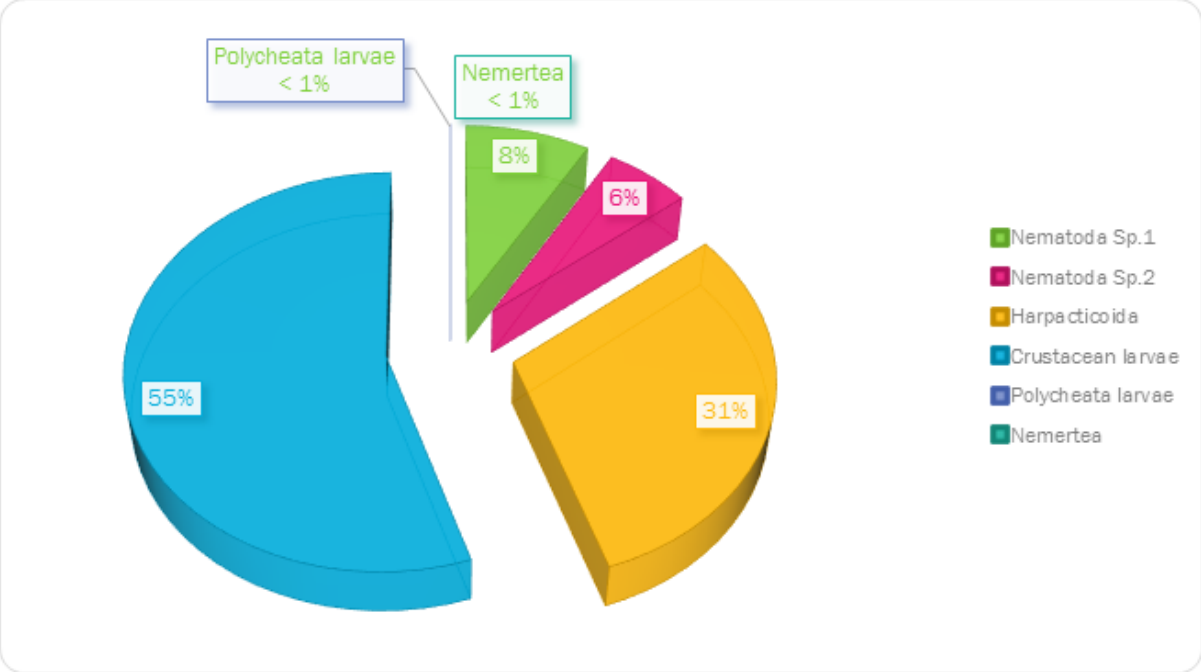


Fig. 4.22. Pie chart showing the composition (%) of total meiofauna in Amba river

Species indices of macrofauna

Among the sampled stations, St-3 showed higher species diversity and highest species richness. Specifically, St-8 showed lowest diversity, dominance and species richness as the only organism found was *Paraprionospio pinnata.* No macrofauna was found at St-4.

Table 4.13: Species indices of macrofauna studied

Sample	d	J'	H'	1-λ'
St-1	0.5057	0.8691	1.205	0.6645
St-2	0.5815	0.8962	1.242	0.6705
St-3	1.258	0.9826	2.043	0.8675
St-4	****	****	0	****
St-5	0.4478	1	1.099	0.6744
St-6	0.2104	0.8113	0.5623	0.3783
St-7	0.3527	0.8587	0.9433	0.582
St-8	0	****	0	0
St-9	0.8037	1	1.609	0.8056
St-10	0.5646	0.8322	1.154	0.6153

Table 4.14: Species indices of meiofauna studied

Sample	d	J'	H'(loge)	1-λ'
St-1	0.4595	0.7684	1.065	0.5927
St-2	0.6667	0.9201	1.276	0.7119
St-3	0.346	0.9641	0.6682	0.5033
St-4	0.3693	0.8366	0.5799	0.419
St-5	****	****	0	****
St-6	****	****	0	****
St-7	0.5771	0.9659	1.061	0.6633
St-8	1.045	0.9716	1.564	0.7981
St-9	0	****	0	0
St-10	0.346	0.9641	0.6682	0.5033

However, for the meiofauna, the maximum values of H', 1-λ', d and J' were 1.56, 0.8, 1.04 and 0.97 respectively (Table 4.12). At Station-8, higher species diversity, richness, evenness and dominance were recorded. Lowest evenness was recorded in Station 1 and no meiofauna was recorded at Station-5 and 6.

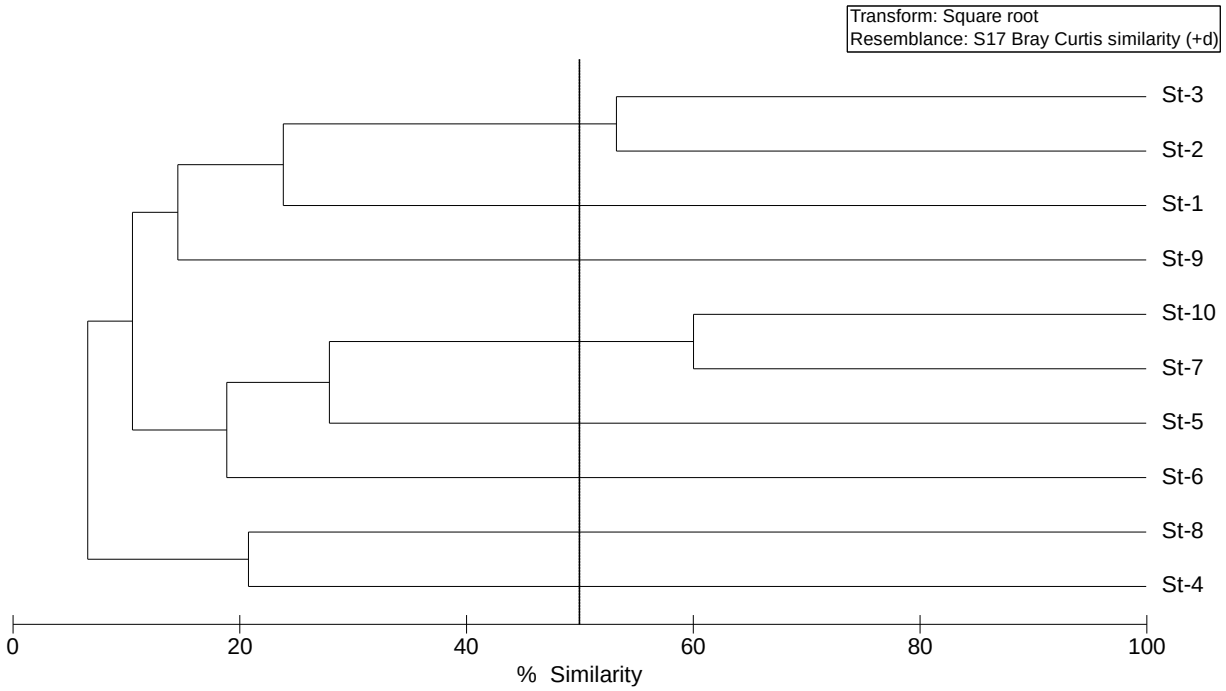


Fig. 4.23. Cluster analysis of macrofauna in the present study

Bray–Curtis cluster analysis for macrofauna:

Percentage similarity (Bray-Curtis) cluster analyses based on the macrofaunal assemblage has showed that 10 stations were grouped into 2 major clusters (Fig. 4.23). First cluster included St1, St- and St3,, indicating the presence of low saline zone and consequent occurrence of *Nereis sp*. The presence of *Sabellaria sp*. and Nemertea at St7 and St 10 resulted in the second cluster (Fig. 4.23 and Fig. 4.24).

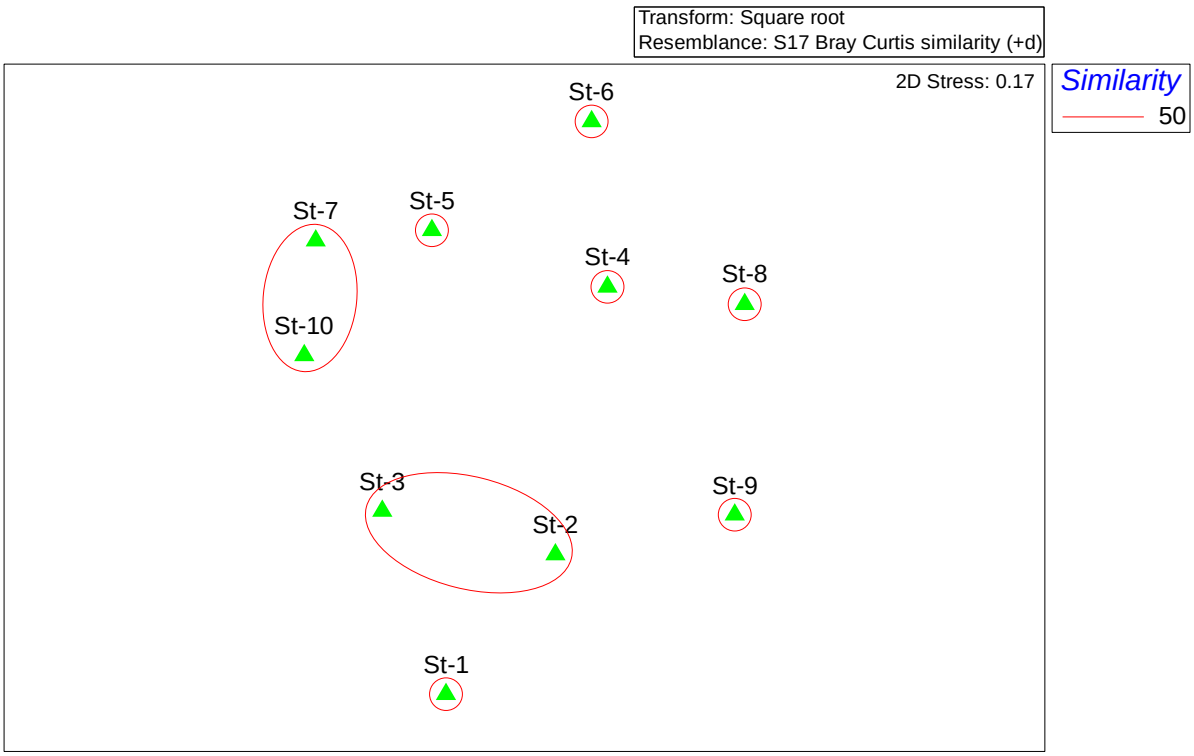


Fig. 4.24: nMDS graphical representation of cluster analysis for macrofauna

Bray–Curtis cluster analysis for meiofauna:

Bray–Curtis cluster analysis for meiofauna was also carried out and grouped 10 stations into 2 major clusters (Fig. 4.25). Based on the presence of nematodes at St 3, St 9, and St 10, these stations were grouped into one cluster, indicating common meiofauna diversity. The similarity percentage based on meiofaunal species composition was greater than 60% (Fig. 4.25 and 4.26). Community structure or species composition of benthic invertebrates has genetrally been used in environmental monitoring and assessment of aquatic systems.

In Amba River, overall low abundance of macro and meio benthos was found from the sampling stations. Macrobenthic was majorly dominated by Nemertea, Ophiuroidea and Brachuyra. In Polychaeta *Nephtys sp, Nereis sp* and *Sabellaria sp* were the major dominant species. Polychaetes such as *Paraprionospio pinnata* (deposit feeder) and *Nephtys sp., Nereis sp*. (carnivore) were found generally abundant in the semi-polluted condition. Among sampled stations, with respect to macrobenthos station 8 showed lowest diversity, dominance and species richness because the only organism found was Polychaeta (*Paraprionospio pinnata*). Whereas in the meiobenthos, station-8 showed higher species diversity, richness, evenness and dominance compare to other sampling locations. The crustacean larvae were found to be dominant taxa followed by Harpacticoida and Nematoda in meiofaunal community.

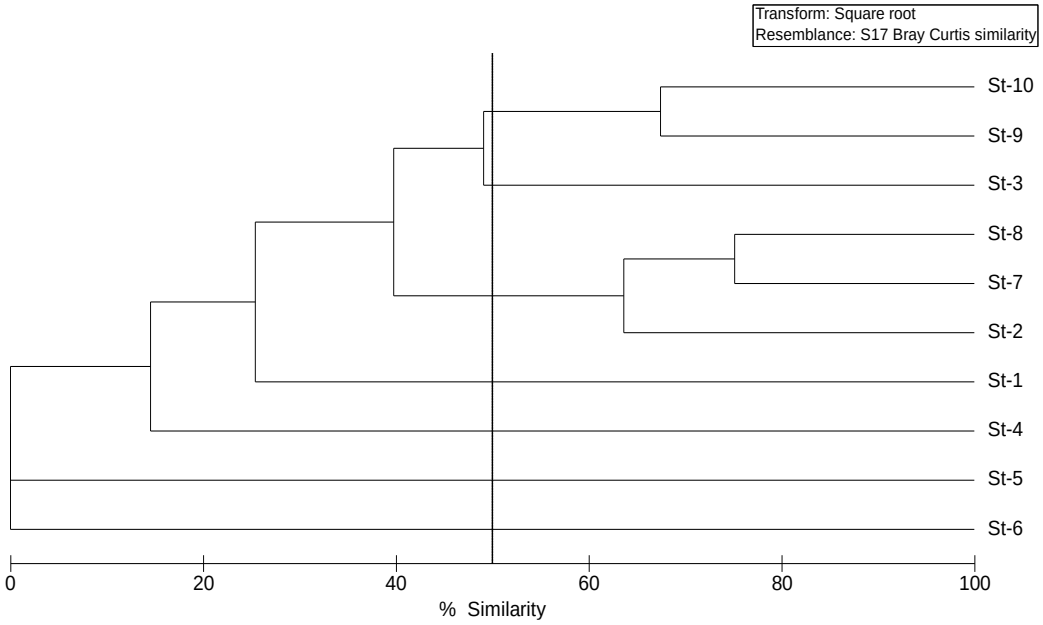


Fig. 4.25. Cluster analysis of meiofauna in the present study.

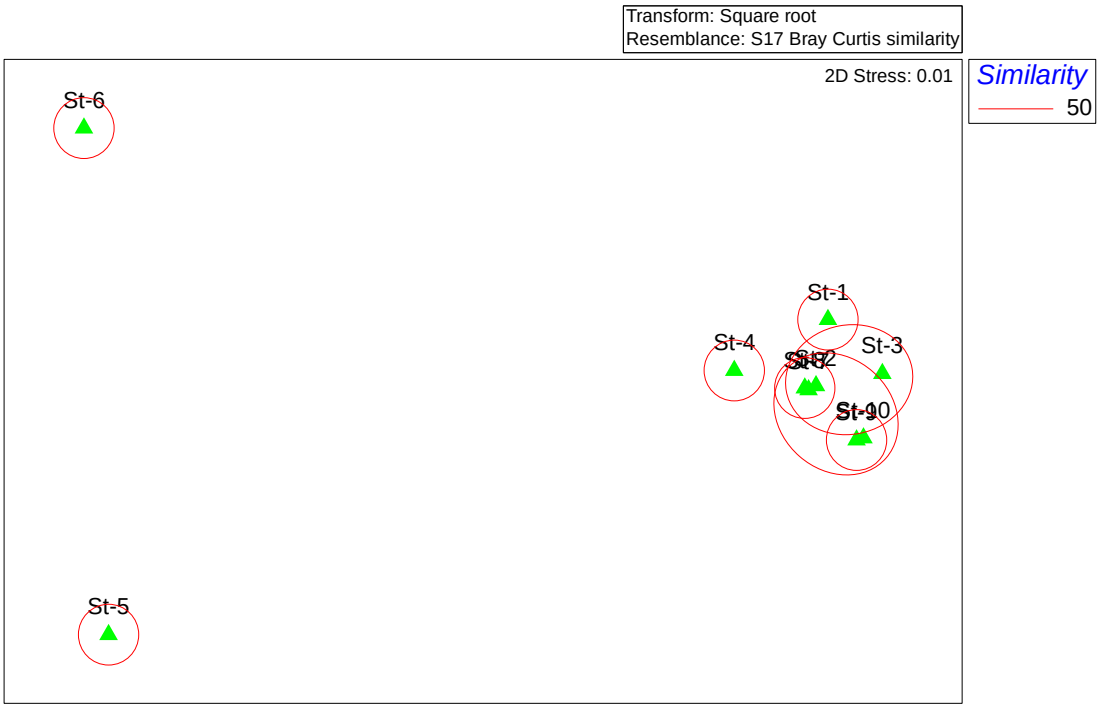


Fig. 4.26. nMDS graphical representation of cluster analysis for meiofauna

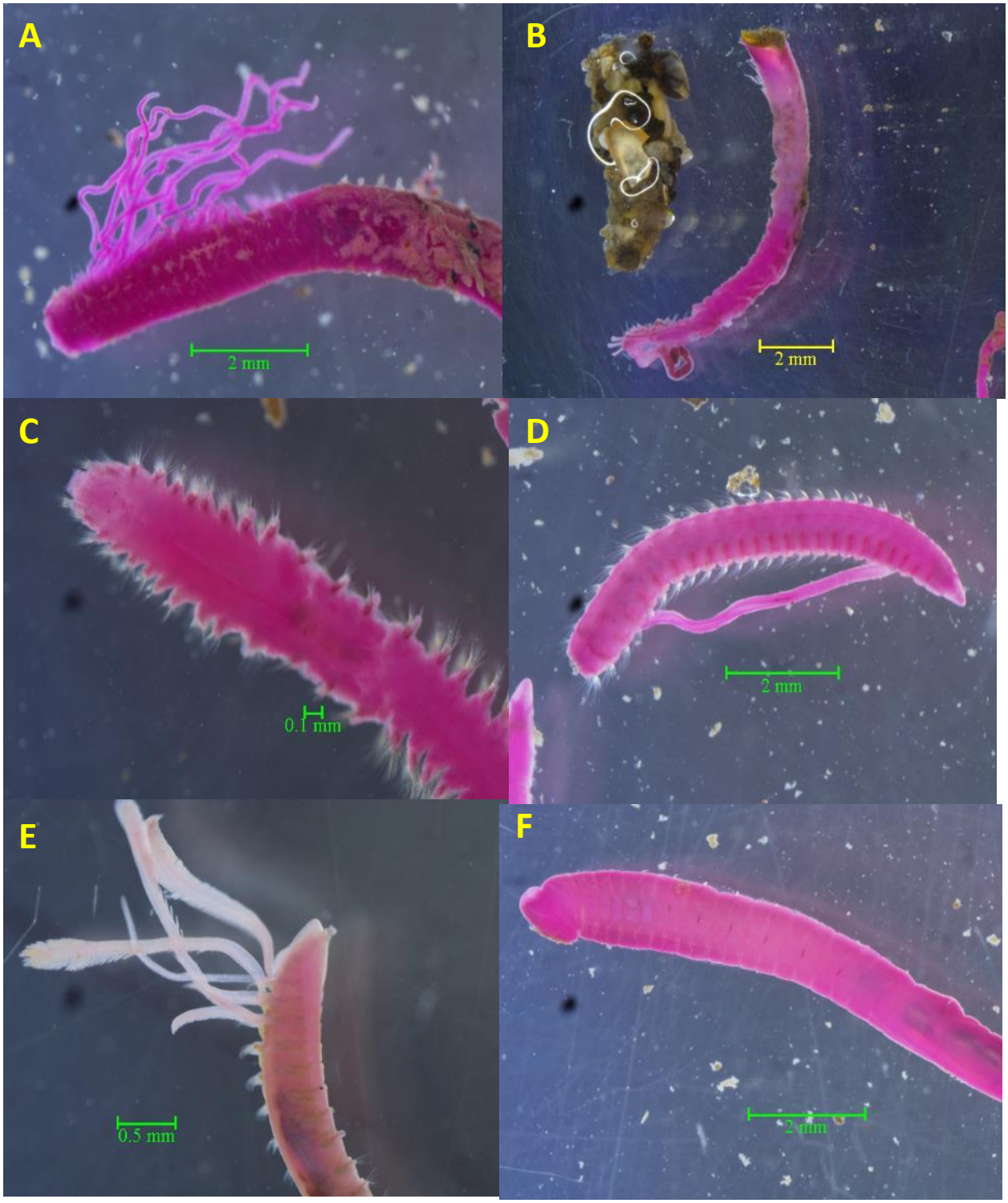


Fig. 4.27: Benthic polychaetes from Amba River. A, Cirratulus sp. B) Sabellaria sp. C) Nephtys sp. D) Cossura sp. E) Paraprionospio pinnata. F) Capitella sp.

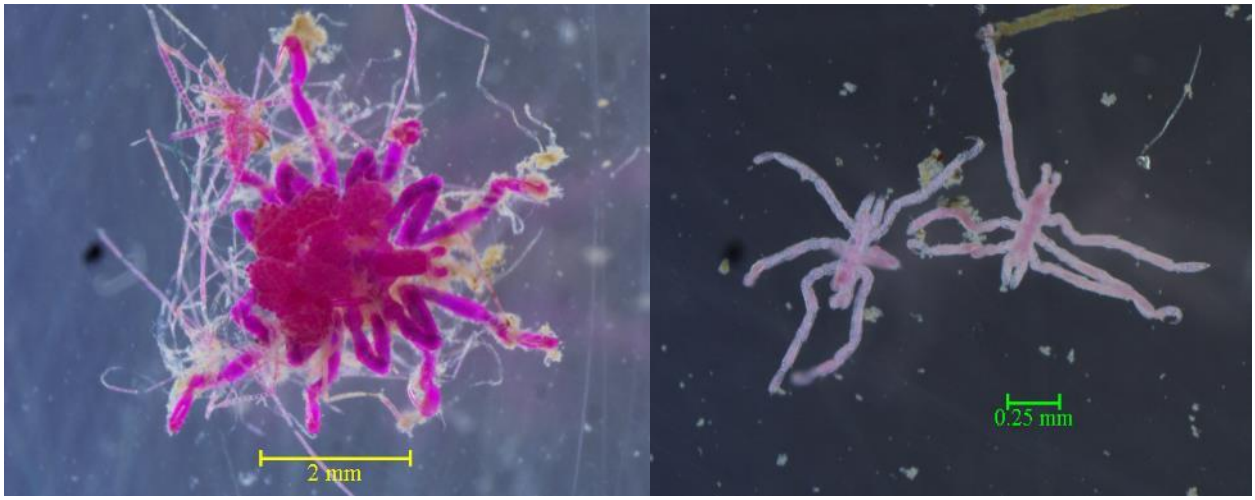


Fig. 4.28: Macrofauna from Amba River. A, Egg bearing Pantopoda B, Pantopoda.

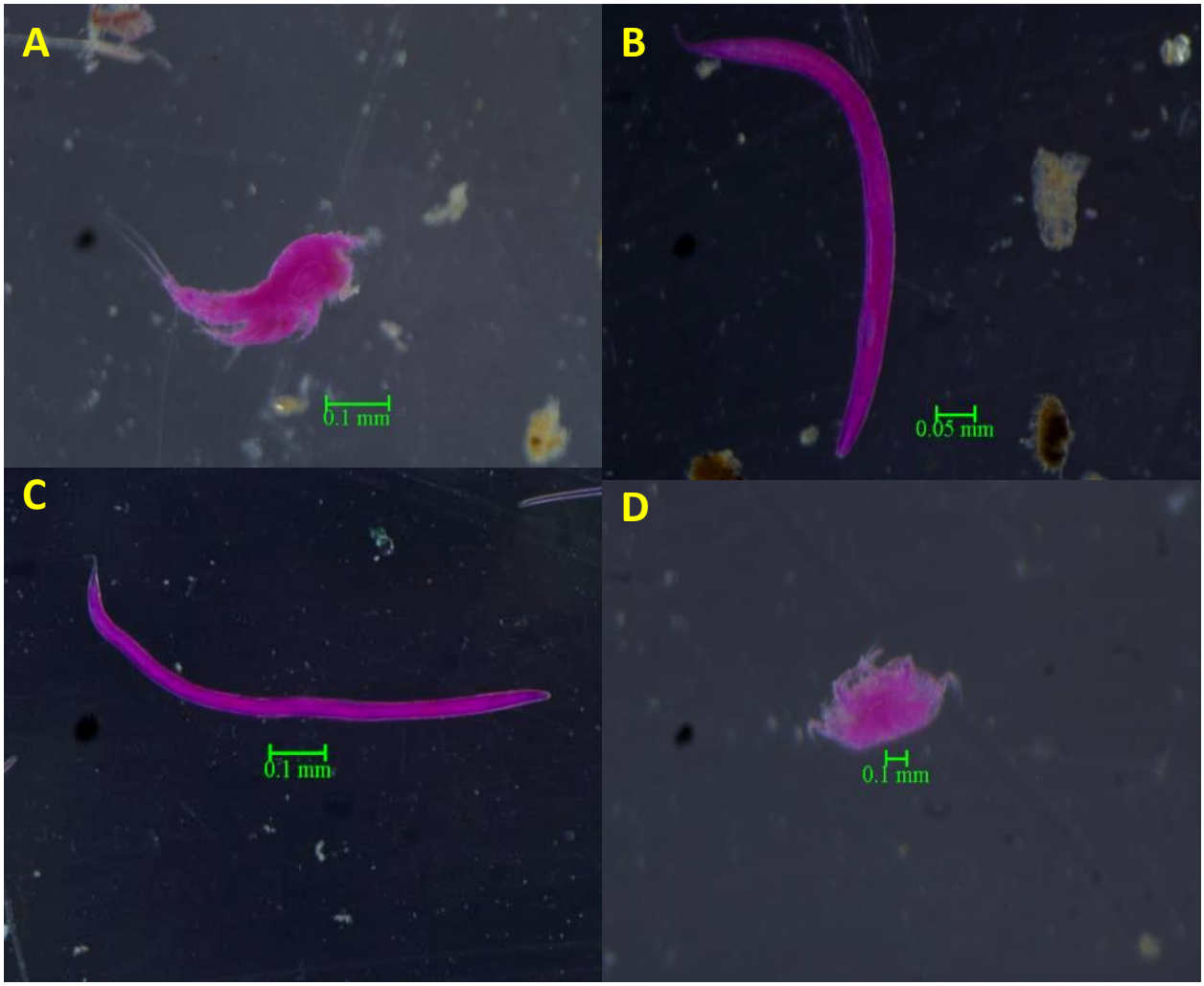


Fig. 4.29: Meiofauna from Amba River. A, Harpacticoida B, Nematoda sp.2 C, Nematoda sp.1 D, Crustacean larvae

5. Summary

A detailed survey was made at Dharamtar Jetty facility in Village Dolvi of District Raigad (Maharashtra) by a team of scientists from National Centre for Sustainable Coastal Management as per the recommendations of EAC, the Ministry of Environment, Forest & Climate Change vide MoEF&CC letter No. F. No. 11-79 / 2013-IA.III dated 26/11/2015.

The objectives of the survey were to carry out quarterly monitoring survey (4th) to assess the environmental quality and health. Following salient observations were made during the survey (March 2018)

(a) Air & Noise quality

- *Mean PM_{10} and $PM_{2.5}$ concentrations were well within the permissible limits prescribed for the industrial areas defined by CPCB.*
- *Occasional fluctuation subjected to specific port activities were observed during day hours.*
- *Lower concentrations were observed during October compared to the other months. However, deposition of a layer of fine black dust was observed on the leaves of mangroves and other terrestrial vegetation near the jetty.*
- *Peak sound pressure level was highest in present survey however the LEX8: L_{eq} (equivalent Continuous Sound Level corrected for 8 hour) was low*
- *These results showed that the noise level is satisfactory with respect to the CPCB standard.*

(b) Water and Sediment Quality

- Water quality was as per Class D of CPCB norms for surface water indicating that water was suitable for propagation of Wild life and Fisheries. River bed sediment was mostly clay silt in nature.
- High EC in the water can attributed to tidal inflow and mixing indicating a typical estuarine characteristic
- Dominance of diatoms indicated a healthy estuarine environment

(c) Flora & Fauna

- A total of 26 species under 19 genera of phytoplankton were observed in the field stations.

- *Water column was healthy with respect to phytoplankton particularly diatoms and zooplankton diversity Maximum phytoplankton population density was observed at estuarine mouth.*
- *Coscinodiscus oculus-iridis was the most abundant species as compared to other.*
- *Zooplankton composed of 23 taxa mainly dominated by Copepods. Bestiolina similis, Acartia spinicauda* and *Acartia tropica were the most abundant copepod species observed in the region*
- Meiofaunal density was high (919 ind/10 cm^2) and Crustacean dominated the diversity followed by Harpacticoida and Nematoda (14%)

Annex I

Check list of phytoplankton in the creek waters of Amba River

Stations	St.1	St.2	St.3	Mean	%	St.4	St.5	St.6	St.7	Mean	%	St.8	St.9	St.10	Mean	%
Cyanophyceae	Upper zone					Middle zone						Estuarine mouth				
Trichodesmium sp.	150	0	70	73.3	4.8	30	0	90	220	340	5.0	130	310	290	243.3	6.2
Bacillariophyceae																
Biddulphia sp.	20	0	10	10	0.7	0	0	20	0	20	0.3	0	40	0	13.3	0.3
Campylodiscus limbatus	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	70	23.3	0.6
Coscinodiscus asteromphalus	230	120	160	170	11.1	110	70	100	230	510	7.6	450	610	1240	766.7	19.6
Coscinodiscus centralis	80	100	100	93.3	6.1	190	220	170	370	950	14.1	440	670	1530	880.0	22.5
Coscinodiscus granii	40	70	30	46.7	3.1	110	70	100	220	500	7.4	260	300	170	243.3	6.2
Ditylum brightwellii	40	60	30	43.3	2.8	110	70	40	130	350	5.2	150	240	200	196.7	5.0
Ditylum sol	0	0	0	0	0.0	0	0	30	0	30	0.4	70	0	40	36.7	0.9
Navicula sp.	10	0	40	16.7	1.1	0	0	10	0	10	0.1	30	0	20	16.7	0.4
Nitzschia sigma	0	40	0	13.3	0.9	30	0	20	10	60	0.9	0	20	50	23.3	0.6
Nitzschia sp.	40	0	0	13.3	0.9	60	0	30	0	90	1.3	20	0	60	26.7	0.7
Odontella mobiliensis	560	350	280	396.7	26.0	420	190	220	560	1390	20.6	470	380	670	506.7	13.0
Odontella sinensis	220	140	170	176.7	11.6	110	130	100	90	430	6.4	150	220	130	166.7	4.3
Pleurosigma affine	170	210	270	216.7	14.2	230	160	220	100	710	10.5	230	200	170	200.0	5.1
Pleurosigma sp.	20	40	0	20	1.3	0	0	20	60	80	1.2	80	30	20	43.3	1.1
Pseudo-nitzschia sp.	230	170	100	166.7	10.9	180	150	250	140	720	10.7	190	220	290	233.3	6.0
Rhizosolenia setigera	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	40	13.3	0.3
Skeletonema costatum	0	0	10	3.3	0.2	0	10	0	0	10	0.1	10	20	70	33.3	0.9
Thalassionema frauenfedii	20	0	30	16.7	1.1	0	10	0	10	20	0.3	0	50	0	16.7	0.4
Thalassionema nitzschioides	0	0	0	0	0.0	0	0	0	0	0	0.0	60	0	0	20.0	0.5
Thalassiosira eccentrica	20	40	0	20	1.3	130	0	100	60	290	4.3	0	70	220	96.7	2.5
Thalassiothrix longissima	0	60	0	20	1.3	0	120	0	0	120	1.8	0	0	130	43.3	1.1
Triceratium sp.	0	30	0	10	0.7	70	0	30	20	120	1.8	0	80	120	66.7	1.7
Density (cells/l-1)	**1850**	**1430**	**1300**	**1526.7**	**100.00**	**1780**	**1200**	**1550**	**2220**	**6750**	**100**	**2740**	**3460**	**5530**	**3910**	**100.0**

Annex II

List of copepod species and zooplankton diversity (ind. m^{-3}) at different stations

Zooplankton (ind. m^{-3})	JSW-1	JSW-2	JSW-3	JSW-4	JSW-5	JSW-6	JSW-7	JSW-8	JSW-9	JSW-10	Mean	Percentage
Acartia spinicauda	2.59	0.72	0	0	10.86	13.16	7.11	0.96	2.35	0.89	3.87	**1.85**
Acartia tropica	72.62	65.94	19.12	125.32	0	17.28	4.74	0	0	0	30.5	**14.59**
Acartiella erythraea	0	0	0	0	0	0	0	17.34	0	0	1.73	**0.83**
Bestiolina sp.	0	34.78	9.98	121.93	0	6.58	0	4.82	0	0	17.81	**8.52**
Parvocalanus sp.	44.96	39.85	3.33	113.46	244.43	116	33.17	34.68	18.82	0	64.87	**31.02**
Pseudodiaptomus sewelli	4.32	26.09	3.33	54.19	3.62	10.7	1.18	0	0	0	10.34	**4.95**
Pseudodiaptomus annandali	0	0	0	1.69	0	0	0	0	0	0	0.17	**0.08**
Pseudodiaptomus ardjuna	0	0	0	1.69	0	0	0	0	0	0	0.17	**0.08**
Tortanus forcipatus	0	0	0	0	0	0	0	0.96	1.18	0	0.21	**0.1**
Pseudodiaptomus copepodids	1.73	0	0	0	0	0	0	0	0	0	0.17	**0.08**
Eucalanus copepodids	0	0	0	1.69	0	0	0	0	0	0	0.17	**0.08**
Acartia copepodids	5.19	0	0	0	34.4	0	0	0	43.52	0.89	8.4	**4.02**
Labidocera copepodids	0	0	0	1.69	0	0	0	0	1.18	0	0.29	**0.14**
Calaniod copepodids	0	0	5.82	47.42	0	50.19	14.21	23.12	24.7	0.89	16.63	**7.95**
Harpacticoida	0	0	0	0	3.62	0	0	0	0	0	0.36	**0.17**
Hydromedusa	0	0	0	0	0	0	0	2.89	0	0	0.29	**0.14**
Chaetognaths	3.46	5.8	1.66	1.69	8.15	4.11	4.74	3.85	1.18	0	3.46	**1.66**
Lucifer sp.	0.86	0	0	0	0	0	0	0.96	1.18	0	0.3	**0.14**
Oikopleura sp.	0	0	0	0	0	2.47	2.37	3.85	0	0	0.87	**0.42**
Nauplii	0	44.92	13.3	5.08	57.94	0	7.11	69.35	49.41	0	24.71	**11.82**
Decapod larva	1.73	23.19	0.83	13.55	0	45.25	18.95	19.26	22.35	3.55	14.87	**7.11**
Fish larva	0.86	0.72	0.83	3.39	12.67	0	1.18	0.96	2.35	1.78	2.48	**1.18**
Polychaete larvae	0	0	0	0	0.91	0	0	0.96	0	0	0.19	**0.09**
Gastropod veliger	1.73	20.29	0	0	3.62	5.76	1.18	0	0	0	3.26	**1.56**
Foraminifera	0	0	0	0	0	0	1.18	0	0	0	0.12	**0.06**
Amphipoda	0	0.72	0	0	0	0	0	0	1.18	0	0.19	**0.09**
Ctenophora	0	0	0	0	0	0	1.18	0	0	0	0.12	**0.06**
Metis sp.	0.86	0	0.83	0	0	0	0	0	0	0	0.17	**0.08**
shrimp larva	0.86	0	0.83	0	5.43	0	2.37	0	0	0	0.95	**0.45**
Mycidacea	0.86	0	0.83	3.39	0	0	0	0	0	3.55	0.86	**0.41**
Cummaceans	0	0	0.83	1.69	0	0	0	0	0	0	0.25	**0.12**
Megalopa	0	0	0	0	0	0	0	0	1.18	0.89	0.21	**0.1**
Isopoda	0	0	0	0	0	0	0	0	1.18	0	0.12	**0.06**
Total	**142.65**	**263.02**	**61.52**	**497.88**	**385.66**	**271.49**	**100.69**	**183.97**	**171.74**	**12.44**	**209.11**	**100**

Annex III:

Macrofaunal abundance individuals/m² in Amba River

		Genera	St-1	St-2	St-3	St-4	St-5	St-6	St-7	St-8	St-9	St-10
Annelida	Polychaeta	*Paraprionospio pinnata*	0	0	0	0	0	0	0	58	0	0
		Sabellaria sp.	0	0	29	0	0	0	29	0	0	29
		Nereis sp	58	29	29	0	0	0	0	0	0	0
		Prionospio sp.	0	0	0	0	29	0	0	0	0	0
		Cirratulus sp	0	0	0	0	0	0	0	0	29	0
		Cossura sp.	0	0	0	0	0	0	0	0	29	0
		Capitella Sp	0	0	0	0	0	0	0	0	29	0
		Nephtys sp	116	0	0	0	0	0	0	0	0	0
		Polynoinae	0	0	0	0	0	29	0	0	0	0
		Polychaete larvae	0	29	0	0	0	0	0	0	0	29
Crustacea	Amphipoda	Ampeliscidae	29	0	29	0	0	0	0	0	0	0
		Isopoda	0	0	29	0	0	0	0	0	0	0
		Cumacea	0	0	0	0	0	0	0	0	29	0
		Brachyura	174	0	0	0	0	0	0	0	0	0
	Others	Nemertea	0	0	29	0	29	0	116	0	0	116
		Ophiuroidea	0	0	0	0	0	87	145	0	0	0
		Pantopoda	0	87	58	0	0	0	0	0	0	0
		Bivalve live	0	29	29	0	0	0	0	0	29	0
		Anemone type larvae	0	0	29	0	29	0	0	0	0	0
		Nematoda	0	0	0	0	0	0	0	0	0	29

Annex IV

Meiofaunal abundance individuals/m² in Amba River

	Genera	St-1	St-2	St-3	St-4	St-5	St-6	St-7	St-8	St-9	St-10
Nematoda	*Nematoda Sp.1*	58	32	7	0	0	0	11	14	15	11
	Nematoda Sp.2	40	29	11	0	0	0	0	0	0	0
Crustacea	*Harpacticoida*	209	22	0	0	0	0	14	11	0	0
	Crustacean larvae	378	0	0	11	0	0	0	7	0	0
	Polycheata larvae	0	7	0	4	0	0	7	7	0	0
	Nemertea	0	0	0	0	0	0	0	7	0	7

ANNEXURE II

F. No. 11-79/2013 - IA III
Government of India
Ministry of Environment, Forest & Climate Change
(I.A. Division)

Indira ParyavaranBhawan
Aliganj, Jorbagh Road,
New Delhi -110003

E-mail :aditya.narayan@nic.in
Telefax:011: 24695398
Dated: 26th March, 2016

To,

The Vice President (Projects),
M/s JSW Dharamtar Port Pvt. Ltd.
JSW Centre, Bandra- Kurla Complex, Bandra (E),
Mumbai-51 (Maharashtra)

E-mail: rasmiranjan.patra@jsw.in; santosh.nair@jsw.in; Phone: 022-42861000;

Subject : Expansion of Dharamtar Jetty facility at Dolvi of District Raigad (Maharashtra) by M/s JSW Dharamtar Port Pvt Ltd – Amendment in Environmental and CRZ Clearance.

Ref.: (i) Ministry's letter of even no. dated 26th November, 2015.

(ii)Your online proposal no. IA/MH/MIS/34131/2015 dated 9th December, 2015.

Sir,

This is in continuation of this Ministry's letter dated 26th November, 2015 regarding the above mentioned subject, wherein following points are mentioned:

At S.N. (iii) of para 4.0 of the Environmental Clearance and CRZ Clearance dated 26th November, 2015: "*There will be no disposal of dredged material into the sea. But to be reused for reclamation, and for shore enrichment based on its characteristics, as committed.*""

2.0 It was noted that CWPRS, Pune has carried out mathematical model study to determine the impact of the waterfront development. As per study report, it is reported that dumping ground is suitable for disposal of excess soil from the dredging. The granular and rocky materials could be used for landfilling and grading. Dumping location of the dredge spoil indicating the location of the disposal ground in the geographical coordinates viz. Disposal Ground No. 1 : 18°52'29.96"N, 72°52'17.98" E and Disposal Ground No. 18°45'11.97"N, 72°48'24.0" E. In this regard, PP has submitted the copy of corrigendum no MMCE/2015 dated 22.12.2015 issued by CWPRS, Pune showing locations of dumping grounds alongwith geographical co-ordinate.

3.0 The proposal was considered by the Reconstituted Expert Appraisal Committee (Infrastructure-2) in its 1st meeting held during 21st – 22nd December, 2015 and the Committee recommended the proposal for the following amendment:

i) As proposed, the granular and rocky materials shall be used for landfilling and grading. Other dredge materials shall be disposed at designated disposal ground off Mumbai Port as suggested by Central Water and Power Research Station (CWPRS), Pune indicating

the location of the disposal grounds in the geographical coordinates viz. Disposal Ground No. 1 : 18°52'29.96"N, 72°52'17.98" E and Disposal Ground No. 18°45'11.97"N, 72°48'24.0" E".

4.0 The Ministry accepts the recommendation of the Expert Appraisal Committee (Infrastructure - 2) for amendment in the existing environmental clearance subject to compliance of specific conditions and general conditions.

5.0 All other conditions will remain unchanged.

6.0 In future, in case of change in the scope of the project, the company shall obtain fresh environmental clearance.

7.0 This issues with the prior approval of the Competent Authority.

(A N Singh)
Scientist D

Copy to:-

1.0 The Principal Secretary, Environment Department, Government of Maharashtra, 15th Floor, New Administrative Building, Mantralaya, Mumbai - 400 032
2.0 The Chief Conservator of Forests (Central), Kendriya Paryavaran Bhavan, Link Road No.3, Bhopal-462016.
3.0 The Chairman, Central Pollution Control Board Parivesh Bhavan, CBD-cum-Office Complex, East Arjun Nagar, New Delhi - 110 032.
4.0 The Chairman, Maharashtra Pollution Control Board, Kalpataru Point, 3rd and 4th floor, Opp. Cine Planet, Sion Circle, Mumbai-400 022.
5.0 Monitoring Cell, Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhavan, *Jorbagh Road*, New Delhi.
6.0 Guard File/Monitoring File/Record File.

(A N Singh)
Scientist D

ANNEXURE III

Final Report

On

Underwater noise monitoring at JSW Dharamtar Port Pvt. Ltd.

Submitted

To

JSW Dharamtar Port Pvt. Ltd., Raigad, Maharashtra

By

Department of Mechanical Engineering
Indian Institute of Technology Kharagpur
Kharagpur 721302, INDIA

July, 2017

NOTICE

THE INFORMATION IN THIS FINAL REPORT IS BASED ON AVAILABLE INFORMATION OBTAINED AT **JSW DHARAMTAR PORT PVT. LTD.** AND THE PROFESSIONAL EXPERTISE AND OPINION OF THE CONSULTANT FROM **INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR.**

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Introduction

This final report is made after executing two on-site measurements at JSW Dharamtar Port Pvt. Ltd. on the 3rd June, 2016 and 17th February 2017, as per the purchase order P.O. No. PO/JSWDPPL/16-17/03 dated 27-05-2016. The underwater noise measurements were made duirng the piling operation. Two underwater measurements were done at a distance of 100 m and 2 km from the piling site in the Amba River. The general area of measurement in the Amba river near the port where piling is being done is shown in the Google Map in Figure 1.

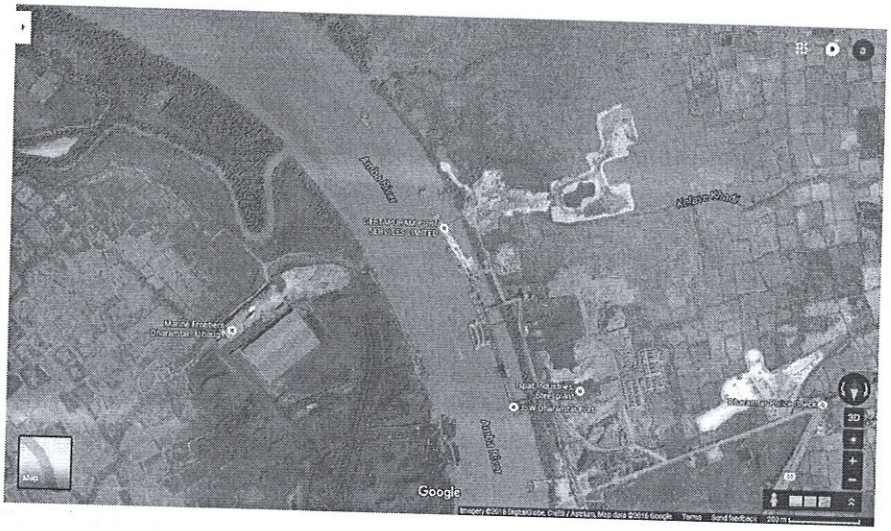

Figure 1: General area of measurement location

In this report the protocol of measurements as per established international maritime practices is adopted and for the sake of clarity, explicitly mentioned. This is followed by a description of the measurement equipment used and the analysis of the underwater noise.

The report concludes with a set of recommendations to be followed for underwater noise monitoring, which can be a guidance for the environmental health of the marine eco-system.

Measurement Protocol

1.) The general guidelines of measurements of underwater noise provided in ISO 17208.
2.) The hydrophone used for measurements must comply with IEC 60500 standard.
3.) The hydrophone must be calibrated both before and after measurements by a pistonphone calibrator.
4.) The ambient, temperature, local pressure and wind direction and speed condition must be reported. In general the weather condition be recorded.

5.) The locations of the hydrophone by a GPS system must be reported, along with the depth at which the hydrophone is placed.
6.) The hydrophone must have its appropriate battery powered signal conditioning amplifier.
7.) The hydrophone must be suspended in the water at the appropriate measurement height with a steel cable alongwith a weight at the bottom, so that the hydrophone doesn't sway sideways in the water.
8.) The analog signal from the hydrophone through the signal conditioning amplifier, be acquired by a computer aided data acquisition system with a minimum sampling frequency of 48 kHz. Adequate digital data points be captured so that the high frequency contents of the signal due to the piling impacts are captured.
9.) The data acquistion system must have adequate dynamic range to capture the signal, at a minimum it must be of 24 bit resolution with low pass anti-aliassing analog filters before the analog to digital conversion.
10.) The data acquistion system must have adequate on board memory to store the acquired digital data, and driven by a software with a GUI.
11.) The measurement report should contain the time history of the underwater measured noise by the hydrophones at all the locations.
12.) The peak level of the underwater noise at the measured locations be reported in dB (with reference of 10^{-6} Pa).
13.) The measurements should be made and reported in every quarter for a minimum of two years, to show the impact of piling on the marine environment eco-system.

Equipment Details

The details of the measuring equipment belonging to Indian Institute of Technology Kharagpur used in the measurements are given in Table 1.

Table 1. Equipment Details

Sl. No.	Equipment Name	Model No.	Serial No.
1.	Hydrophone with integrated 10 m cable	B&K 8104	2487076
2.	Charge Amplifier	B&K 2635	2744066
3.	Data Acquisition System	NI USB 4431	14287FB
4.	Hydrophone Calibrator	B&K 4229	2733820
5.	Laptop with NI LabVIEW Software	Dell Latitude E6430	3897281793

A view of the equipment on the boat used during measurement are shown in Figure 2. Figure 3. Shows the hydrophone cable along side the anchoring chain from the boat.

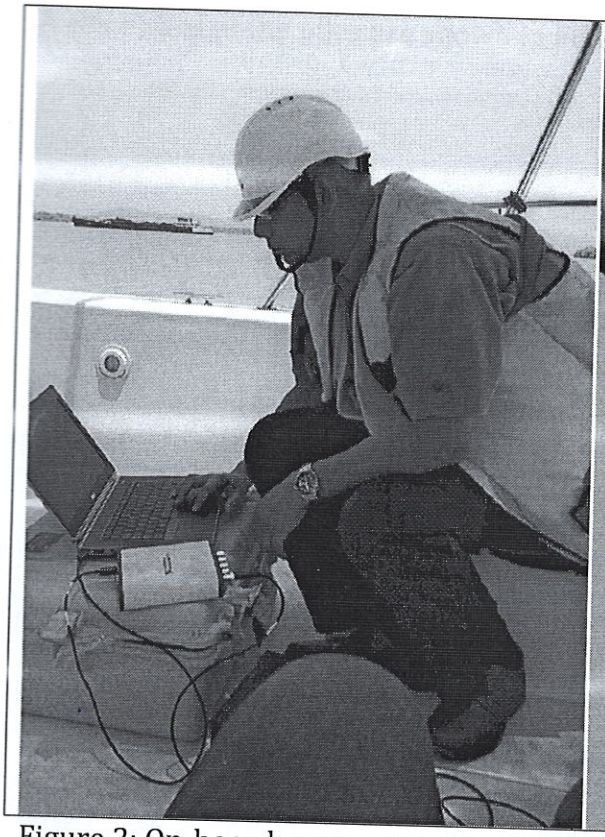

Figure 2: On-board measurement equipment

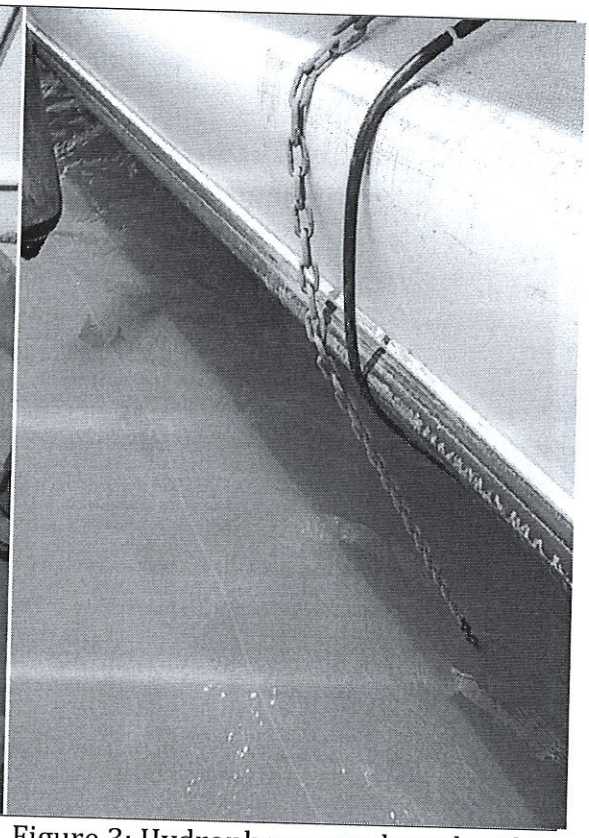

Figure 3: Hydrophone overboard with guide chain.

Piling Details

A view of the piling machine on the Amba river is shown in Figure 3. The pile had a weight of 1.5 tons, being dropped from a height of 1.5 m dropped by a pneumatic power source, which corresponds to a pile energy of 22 kJ. The pile diameter is of 0.5 m.

Figure 3. View of the pile in the background.

A close view of the piles are shown in Figure 4.

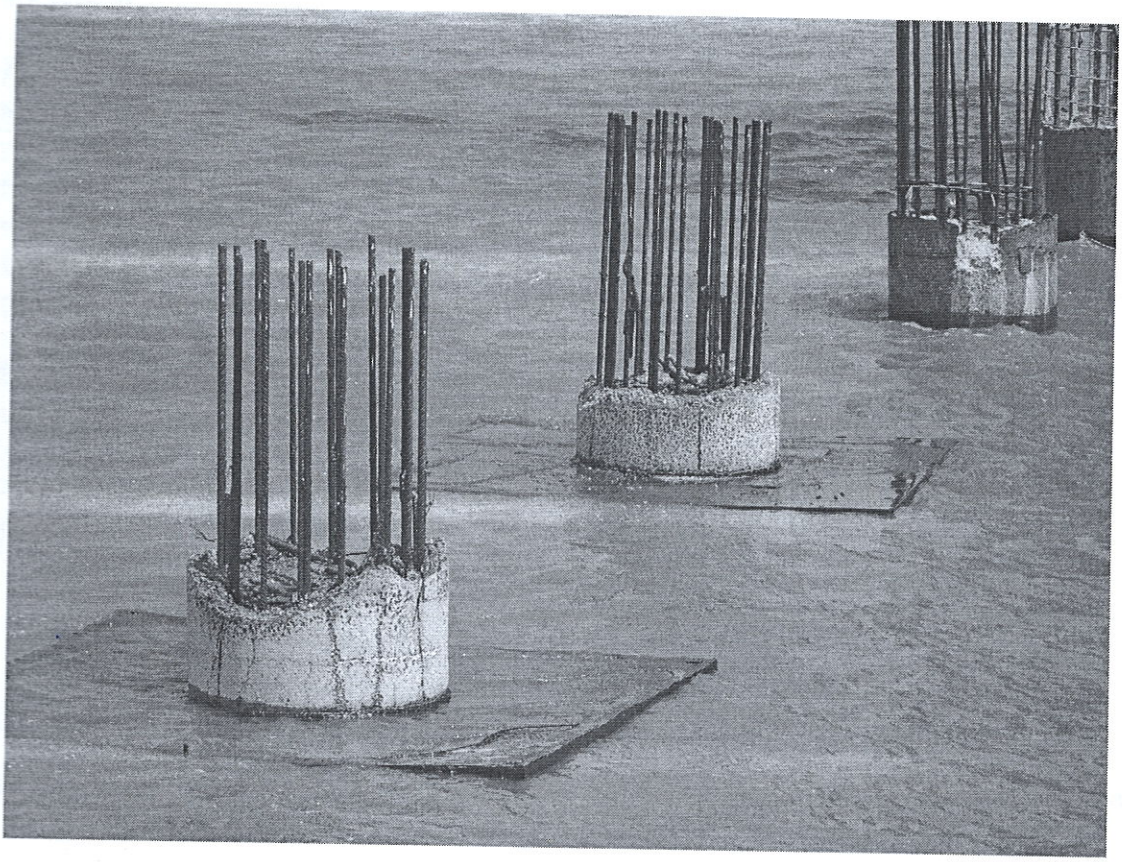

Figure 4: View of the 0.5 m diameter piles on the Amba river

Measurement Locations

A speedboat with outboard motors was used to traverse the site with the measuring equipment. During the measurements the speedboat outboard motors were switched off. It was noticed that at low tides the water waves splashed the boat hull and the boat drifted. However, care was taken to perform the measurements at the same location.

The GPS coordinates for measurement 1, 100 m away from the pile are 18^0 42'10"N $73^0$1'44"E. The GPS coordinates of measurement location 2, at a distance of 2 km away from the pile are 18^0 43'42"N 73^0 1'44"E for the measurements on the 3rd June, 2016.

Weather condition

During the measurements on 3rd June 2016 at Amba river, there were no rains, and the river was calm, with calm wind blowing. The ambient temperature was 33^0C.

Measured Time History

At each measurement location the underwater noise was measured using the hydrophone for a duration of 30 seconds at depths of every one meter from the river surface. The signal from the hydrophones were acquired at a sampling frequency of 50 kHz and for a 2 second time history, 100000 digital data points were stored, using a data logger software developed in LabVIEW at the Indian Institute of Technology Kharagpur. Measurements were done for the case of no piling and the case of piling. The average depth of the river was within 5 to 6 m in the entire measurement zone. The measurements close to the river bed would have reflections from the bed, thus for all the cases the measurement time history at a location of 3 m from the river surface are shown.

Figure 5. shows the background noise at 100 m location from the pile at 3 m depth.

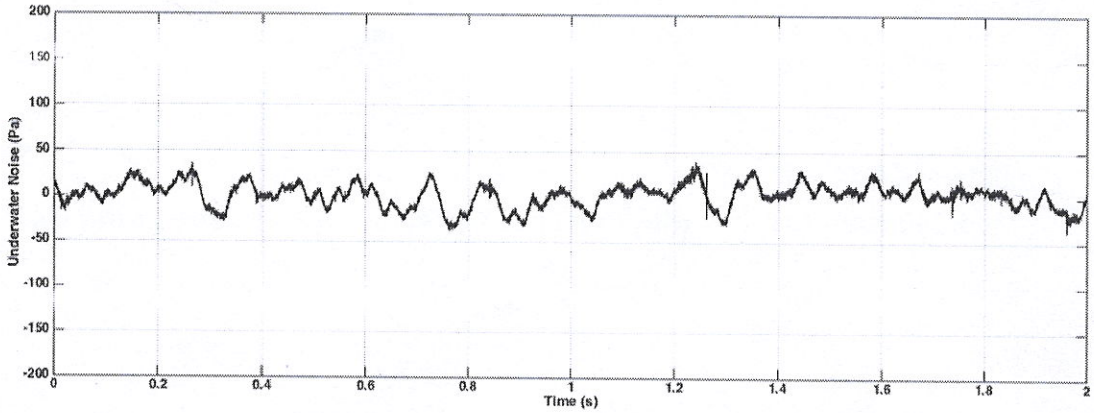

Figure 5: Measured underwater noise 100 m from piling location with no piling operation at a depth of 3 m.

Figure 6. shows the measured underwater noise at 100 m from the piling location while piling was being done.

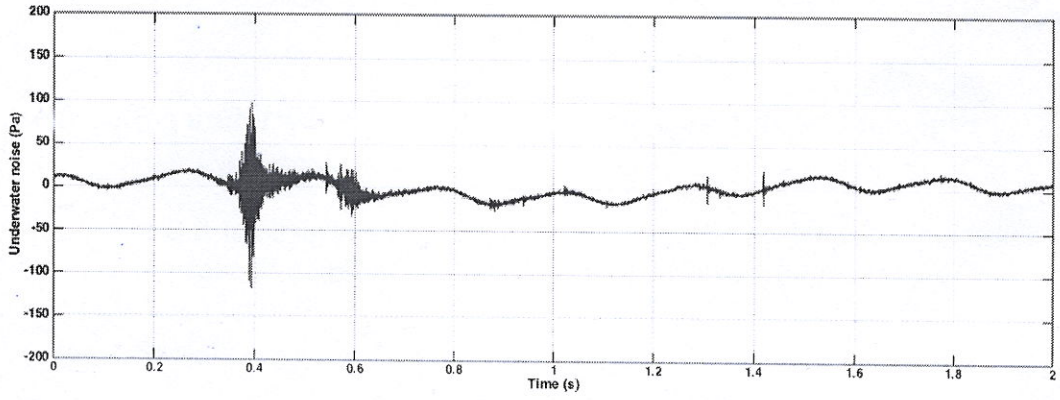

Figure 6: Measured underwater noise at 100 m from piling location during the piling at 3 m depth.

In figure 4m, the maximum impact noise of 100 m due to piling can be noticed at 400 ms.

Similar measurements were done at 2 km away from the pile, Figure 7 and 8 show the time history of the underwater noise without piling and with piling at 3 m depth.

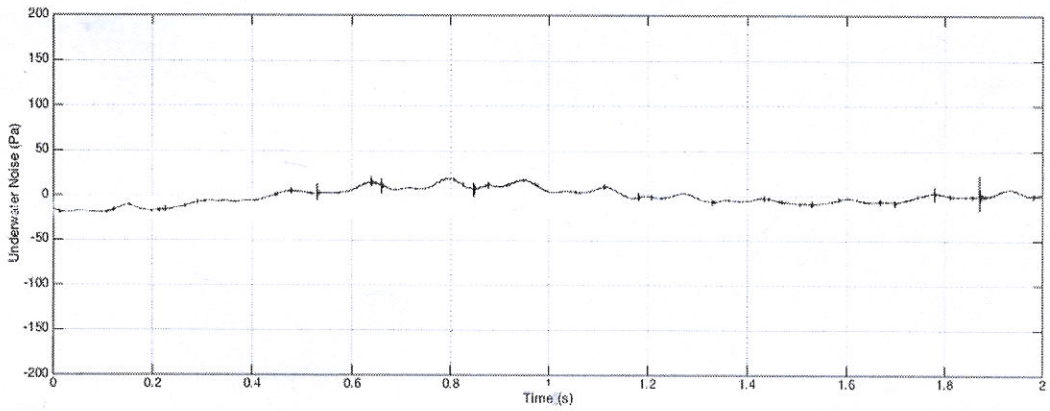

Figure 7: No piling underwater noise at 2 km from piling site at depth of 3 m

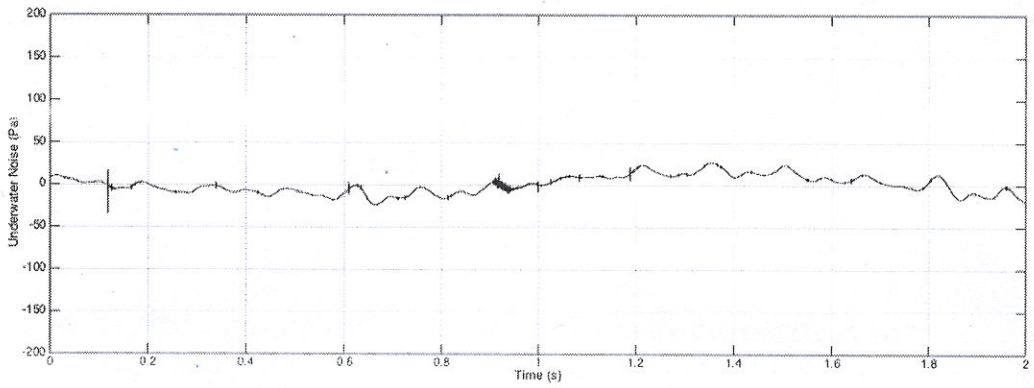

Figure 8: Piling underwater noise at 2 km away from pile at 3 m depth.

From Figures 7 and 8 it is observed that during the piling the underwater noise is almost equal to the case of no piling. And in Figure 6, around 900 ms the noise impact due to piling can be noticed.

Table 2 gives a summary of the underwater peak noise levels as measured at 3 m depth for the two locations. The underwater peak noise level given in Table 2 in decibel is with a reference of 10^{-6} Pa.

Table 2: Measured underwater peak noise levels at 3 m depth on 3rd June, 2016

Sl. No.	Distance from pile Location (m)	No piling	With Piling
1	100	25 Pa (147 dB)	100 Pa (160 dB)
2	2000	15 Pa (143 dB)	15 Pa (143 dB)

The underwater measurements were again done on the 17th February 2017 as per the previous protocol. Figure 9 shows the no piling noise at a distance of 100 m and a depth of 3 m from the piling source. And Figure 10 shows the measured noise for the case of piling.

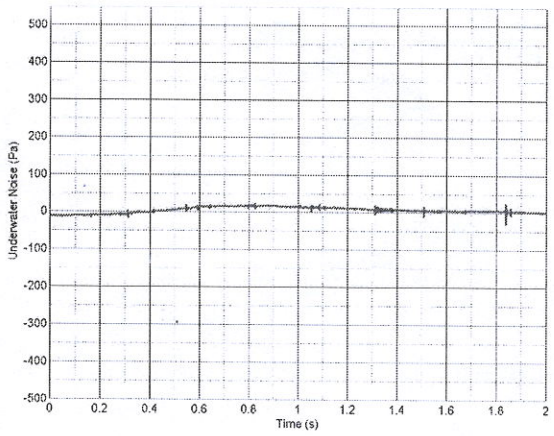

Figure 9: Measured underwater noise 100 m from piling location with no piling operation at a depth of 3 m on 17th Feb 2017.

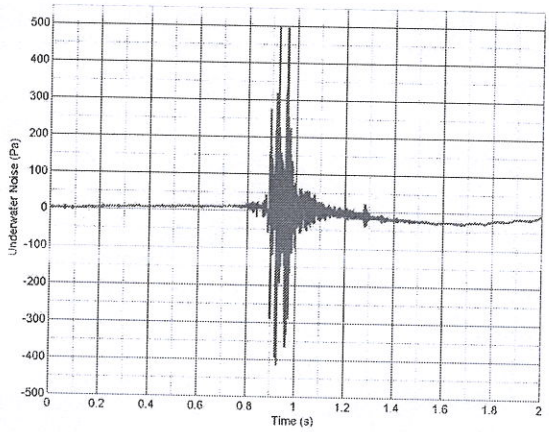

Figure 10: Measured underwater noise 100 m from piling location during piling operation at a depth of 3 m on 17th Feb 2017.

Similar measurements were done at a distance of 2 km from the piling source and are shown in Figures 11 and 12 for the no piling and piling case.

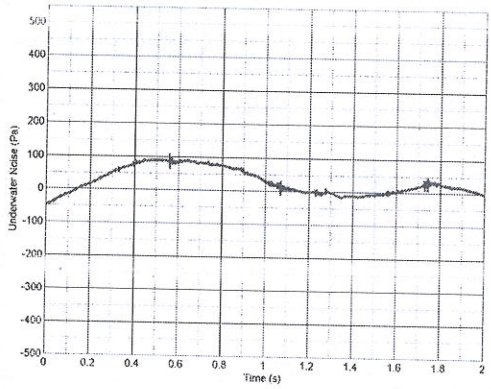

Figure 11: Measured underwater noise 2000 m from piling location with no piling operation at a depth of 3 m on 17th Feb 2017.

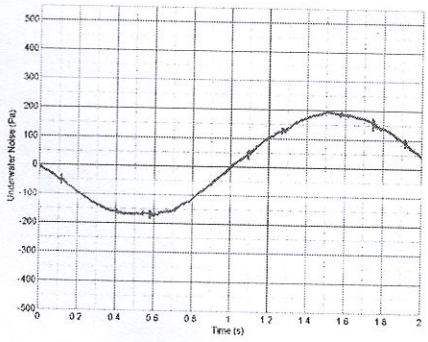

Figure 12: Measured underwater noise 2000 m from piling location during piling operation at a depth of 3 m on 17th Feb 2017.

Table 3 gives a summary of the underwater peak noise levels as measured at 3 m depth for the two locations on the 17th Feb 2017. The underwater peak noise level given in Table 3 in decibel is with a reference of 10^{-6} Pa.

Table 3: Measured underwater peak noise levels at 3 m depth on 17th Feb 2017

Sl. No.	Distance from pile Location (m)	No piling	With Piling
1	100	20 Pa (147 dB)	500 Pa (174 dB)
2	2000	15 Pa (143 dB)	15 Pa (143 dB)

Conclusions

From the measurements done at the site at two different times over a period of one year indicate that due to the year round piling activities being undertaken there is no significant change in the underwater noise levels at a distance of 2 km from the piling site.

For and behalf of Indian Institute of Technology Kharagpur.

Prof. A. R. Mohanty (Ph.D., University of Kentucky, USA)
Fellow Acoustical Society of India
Consultant-in-Charge
Professor of Mechanical Engineering
Indian Institute of Technology Kharagpur
Kharagpur 721302, INDIA

Tel: 03222-282944, Fax: 03222-255303
Mobile: +91-9434016966
Email: amohanty@mech.iitkgp.ernet.in
Web: www.iitnoise.com, www.iitkgp.ac.in

Dr. A. R. Mohanty
Professor
Mechanical Engineering Departmen
Indian Institute of Technology Kharagpur
KHARAGPUR 721 302, INDIA

Tel: (03222)-282944
Fax: (03222)-255303
Mobile: 94340-16966
Email: amohanty@mech.iitkgp.ernet.in
Web: www.iitnoise.com

Professor A. R. Mohanty is currently a professor in the department of mechanical engineering at the Indian Institute of Technology Kharagpur, where he has been a faculty since 1996. His specialization and research interests are in the areas of noise & vibration, condition monitoring, machine design, vehicle dynamics, underwater acoustics and instrumentation. At IIT Kharagpur he teaches Machinery Fault Diagnosis & Signal Processing, Noise and Vibration Control, Machine Design and Automobile Engineering. At IIT Kharagpur he has established a state-of-the-art research laboratory for Acoustics and Condition Monitoring. At IIT Kharagpur he is also a faculty adviser to the Formula SAE student's car project.

Dr. Mohanty obtained his B.Sc Engg (Hons) in Mechanical Engineering from the REC, Rourkela, (Now National Institute of Technology, Rourkela) in 1986. He holds an M. Tech Degree in Machine Design specialization from IIT Kharagpur. His Ph.D in the areas of noise control is from the University of Kentucky, USA and was a post-doctoral fellow at the Ray W. Herrick Labs of Purdue University, USA, in the areas of noise control. He has worked at Larsen & Toubro Limited, Mumbai and Ford Motor Company, Detroit, USA in their respective R&D divisions in the areas of noise and vibration.

Prof. Mohanty has been awarded the Chancellor's Award for Outstanding Teaching by the University of Kentucky, USA and the Rais Ahmed Memorial Award of the Acoustical Society of India, he is also a life fellow of the Acoustical Society of India. He has been awarded the overseas research fellowship of the National University of Singapore. He is a member of the national committee on noise pollution control of the Central Pollution Control Board of the Government of India. He is on the advisory and technical boards of many private and government organizations.

Prof. Mohanty has been a consultant to more than 50 companies in India in the areas of noise & vibration and machinery condition monitoring. Some such companies are Philips, Tata Steel, Larsen & Toubro Limited, Mahindra & Mahindra, Tata Motors, Tata Cummins, Escorts, Eicher Motors, John Deere, Whirlpool, Emami Paper Mills, Dhamra Port, Blue Star, SAIL Rourkela Steel Plant etc. He has more than 70 journal, one book chapter, one patent and over 100 conference publications to his credit in the areas of noise and vibration, condition monitoring and signal processing. Some of the path breaking researches of Prof. Mohanty are in the areas of Motor Current Signature Analysis for machinery condition monitoring and use of naturally occurring bio-degradable materials for industrial and automotive noise control.

Prof. Mohanty has several of his research projects sponsored by the Ministry of Human Resources Development, Ministry of Ocean and Earth Sciences, Ministry of Information Technology, Defense Research Development Organization of the Govt. of India, and many public & private sector industries in the areas of noise and vibration and machinery condition monitoring.

SHORELINE CHANGE STUDY

(DURING THE PERIOD 2009–2021) FOR JSW DHARAMTAR PORT, DOLVI RAIGAD DISTRICT, MAHARASHTRA

Submitted to

JSW Infrastructure Limited
Dolvi, Raigad District, Maharashtra

National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
GOVERNMENT OF INDIA

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GOVERNMENT OF INDIA

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1. Introduction

Beach erosion is a persistent problem all along the coast of India. An idealized definition of shoreline is that it coincides with the physical interface of land and water (Dolan et al., 1980). The shoreline can be defined as “the intersection of the land with the water surface” (Gill and Schultz, 2001). These statements are easy to define but difficult to capture owing to the changing water levels. Consequently, shoreline position changes continually through time because of cross-shore and alongshore sediment transport because of the dynamic nature of water levels of the coastal boundary (eg. waves, tides, groundwater, storm surge, run up etc.). Therefore, shoreline must be considered temporally and time scale chosen will depend on the context of the investigation (Elizabeth H. Boak, et al, 2005). Conventional mapping of shorelines using field survey and GPS requires lots of skilled man power and is a time-consuming process. Remote sensing is an effective tool that has ensured synoptic and repetitive coverage for the entire earth. Consistent interpretation technique which is visually discernible feature such as wet/dry line or previous high tide line can be achieved through multi-temporal satellite imagery. The impacts of shoreline change due to sea level rise over the next century poses a serious problem to social, economic and environmental concern (Pritam Chand, et al, 2010).

The shoreline changes for parangtritis, Yogyakarta was achieved by multi spatio-temporal data using Remote Sensing and Geographical Information System (GIS). Shoreline change analysis of erosion and accretion information is very important to calibrate and verify using numerical models (Hanson et al 1988) to assess sea level rise (Leatherman 2001), formulate policies, regulate coastal development (National research council (NRC) 1990), to assist with legal property boundary definition (Morton & Speed 1998), coastal research and monitoring (Smith & Jackson 1992). Nicholls et al 2013 examined long-term coastal change for England and Wales recognising the change dynamics i.e patterns of erosion and accretion in the vicinity of ports and estuaries. Thus, long-term shoreline changes are responsible for policy framework, shoreline management and for managing flood and erosion risks on changing coasts. The western tombolo of Giens in the South of France (Than & Lacroix, 2016) analysed the shoreline change analysis based on statistical methods derived from Digital Shoreline Analysis System (DSAS) model. Determination of shoreline change analysis in the Western tombolo helps to analyse the key factors driving the shoreline change. Global historical shoreline change assessment for the period 1984-2016 were identified using free available satellite images. It is found that 24% of the world’s sandy beaches are eroding, 28% are accreting and 48% are stable. These are due to human interventions such

as sand mining, coastal structures, sand nourishments and interception of longshore drift by coastal structures (Luijendijk et al, 2018).

Integration of coastal spatial information helps to support decision making processes. In this study, the term “erosion” is used to indicate the measured landward movement or retreat of the shoreline and the term “accretion” is the measured seaward progradation of the shoreline. Thus, shoreline change analysis identifies the erosion and accretion rates of change with different multi-temporal data and also to predict the future trends of shoreline movement.

2. Study Area and Methodology

JSW Dharamtar Port is located at Dolvi in Raigad district, Maharashtra, about 23 nautical miles from Mumbai Harbor. JSW Dharamtar Port is a riverine facility that handles bulk cargo. The study area is located at 18°42'12.34"N latitude, 73° 1' 45.50" E longitude, situated in the Dharamtar creek. The EC condition regarding shoreline change studies states that “(xviii) Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary. The details shall be submitted along with the six monthly monitoring report”. Therefore, the Client has requested NCSCM to study site specific shoreline change rates which have been estimated using satellite images for the years 2009-2021.

Short-term shoreline change for the study is based on the analysis of four satellite images for the period between 2009 to 2021. Table 1 shows the list of Data sources and the time period to determine short-term rates.

Table 1: Data source for extraction of shoreline

Year of Pass	Satellite	Resolution (m)
2009	Landsat TM	24
2016	Sentinel	10
2019	Sentinel	10
2021	Sentinel	10

The following figure 1 describes the flow diagram of shoreline change analysis.

3. Preprocessing of Satellite Images

Extraction of shoreline positions from these data sources involves georeferencing of satellite images using aerial photos and subsequently digital image classification of shoreline positions. Rigorous geometric correction of the satellite images is done for the following systematic and non-systematic errors. Systematic errors are

corrected through analysis of system characteristics and ephemeris such as scan skew, mirror-scan velocity variance, panoramic distortion, platform velocity, and earth rotation.

Non-systematic errors are mainly corrected for variation in altitude and sensor platform attitude using Ground Control Points (GCPs) (Jensen, 1996). Rectification of Satellite images involves georeferencing process i.e. process of assigning map coordinates to image data. In this study image-to-image, registration was applied to rectify satellite images using orthophotos as reference image in ERDAS Imagine software. Geo-referencing of all satellite images using orthophotos i.e to a common coordinate system is necessary in order to compare the historical images for analyzing the shoreline change rates of the entire Indian coast.

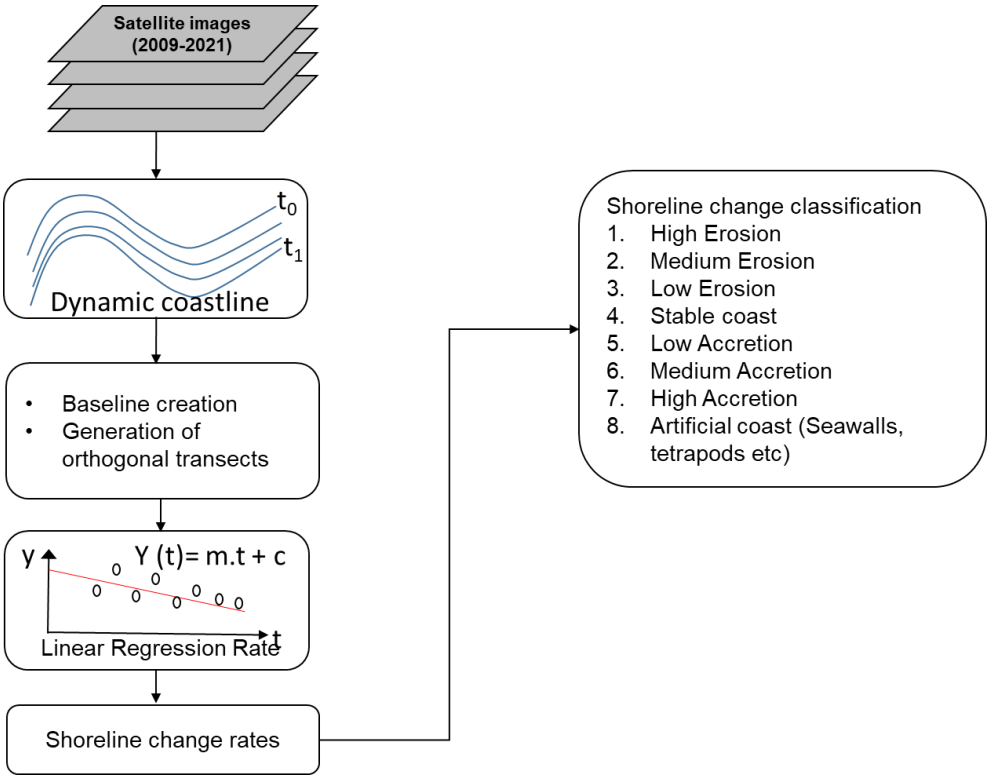


Figure 1. Workflow diagram for Shoreline change rate analysis

4. Shoreline Extraction

The next step is to extract shoreline position from these georeferenced satellite images and subsequently extracting shoreline using digital classification. Shoreline indicators were used to identify the morphological features and non-morphological features using satellite images for the years 2009, 2016, 2019 and 2021.

4.1 Shoreline Indicator

Because of its dynamic nature of the idealized shoreline boundary, practically shoreline indicators are adopted in defining the boundary. A shoreline indicator is a feature used as a proxy (fig.1) to represent the true shoreline position (Boak etal, 2005). In this study different shoreline indicators were adopted based on morphological and non-morphological features: i) Morphological features include vegetation line, berm crest, and cliff toe ii) non-morphological features include wet/dry line, high water line and iii) Man-made Structures such as seawalls These are selected based on location, data source, and scientific preference used to analyse the shoreline change, (Cheryl et al, 2010). Extraction of shoreline indicators have been processed through various image processing techniques.

4.2 Shoreline Proxies

Visual image interpretation technique for delineating shoreline was adopted manually for identifying the feature. Image interpretation is carried out using elements of visual interpretation techniques such as tone, size, shape, texture, pattern, colour and association. Using these elements, identified features like berm line, dune vegetation line, swash line, base of bluff/cliff, high water line, seawall and salt pan on the satellite images were mapped.

a) **Berm crest:** In the case of multiple berms, the most landward crest of the berm was chosen in the case of wide sandy beaches.

b) **Beach cusp:** The beach cusp is a crescent-shaped followed by accumulation of sand surrounding a semi-circular depression on a beach.

c) **Dune Vegetation line:** The toe of the foreshore face of the dune is considered as shoreline.

d) **High water line:** High water line (HWL) is considered as the best shoreline indicator by many researchers, because they mark the effective shoreline and is equivalent to "wet/dry line". HWL is the previous tide which is clearly identifiable from all images and is found most appropriate to analyse the shoreline changes.

e) **Onshore structures:** Seawall towards landward was consider for shoreline mapping, so that major significant change in long and short term rates was computed.

5. Digital Shoreline System Analysis (DSAS) model

Multiple shorelines extracted from satellite images were used to calculate shoreline change rates using Digital Shoreline Analysis System (DSAS) model developed by United States Geological Survey (USGS) in an ArcGIS environment (Thieler and other, 2009). DSAS employs the single-transect method (ST) to calculate change rates and rate uncertainties at regularly spaced transects (measurement locations) alongshore. ST uses various methods (for example, end point rate, least squares, weighted least squares) to fit a trend line to the time series of historical shoreline positions at a transect. ST is the most commonly utilized method for calculating shoreline change (for example, see Fletcher and others, 2003; Morton and others, 2004; Morton and Miller, 2005; Hapke and others, 2006; Hapke and Reid, 2007). Rates of short-term shoreline change were calculated approximately every 200 m alongshore using the linear regression calculation methods included in the Digital Shoreline Analysis System.

To calculate the rate of change, statistical baselines were constructed on the landward side at a distance of ~100 m adjacent to the series of shoreline positions. Transects were spaced approximately at 200m intervals alongshore, roughly perpendicular to the trend of the shoreline.

6. Computation Rates of erosion/ accretion using Linear Regression Rate (m/yr)

A linear regression rate-of-change statistic was determined by fitting a least-squares regression line to all shoreline points for a particular transects. The regression line is placed so that the sum of the squared residuals (determined by squaring the offset distance of each data point from the regression line and adding the squared residuals together) is minimized. The linear regression rate is the slope of the line. The method of linear regression includes these features:

1) All the data are used, regardless of changes in trend or accuracy, 2) The method is purely computational, 3) The calculation is based on accepted statistical concepts, and 4) The method is easy to employ. Shorelines were not delineated nor change rates calculated for river deltas because of the high natural variability and complexity of these shoreline reaches.

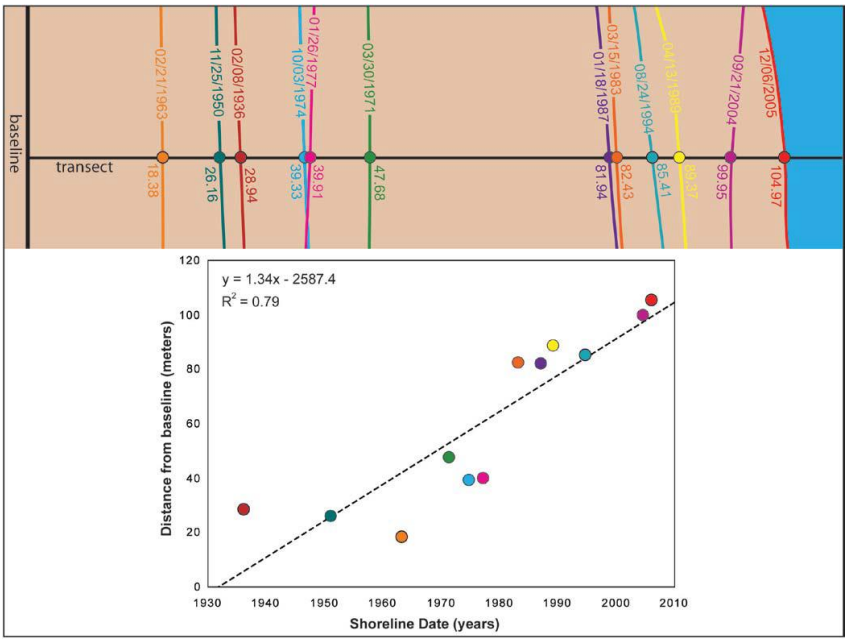


Figure 2: Shoreline position graph plot of the Linear Regression Rate Transect
(Source: Crowell and Leatherman (1999)

7. Results

Rates of shoreline change were evaluated for short-term change analysis from 2009 -2021 shown in Table 2.

Table 2: Classification of Shoreline Change Rates

Shoreline Classification	Length (km)	% of Erosion and Accretion	Cumulative % of Erosion and Accretion
Length of Coastline (km)	**28.52**		
Low Erosion	3.56	12.48	12.48
Stable coast	17.29	60.66	60.66
Low Accretion	7.66	26.87	26.87

The study area of Dharamtar port encompasses Amba River extends to a length of about 28.5 km. This region is found to be accreting and has an average rate of 0.11 m/yr (ranging from -1.77 m/yr to 1.85 m/yr). Rates of change for long term is predominated by stable coast in the for a length of about 8.7 km in the right side of the river and there is no much significant change in the left side of the river (8.6 km). Low erosion is more in the left side of the river for a length of about 3 km while there is a decrease in right side by a length of about 0.7 km. the length of the low accretion in the left side is found to be 3 km whereas right side occupies a length of about 5 km. Overall the coast shows 61 % stable coast, 27% low accretion and 12.5% low erosion.

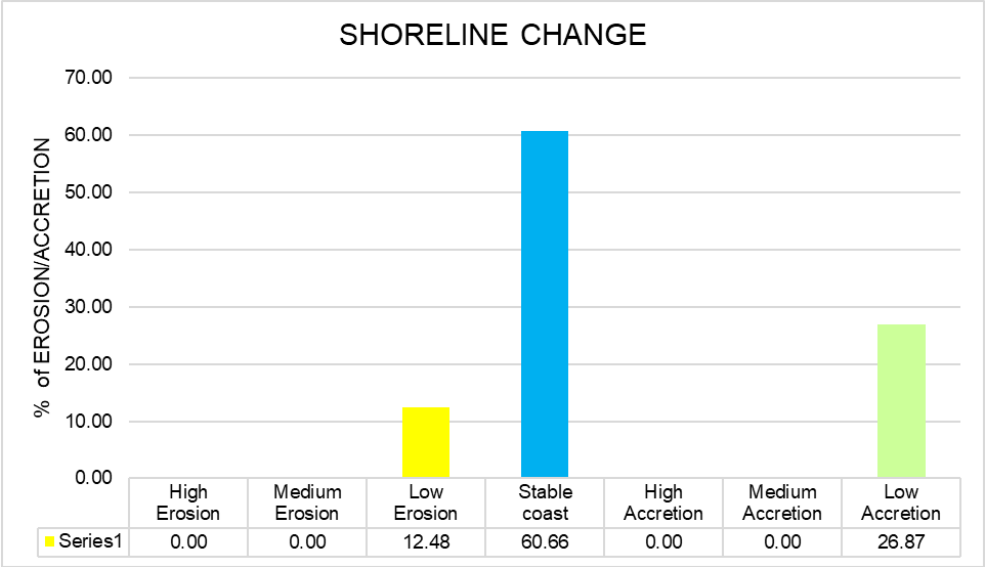


Figure 3: Percentage of shoreline change for short term

At Dharamtar port, both left and right side of the river has low accretion and stable coast and the net shoreline movement is found to be approximately 17m. Low erosion is more dominated in the lower portion of the left bank side of the river. From 2009 to 2021, the annual change rate of shoreline were found to be stable due to the continuous flow of sediment transport in the river.

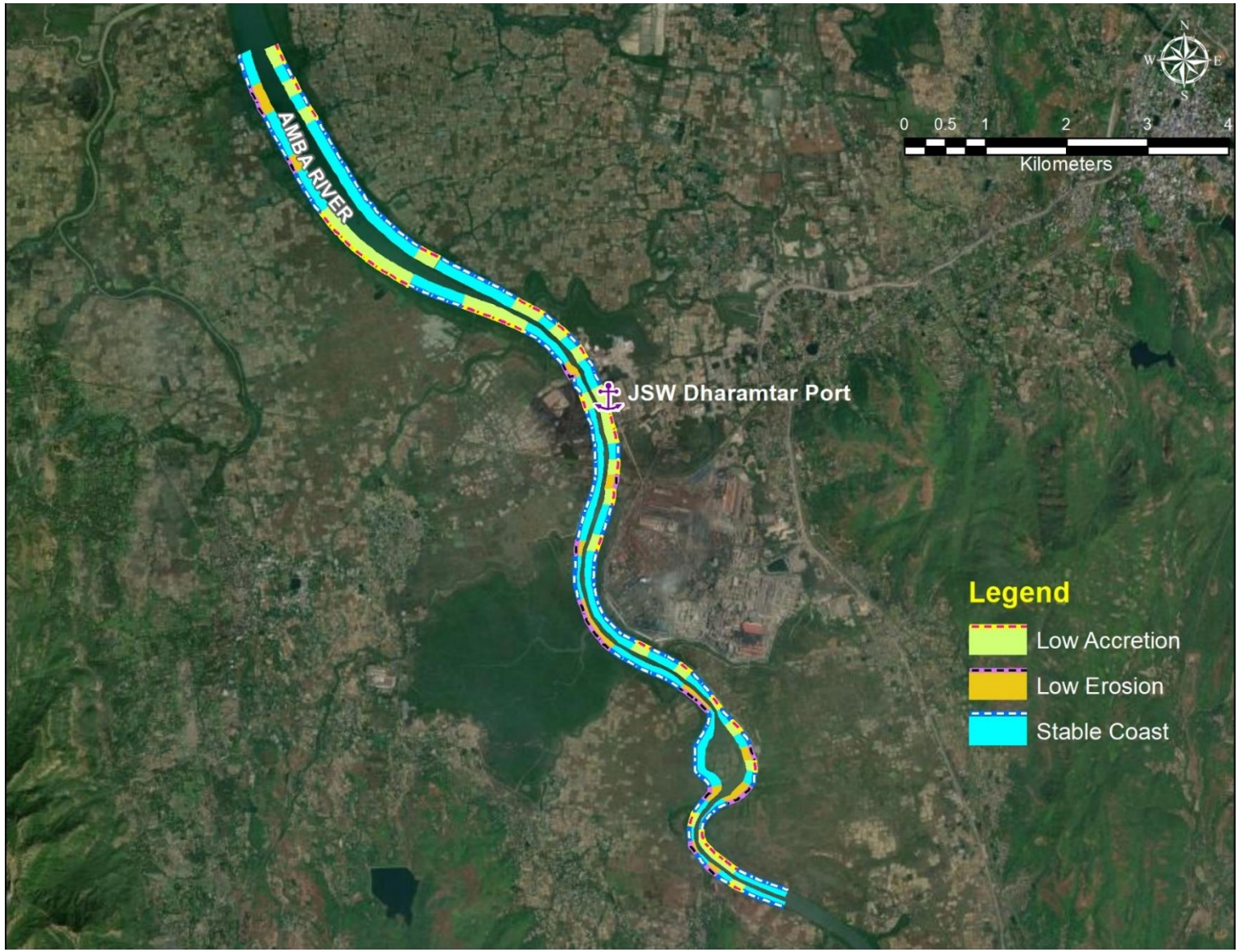


Figure 4: Shoreline change map for Short term change – Dharamtar Port

8. References

1. Dolan R., Hayden B., May P., and May S.K. 1980. The reliability of shoreline change measurements from aerial photographs. *Shore and Beach*, 48 (4), 22-29.
2. Gill, S. K., Schultz, J. R. 2001. "Tidal Datums and Their Applications." NOAA National Ocean Service Center for Operational Oceanographic Products and Services. 58.
3. Boak, Elizabeth H., and Ian L. Turner. "Shoreline Definition and Detection: A Review." Journal of Coastal Research 214 (July 2005): 688–703. doi:10.2112/03-0071.1.
4. Pritam chand, Prasenjit Acharya (2010), Shoreline change and sea level rise along coast of Bhitarkanika wildlife sanctuary, Orissa: An Analytical approach of remote sensing and statistical techniques, International Journal of Geomatics and Geosciences, Volume 1, no 3.
5. HANSON, H.; GRAVENS, M.B., and KRAUS, N.C., 1988. Prototype applications of a generalized shoreline change numerical model. Proceedings of the 21st International Conference on Coastal Engineering (Costa del Sol-Malaga, Spain), pp. 1265–1279.
6. LEATHERMAN, S.P., 2001. Social and economic costs of sea level rise. In: DOUGLAS, B.C.; KEARNEY, M.S., and LEATHERMAN, S.P. (eds.), Sea Level Rise History and Consequences. San Diego, California: Academic Press, p. 232
7. NATIONAL RESEARCH COUNCIL, 1990. Managing Coastal Erosion. Washington, DC: National Academy Press, 182p
8. MORTON, R.A. and SPEED, F.M., 1998. Evaluation of shorelines and legal boundaries controlled by water levels on sandy beaches. Journal of Coastal Research, 14(4), 1373–1384.
9. SMITH, A.W.S. and JACKSON, L.A., 1992. The variability in width of the visible beach. Shore and Beach, 60(2), 7–14.
10. Nicholls, R.J., S.E. Hanson, J.A. Lowe, R.A. Warrick, X. Lu, and A.J. Long, 2013: Sealevel scenarios for evaluating coastal impacts. Wiley Interdisciplinary Reviews: Climate Change, 5(1), 129-150.
11. Lacroix, Y., Than, V.V., Leandri, D, (2016). Analysis of Shoreline Changes for the Western Tombolo of Giens. International Journal of Environmental, Ecological, Geological and Geophysical Engineering, 9, 108 - 707 116
12. Luijendijk, A., Hagenaars, G., Ranasinghe, R. et al. The State of the World's Beaches. *Sci Rep* **8,** 6641 (2018). https://doi.org/10.1038/s41598-018-24630-6

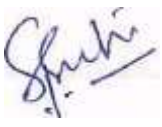
JSW Dharamtar Port Private Limited

INTEGRATED MANAGEMENT SYSTEM (IMS) POLICY

JSW Dharamtar Port Private Limited (JSW DPPL) committed to satisfying our customers & users by providing them timely handling, storage & delivery of cargo from its Amba River-based port facilities at Dharamtar with security and safety while ensuring compliance with Environmental, legal & other requirements.
JSW DPPL maintain JSW Core values: Commitment, Courage, Agility, Collaboration & Compassion.

In implementing this IMS policy, Top management shall ensure that:

- Quality, Environment, Occupational Health & Safety (QEHS) is a prime consideration at all stages of the organization's planning, project and decision making processes.
- Operations comply with relevant QEHS legal and other requirements by way of best practice and technical innovation.
- All employees, customers, and user's requirements are fulfilled, hazardous activities are identified and any associated significant risks eliminated where possible and adequately controlled.
- All employees are competent, informed, instructed, and adequately trained in QEHS and are provided with an appropriate level of supervision.
- All employees are committed to the protection of the environment, including prevention of pollution, sustainable resource use, climate change mitigation, adoption and protection of biodiversity and ecosystems
- Management is committed to consultation and participation of workers and worker's representative
- A safe working, wellbeing environment is provided as practical and adequate facilities and arrangements for staff welfare.
- Continually improve QEHS management and performance through the setting of, and reviewing of, objectives and targets, undertaking audits, carrying out reviews, and implementation of adequate corrective and preventative actions on time.



Dharamtar
Date: 03rd Aug 2023
Next revision date: 01st April 2025

AVP & Unit in Charge
JSW Dharamtar Port Private Limited

JSW Dharamtar Port Private Limited

एकात्मिक व्यवस्थापन प्रणाली (IMS) धोरण (मराठी आवृत्ती)

जेएसडब्ल्यू धरमतर पोर्ट प्रायव्हेट लिमिटेड आमच्या ग्राहकांना आणि वापरकर्त्यांना अंबा नदी-आधारित बंदर सुविधांमधून वेळेवर हाताळणी, साठवणूक आणि मालाची डिलिव्हरी सुरक्षितता आणि सुरक्षिततेसह प्रदान करून पर्यावरणीय, कायदेशीर आणि इतर गोष्टींचे पालन करण्यासाठी वचनबद्ध आहे.
जेएसडब्ल्यूची मुख्य मूल्ये वचनबद्धता, धैर्य, चपळता, सहयोग आणि करुणा यांचे पालन करते .

एकात्मिक व्यवस्थापन प्रणाली धोरणाची अंमलबजावणी करताना, प्रमुख व्यवस्थापन हे सुनिश्चित करेल :

- गुणवत्ता, पर्यावरण, व्यावसायिक आरोग्य आणि सुरक्षितता हा संस्थेच्या नियोजन, प्रकल्प आणि निर्णय प्रक्रियेच्या सर्व टप्प्यांवर मुख्य विचार केला जातो.
- सर्वोत्कृष्ट सराव आणि तांत्रिक नव्या कल्पनाद्वारे ऑपरेशन्स मध्ये संबंधित कायदेशीर आणि इतर आवश्यकतांचे पालन करतात.
- सर्व कर्मचारी, ग्राहक आणि वापरकर्त्याच्या गरजा पूर्ण केल्या जातात, धोकादायक कार्य ओळखले जातात आणि शक्य तितक्या आणि पुरेसे नियंत्रण मिळवून संबंधित महत्त्वपूर्ण जोखीम दूर केल्या जातात.
- सर्व कर्मचारी सक्षम, माहिती, निर्देश आणि गुणवत्ता, पर्यावरण, व्यावसायिक आरोग्य आणि सुरक्षितता मध्ये पुरेसे प्रशिक्षित आहेत आणि त्यांना योग्यस्तरावर पर्यवेक्षण प्रदान केले आहे.
- सर्व कर्मचारी पर्यावरणाच्या संरक्षणासाठी वचनबद्ध आहेत, ज्यामध्ये प्रदूषण रोखणे, संसाधनांचा शाश्वत वापर, हवामान बदल कमी करणे, जैवविविधता आणि परिसंस्थांचे अवलंब करणे आणि संरक्षण यांचा समावेश आहे.
- व्यवस्थापन कामगार आणि कामगार प्रतिनिधी यांच्या सल्लामसलत आणि सहभागासाठी वचनबद्ध आहे
- कर्मचारी कल्याणासाठी व्यावहारिक आणि पुरेशा सुविधा आणि व्यवस्था म्हणून सुरक्षित काम व आरोग्यदायी वातावरण प्रदान केले जाते.
- उद्दिष्टे ठरवणे आणि त्यांचे पुनरावलोकन करणे, ऑडिट करणे, पुनरावलोकने पार पाडणे आणि वेळेवर पुरेशा सुधारात्मक आणि प्रतिबंधात्मक कृतींची अंमलबजावणी करणे इत्यादी द्वारे गुणवत्ता, पर्यावरण, व्यावसायिक आरोग्य आणि सुरक्षितता व्यवस्थापन आणि कार्यप्रदर्शनामध्ये सतत सुधारणा करणे.

Dharamtar
Date: 03rd Aug 2023
Next revision date: 01st April 2025

AVP & Unit in Charge
JSW Dharamtar Port Private Limited

JSW Dharamtar Port Private Limited

एकीकृत प्रबंधन प्रणाली (आईएमएस) नीति (हिंदी अनुवाद)

जेएसडब्ल्यू धरमतर पोर्ट प्राइवेट लिमिटेड पर्यावरण, कानूनी और अन्य के अनुपालन को सुनिश्चित करते हुए सुरक्षा और रक्षा के साथ अपने अंबा नदी स्थित बंदरगाह सुविधाओं से समय पर कार्गो की हैंडलिंग, भंडारण और वितरण प्रदान करके हमारे ग्राहकों और उपयोगकर्ताओं को संतुष्ट करने के लिए प्रतिबद्ध है।

जेएसडब्ल्यू धरमतर पोर्ट , जेएसडब्ल्यू के मूल मूल्यों को प्रतिबद्धता, साहस, चपलता, सहयोग और करुणा बनाए रखता है।

इस एकीकृत प्रबंधन प्रणाली नीति को लागू करने में, शीर्ष प्रबंधन यह सुनिश्चित करेगा कि:

- गुणवत्ता, पर्यावरण, व्यावसायिक स्वास्थ्य और सुरक्षा संगठन की योजना, परियोजना और निर्णय लेने की प्रक्रियाओं के सभी चरणों में एक प्रमुख विचार है।
- सभी प्रचालन सर्वोत्तम अभ्यास और तकनीकी नवाचार के माध्यम से प्रासंगिक क्यूईएचएस कानूनी और अन्य आवश्यकताओं का अनुपालन करते हैं।
- सभी कर्मचारियों, ग्राहकों और उपयोगकर्ता की आवश्यकताओं को पूरा किया जाता है, खतरनाक गतिविधियों की पहचान की जाती है और जहां संभव हो और पर्याप्त रूप से नियंत्रित किया जाता है तथा वहां किसी भी महत्वपूर्ण जोखिम को समाप्त कर दिया जाता है।
- सभी कर्मचारी गुणवत्ता, पर्यावरण, व्यावसायिक स्वास्थ्य और सुरक्षा में सक्षम, सूचित, निर्देशित और पर्याप्त रूप से प्रशिक्षित हैं और उन्हें उचित स्तर का पर्यवेक्षण प्रदान किया जाता है।
- सभी कर्मचारी पर्यावरण की सुरक्षा के लिए प्रतिबद्ध हैं, जिसमें प्रदूषण की रोकथाम, सतत संसाधन उपयोग, जलवायु परिवर्तन शमन, अवलंब लेने और जैव विविधता और पारिस्थितिक तंत्र की सुरक्षा शामिल है
- प्रबंधन श्रमिकों और श्रमिकों के प्रतिनिधियों के परामर्श और भागीदारी के लिए प्रतिबद्ध है
- कर्मचारियों के कल्याण के लिए व्यावहारिक और पर्याप्त सुविधाओं और व्यवस्थाओं के रूप में एक सुरक्षित कार्य, कल्याणकारी वातावरण प्रदान किया जाता है।
- उद्देश्यों और लक्ष्यों की स्थापना, और उनकी समीक्षा, लेखापरीक्षा करने, समीक्षा करने, और समय पर पर्याप्त सुधारात्मक और निवारक कार्रवाइयों के कार्यान्वयन के माध्यम से गुणवत्ता, पर्यावरण, व्यावसायिक स्वास्थ्य और सुरक्षा प्रबंधन और प्रदर्शन में लगातार सुधार करें।

Dharamtar
Date: 03rd Aug 2023
Next revision date: 01st April 2025

AVP & Unit in Charge
JSW Dharamtar Port Private Limited

JSW DHARAMTAR PORT PVT LTD

DHARAMTAR, DOLVI - 402 107, TALUKA - PEN, DIST.- RAIGAD.

JETTY AMBIENT AIR QUALITY / NOISE MONITORING REPORT

MONTH: JUNE-24 to NOV -24

MoEF Certification No.857 E

Sr. No.	DATE	PM 10 (µg/m3)	PM 2.5 (µg/m3)	SO_2 (µg/m3)	NO_X (µg/m3)
1	04.06.2024	56	36	12.7	30.6
2	07.06.2024	58	32	11.6	32.8
3	11.06.2024	54	34	10.4	31.7
4	14.06.2024	54	30	13.9	29.2
5	18.06.2024	57	31	11.6	30.2
6	21.06.2024	54	38	11.6	28.4
7	25.06.2024	53	30	10.4	31
8	28.06.2024	54	33	9.3	28.8
9	02.07.2024	53	33	10.4	28.4
10	05.07.2024	56	36	12.7	30.2
11	09.07.2024	54	30	29.2	29.3
12	12.07.2024	50	28	11.6	27.7
13	16.07.2024	47	25	10.4	31
14	19.07.2024	55	35	15	32.8
15	23.07.2024	53	32	11.6	31.4
16	26.072024	44	23	10.4	29.9
17	31.07.2024	51	28	11.6	28.4
18	02.08.2024	46	27	10.4	27.3
19	06.08.2024	48	28	9.6	29.2
20	09.08.2024	47	26	9.7	28.4
21	13.08.2024	49	30	9.3	26.9
22	16.08.2024	48	27	8.5	26.2
23	20.08.2024	43	24	8.1	28.8
24	23.08.2024	45	25	9.1	25.7
25	27.08.2024	46	23	9.7	26.9
26	30.08.2024	44	22	10.4	27.1
27	03.09.2024	46	31	10.5	26.9
28	06.09.2024	49	34	9.3	26.2
29	10.09.2024	51	36	9.3	25.4
30	13.09.2024	44	29	10.5	29.2
31	17.09.2024	47	32	8.2	24.3
32	20.09.2024	40	25	7	22.1
33	24.09.2024	43	27	9.3	25.8
34	27.09.2024	41	26	10.5	21.3
35	01.10.2024	55	31	15.2	33.3
36	04.10.2024	48	28	12.8	30.7
37	08.10.2024	53	30	8.2	23.9
38	11.10.2024	60	37	7	25.4
39	15.10.2024	57	34	9.3	22.8
40	18.10.2024	43	25	7	24.3
41	22.10.2024	49	29	9.3	25.8
42	25.10.2024	52	33	9.3	29.9
43	29.10.2024	47	26	10.5	28.8
44	01.11.2024	51	34	10.5	28.4
45	05.11.2024	47	29	5.8	29.9
46	08.11.2024	53	31	8.2	30.7
47	12.11.2024	51	33	11.7	29.5
48	15.11.2024	49	26	9.3	28
49	19.11.2024	53	35	8.2	29.5
50	22.11.2024	48	30	10.5	28.8
51	26.11.2024	55	38	9.3	31.8
52	29.11.2024	52	32	7.7	30.1

Sr.	DATE	NOISE LEVEL dB(A)					
		DAY			NIGHT		
		Leq	Lmin	Lmax	Leq	Lmin	Lmax
1	04.06.2024	67.2	66	68.4	59.65	58.4	60.9
2	11.06.2024	66.3	64.3	68.3	59.55	58.3	60.8
3	18.06.2024	67.55	65.7	69.4	61.55	60.8	62.3
4	25.06.2024	66.35	64.4	68.3	60.65	59.5	61.8
5	02.07.2024	64.8	63.1	66.5	60.15	59.6	60.7
6	09.07.2024	66.15	64.5	67.8	61.55	60.8	62.3
7	16.07.2024	66.4	65.5	67.4	62.3	61.2	63.5
8	23.07.2024	68.5	67.6	69.4	59.4	58.1	60.8
9	06.08.2024	67.25	66.3	68.2	58.25	57.3	59.2
10	13.08.2024	63.5	62.8	64.2	57.6	56.6	58.7
11	20.08.2024	63.4	62.1	64.7	57.3	56.2	58.4
12	23.08.2024	65.3	64.4	66.2	59.2	58.1	60.3
13	03.09.2024	64.6	63.8	65.4	59.35	58.2	60.5
14	10.09.2024	65.75	64.1	67.2	60.45	59.5	61.4
15	17.09.2024	66.5	65.7	67.4	59.5	58.1	60.9
16	24.09.2024	67.2	66	68.4	58.8	57.9	59.7
17	01.10.2024	64.2	63.1	65.4	59.6	58.5	60.8
18	08.10.2024	68.3	62.9	64.7	56.6	55.5	57.7
19	15.10.2024	67.5	66.6	68.4	58.55	57.4	59.7
20	22.10.2024	63.5	62.8	64.2	59.45	58	60.9
21	05.11.2024	67.6	66.7	68.4	61.3	60.1	62.5
22	12.11.2024	65.3	64	66.6	59.45	58.1	60.8
23	19.11.2024	68.3	67.2	69.4	59.6	58.7	60.5
24	26.11.2024	63.35	62	64.7	58.1	57.1	59.1

JSW DHARAMTAR PORT PRIVATE LIMITED

DHARAMTAR, DOLVI - 402 107, TALUKA - PEN, DIST.- RAIGAD.

JETTY CREEK, DRINKING & WASTE WATER MONITORING REPORT

Parameter	Locations									
	Coal Handling Jetty No. 6 Coal Birth	1000 Meter From Towards Sea From Jetty Middle Streame	500 Meter From Towards Sea Left Bank Dharamatar creek	500 Meter From Towards Sea Right Bank Dharamatar creek	Jetty No 10	Coal Handling Jetty No. 6 Coal Birth	1000 Meter From Towards Sea From Jetty Middle Stream	500 Meter From Towards Sea Left Bank Dharamatar creek	500 Meter From Towards Sea Right Bank Dharamatar creek	Jetty No 10
	13.06.2024 to 14.06.2024					**21.06.2024 to 22.06.2024**				
Temprature	39.2	32.1	31.4	30.4	30.9	28.4	28.8	28.5	29.7	29.5
pH	7.68	7.80	7.51	7.74	8.11	7.52	7.59	7.48	7.31	7.27
Turbidity	3.4	2.9	3.20	3.2	2.9	2.7	2.9	2.90	2.8	2.9
Total Dissolved Solids	23920	24000	23790	23900	23800	19080	21640	20410	18610	18560
Oil & Grease	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)
BOD	4	4	5	6	5	3	4	4	4	4
COD	14	14	18	22	20	12	14	16	16	14
Chloride	12496	12496	12996	12996	12996	10997	10996	10497	10996	9997
Nitrate	13.8	14	14	14	14	11.4	11.6	11.5	11.7	11.5
Phenolic Compounds	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
Sulphate	3937	3459	3658	3459	3658	3700	3383	3780	3720	3740
Total Phosphate	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)
Chromium	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)
Salinity	29	28	28	29	29	27	27	28	27	28
Lead	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)
Mercury	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)
Chlorophyll	5.32	5.32	5.33	5.32	5.33	5.34	5.32	5.35	5.33	5.34
Primary Productivity	2	2	2	2	2	2	2	2	2	2
Zooplankton	18	20	19	18	20	18	20	19	19	24
Phytoplankton	12	13	15	12	14	12	14	13	14	13
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Lead (as PB)	17.20	16.30	16.20	17.10	25	5.42	BLQ(LOQ:1)	BLQ(LOQ:1)	19.1	17.4
Chromium (as Cr)	45.2	41.7	38.6	44.1	48.5	50.9	37.8	48.3	55.1	59.9
Microbenthos	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	11.07.2024 to 12.07.2024					**25.07.2024 to 26.07.2024**				
Temprature	29.5	29.7	29.5	29.9	29.4	25.4	25.9	26.1	26.2	26.8
pH	7.92	7.75	7.81	7.63	8.07	8.25	8.92	8.80	8.73	8.63
Turbidity	0.8	0.7	0.70	0.81	0.7	10	13	12.00	11	13
Total Dissolved Solids	200	190	190	140	180	162	160	166	162	164
Oil & Grease	BLQ (LOQ:1)	BLQ (LOQ:1)	BLQ (LOQ:1)	BLQ (LOQ:1)	BLQ (LOQ:1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)
BOD	4	4	3	2	3	2	2	2	2	2
COD	14	13	12	10	12	9	10	7	8	7
Chloride	35	34	35.4	34.4	10.6	32.4	36.4	34.4	37.9	35.4
Nitrate	10.2	10	11	18.4	3.43	6.86	8.29	11.1	8.86	8.12
Phenolic Compounds	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)
Sulphate	31.4	23	31.2	22.5	31.2	18	26.7	22.5	20	19.6
Total Phosphate	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)
Chromium	BLQ (LOQ:0.02)	BLQ (LOQ:0.02)	BLQ (LOQ:0.02)	BLQ (LOQ:0.02)	BLQ (LOQ:0.02)	BLQ (LOQ:0.02)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)	BLQ (LOQ:0.001)
Salinity	1.7	1.8	1.7	1.7	1.8	1.2	1.4	1.3	1.5	1.3
Lead	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)	BLQ (LOQ:0.008)
Mercury	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)	BLQ (LOQ:0.0008)
Chlorophyll	5.35	5.32	5.32	5.32	5.32	5.35	5.34	5.33	5.33	5.34
Primary Productivity	2	2	2	2	2	2	2	2	2	2
Zooplankton	20	19	20	22	21	19	19	20	19	18
Phytoplankton	15	12	13	14	14	14	14	14	14	13
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Lead (as PB)	13.7	9.49	7.87	11.7	13.8	8.65	8.22	8.33	11.1	10
Chromium (as Cr)	53.1	64	58.9	57.2	71.3	34.8	35.4	40.2	51	47.9
Microbenthos	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	12.08.2024 to 13.08.2024					**26.08.2024 to 27.08.2024**				
Temprature	28.1	29.4	29.2	28.4	28.1	28.4	28.7	26.1	25.1	25.6
pH	7.45	7.82	7.53	7.32	7.46	8.16	8.23	7.47	25.1	25.6
Turbidity	0.42	0.40	0.42	0.43	0.41	8.2	8.4	8.2	7.98	7.62
Total Dissolved Solids	66	68	70	180	176	248	318	246	284	224
Oil & Grease	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)
BOD	4	3	3	4	3	4	4	4	4	4
COD	13	12	11	13	11	14	15	16	14	14

Chloride	46.4	45	45	45.4	46	85.9	87	83	45.4	22.4
Nitrate	3.4	4	3.6	4.8	3.3	3.24	3.8	2.95	4.8	3.3
Phenolic Compounds	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
Sulphate	13.2	21.2	19.5	22.5	10.8	36.6	14.7	23.6	24	21.8
Total Phosphate	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)
Chromium	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)
Salinity	1.2	1.2	1.1	1.2	1.1	1.3	1	1.2	1.2	1.3
Lead	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)
Mercury	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)
Chlorophyll	5.34	5.32	5.32	5.33	5.32	5.34	5.35	5.35	5.33	5.34
Primary Productivity	2	2	2	2	2	2	2	2	2	2
Zooplankton	20	21	19	21	21	19	21	20	19	24
Phytoplankton	13	12	13	13	14	13	14	12	14	13
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Lead (as PB)	32.9	16.50	64.6	32.6	28.2	9.47	24.1	21	17.4	15.6
Chromium (as Cr)	41.5	53.3	42.6	50.2	42.3	32.70	28.6	27.5	28.6	32.8
Microbenthos	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	12.09.2024 to 13.09.2024					**26.09.2024 to 27.09.2024**				
Temprature	29.3	29.6	29.3	28.2	28.5	29.1	28.5	28	26.2	26.6
pH	7.59	7.99	7.93	7.86	7.84	7.73	7.53	8.41	8.25	7.62
Turbidity	BLQ(LOQ:0.2)	BLQ(LOQ:0.2)	BLQ(LOQ:0.2)	BLQ(LOQ:0.2)	BLQ(LOQ:0.2)	1.9	2.8	2.10	BLQ(LOQ:0.2)	BLQ(LOQ:0.2)
Total Dissolved Solids	1534	1540	1522	1550	1506	116	208	120	114	106
Oil & Grease	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)
BOD	5	5	4	4	4	5	6	5	5	5
COD	18	18	16	14	16	10	22	20	20	18
Chloride	824	1024	900	999	1049	37.4	37.4	26.4	37.4	36
Nitrate	2.81	2.62	3.74	2.62	2.83	3.2	4.4	2.79	2.1	1.34
Phenolic Compounds	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
Sulphate	40	43.6	48.6	60	44.2	37	26.8	33	27	21.6
Total Phosphate	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)
Chromium	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)
Salinity	1.2	1.3	1.1	1.1	1.3	1.2	1.1	1.3	1.2	1.1
Lead	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	0.030	0.029	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	0.030	0.029	BLQ(LOQ:0.008)
Mercury	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)
Chlorophyll	5.33	5.33	5.32	5.33	5.32	5.32	5.33	5.34	5.32	5.33
Primary Productivity	2	2	2	2	2	2	2	2	2	2
Zooplankton	19	19	20	18	20	18	19	21	20	19
Phytoplankton	14	15	13	14	15	13	14	14	13	14
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Lead (as PB)	32.3	28.90	31.40	11.4	3.89	5.50	5.14	5.17	6.60	9.51
Chromium (as Cr)	67.4	56.9	58.5	58.2	64.7	71.7	68.4	75.2	77.5	63.8
Microbenthos	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	15.10.2024 to 16.10.2024					**29.10.2024**				
Temprature	34.4	34.1	34.2							
pH	8.01	7.96	8.03	7.35	7.66	7.91	7.54	7.58	7.56	7.70
Turbidity	1.8	2	1.80	1.9	1.8	2.2	1.9	2.00	1.9	2.2
Total Dissolved Solids	16120	16180	15430	15600	16360	14380	14390	15140	15310	14380
Oil & Grease	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ (LOQ:1)	BLQ (LOQ:1)	BLQ (LOQ:1)	BLQ (LOQ:1)	BLQ (LOQ:1)
BOD	7	6	6	3	BLQ(LOQ:1)	10	10	10	10	10
COD	29	28	28	12	BLQ(LOQ:5)	40	39	41	39	39
Chloride	10396	10496	10297	10297	10396	8097	7797	7847	7747	7797
Nitrate	2.13	2.07	2.02	2.6	2.4	2.8	2.9	2.9	2.6	2.8
Phenolic Compounds	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
Sulphate	217	227	222	227	228	408	422	447	392	392
Total Phosphate	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)
Chromium	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)	BLQ(LOQ:0.0.2)
Salinity	21	20	20	20	21	14	14	14	14	13
Lead	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)
Mercury	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)
Chlorophyll	5.32	5.33	5.34	5.35	5.34	5.35	5.34	5.32	5.33	5.33
Primary Productivity	2	2	2	2	2	2	2	2	2	2
Zooplankton	19	20	18	24	18	18	20	22	21	19
Phytoplankton	13	14	12	15	12	12	13	14	11	12
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Lead (as PB)	11.6	BLQ(LOQ;1)	BLQ(LOQ;1)	4.39	10.1	5.42	8.83	9.44	8.41	8.91
Chromium (as Cr)	68.1	55.1	29.5	43.3	55.6	22.9	22.8	27.7	31.5	25.9

Microbenthos	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
	13.11.2024					**29.11.2024**				
Temprature	33.8	34.1	34.3	31.2	31.3	28.9	29.3	29.1	29.8	29.4
pH	8.32	7.95	7.82	7.72	7.97	7.87	7.88	6.87	7.32	7.89
Turbidity	2.9	3.1	2.8	2.9	3.1	3.2	3.6	3.4	3.2	3.2
Total Dissolved Solids	18450	18560	17810	18680	18620	19720	19090	19600	19720	19950
Oil & Grease	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)	BLQ(LOQ:1)
BOD	2	2	3	2	2	9	8	9	8	9
COD	6	10	12	10	10	32	28	34	30	32
Chloride	11196	13396	13296	13396	13396	6658	6597	6647	6698	6647
Nitrate	4	4.08	4.1	5	4.3	6.28	6.26	5.97	6.80	6.30
Phenolic Compounds	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)	BLQ(LOQ:0.001)
Sulphate	203	194	195	199	212	264	246	243	262	257
Total Phosphate	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)	BLQ(LOQ:0.1)
Chromium	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)
Salinity	20	20	20	21	21	22	22	21	21	22
Lead	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)	BLQ(LOQ:0.008)
Mercury	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)	BLQ(LOQ:0.0008)
Chlorophyll	5.35	5.32	5.33	5.33	5.33	5.32	5.34	5.33	5.32	5.33
Primary Productivity	2	2	2	2	2	2	2	2	2	2
Zooplankton	19	18	18	19	23	18	20	19	22	22
Phytoplankton	12	12	13	14	15	12	14	13	14	13
Texture	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay	Clay
Lead (as PB)	4.23	13.6	10.5	10.2	5.07	6.38	10.4	9.77	11.4	32.7
Chromium (as Cr)	31	36.2	37.9	35.4	41.9	31	31.4	30.6	28.5	35.5
Microbenthos	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent