

BEFORE THE NATIONAL GREEN TRIBUNAL

SOUTHERN ZONE, CHENNAI

Original Application No. 02 of 2024 (SZ)

In the matter of:

Tribunal on its own motion – SUO MOTU

Based on the news item published in

Newspaper The Times of India Dt. 07.03.2023 titled,

“Oil leaked in Tamil Nadu’s Nagai Spreading along

Coast, say expert’s”

And

The Member Secretary,

TNPCB, Chennai and Others

...Respondent(s)

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Through

Dr. D. Shanmuganathan

Standing Counsel of Tamil Nadu,

National Green Tribunal

Southern Zone, Chennai

Date: 17.03.2024

BEFORE THE NATIONAL GREEN TRIBUNAL (SOUTHERN ZONE)**AT CHENNAI****(Special Original Jurisdiction)****Original Application No.205 of 2023****And Application No.02 of 2024 ((SZ)****In the matter of:**

Tribunal on its own motion - SUO MOTU
based on the news item in Newspaper the
Times of India dt. 07.03.2023 titled "Oil
leaked in Tamil Nadu's Nagai Spreading
along coast, say experts".

...Applicants

Versus

**1. Tamil Nadu Pollution Control Board,
Rep. by its Member Secretary,
No.76, Anna Salai, Guindy,
Chennai – 600 032.
Ph.no. 044-22353134
Email – grievance@tnpcb.gov.in**

**2. Tamil Nadu State Coastal Zone
Management Authority,
Rep. by its Member Secretary,
1st Floor, Panagal Building,
Saidapet, Chennai – 600 015.
Ph.no. 044-24336421
Email – tndoe@tn.nic.in**

**3. Cauvery Basin Refinery, Chennai
Petroleum Corporation Limited,
Rep. by its Managing Director,
Panangudi Village, Nagapattinam District,
Tamilnadu – 611 002.
Ph.no. 04365-256416**

**4. National Centre for Sustainable
Coastal Management (NCSCM),
Rep. by its Director,
Ministry of Environment, Forest and
Climate Change (MoEF&CC), Anna
University Campus,**

Chennai – 600025.
Ph.no. 044-22200600
Email – rramesh au@yahoo.com

**5. Indian Coast Guard Regional East,
Rep by its Commander Coast Guard,**
Rajaji Salai, Near Napier Bridge,
Chennai - 600 009.
Ph.no. 044-25395011
Email – rhq-east@indiancoastguard.nic.in

**6. Commissioner of Fisheries and
Fishermen Welfare,**
3rd Floor, Integrated Animal Husbandry and
Fisheries Building, Nandanam,
Chennai - 600 035.
Ph No: 044 - 29510390 / 29510406 /
29510407 / 29510396

REPLY AFFIDAVIT FILED BY THE 2ND RESPONDENT

I, A.R.Rahul Nadh, I.A.S., S/o. Regu Nadh about 36 years and having office at Ground Floor, Panagal Buildings, Saidapet, Chennai – 600 015 solemnly affirm and sincerely state as follows,

1. I humbly submit that I am the Director, Department of Environment and Climate Change and also the Member Secretary, Tamil Nadu State Coastal Zone Management Authority and I am well acquainted with the facts of the case from the records available and I am filing this reply in my official capacity on behalf of 2nd respondent.
2. I humbly submit that the department came to know that, Crude oil leakage has occurred from the pipeline belonging to Chennai Petroleum Corporation Limited (CPCL) in the Nagapattinam Coast and due to the Oil leakage at the site, dead fish and crabs were found on the shore. Therefore, to assess the quantum and impact of the spill an expert committee was constituted immediately on 05.03.2023 to carry out an on-site assessment and to submit a report in the said area.
3. I humbly submit that the expert committee comprised of: (1) Dr. Hariharan, Scientist C, National Centre for Sustainable Coastal Management (2) Dr.Subbareeddi Bontu, Scientist C, National Centre for Sustainable Coastal Management and (3) Dr.Kariramu, Scientist F, National Centre for Coastal Research, Chennai.

4. I humbly submit that the expert committee members made a field visit on 06.03.2023 & 07.03.2023 and conducted intensive field investigation, such as physical characteristics of the coast, water sample collection along and across the coast and observation of spill patches away from the spill location on the same day. They also discussed the occurrence of the incident and its first notification information at the site and discussed the spill impact on the local community and the fishing community.
5. I humbly submit that, the observation and recommendations of the expert committee are given below;
 - a) Physical characteristics of the coast: the coast is under erosion, and the oceanic forces are continuously affecting the crude oil pipeline, the pipeline is exposed to the open ocean.
 - b) The amount of crude oil spilled: The CPCL authorities informed that about 1000 liters of crude oil spilled over the area where the pipeline was damaged. It will be used to forecast and estimate the impact of crude oil on the marine ecosystem and its fate along and across the coast.
 - c) Prediction of the Spill: Prediction of the crude oil spill is essential for assessing the impact on the adjacent coastal regions and ecosystems. It is recommended that impact studies through field surveys and model simulations on adjacent coastal ecosystems be carried out for two seasons.
 - d) Treatment and removal of oil slick: The spill was completely removed from the beach by the CPCL authorities and the spread was controlled by applying the oil spill dispersant.
 - e) The observed TPH concentration was slightly higher than the concentrations recommended for designated best use for Class SW-1 (salt pans, shell fishing, mariculture and ecologically sensitive zones) by the CPCB.
 - f) Physical and Biological impacts: From intertidal observation along the study area it was observed that the diversity of intertidal organisms remained good and healthy. There is no oil sludge evidence/ marking on the groynes and boulders along the intertidal rocky shore. The organisms of the intertidal area consists of burrowing crabs, gastropods, bivalves and tubicolous polychaetes etc.

6. I humbly submit that, the report of the Expert Committee is annexed with the reply affidavit.

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

Solemnly affirmed at Chennai
This the 15 day of March 2024
and Signed his name in presence

L. J.
15/03/24

For Director of Environment
& Climate Change

DEPARTMENT OF ENVIRONMENT & CLIMATE CHANGE

From

Thiru Deepak.S.Bilgi, I.F.S.,
Director of Environment & Climate
Change,
Ground Floor, Panagal Building
Saidapet, Chennai 600 015

To

The Additional Chief Secretary to
Government,
Environment, Climate Change and
Forest Department,
Secretariat, Chennai - 9

R.C. No.JDO/AE/565/2023-dated 5.03.2023

Madam,

Sub.: Oil Spill - CPCL - Crude Oil leakage from Nine Kilo Meter pipeline at
Nagapattinam Coast - Formation of Expert Committee - Regarding.

Ref: 1. News appeared in The Hindu on 04/03/2023
2. News appeared in Indian Express on 04/03/2023
3. News appeared in Times of India on 05/03/2023

I invite kind attention to the references cited, it is known that Crude Oil leakage has occurred from the pipeline belonging to Chennai Petroleum Corporation Limited in the Nagapattinam Coast. It is further known that due to the Oil leakage at the site, dead fish and crabs were found on the shore. In this connection, it is informed that an Expert Committee is formed to assess the site and requested to submit the report on Oil Spill. The members of the expert committee are

1. Dr.Hariharan, Scientis C,
National Center for Sustainable Coastal Management
2. Dr.Subbareddi Bontu, Scientist C,
National Center for Sustainable Coastal Management
3. Dr.Kariramu, Scientist E,
National Center for Coastal Research

The above expert committee members have been requested to make physical assessment of the site on 06/03/2023 and to submit the report as early as possible. The District Collector and the District Environmental Engineer have also been requested to render necessary assistance to the expert committee members besides request to CPCL Nagapattinam to provide necessary assistance and logistic support.

This is for kind information and necessary action.

Yours faithfully,
Sd/- Deepak.S.Bilgi
Director,
Department of Environment
& Climate Change

//forwarded by order//

D. B. Bilgi
5/3/23
For Director of Environment
& Climate Change

5/3/23

**Report of the Expert Committee on
Assessment of the Crude Oil Spill at Thethi Nagar Beach, Nagore Coast,
Nagapattinam, Tamil Nadu**



Submitted by

Dr. K. Ramu,
Scientist F

National Centre for Coastal
Research (NCCR),
Ministry of Earth Science,
Government of India

Dr. Hariharan G,
Scientist C

National Centre for Sustainable
Coastal Management (NCSCM),
Ministry of Environment, Forest
and Climate Change, Government
of India

**Dr. Subbareddy
Bonthu,** Scientist C

National Centre for Sustainable
Coastal Management (NCSCM),
Ministry of Environment, Forest
and Climate Change, Government
of India

Submitted to

Department of Environment (DoE) and Climate Change,
Government of Tamil Nadu, Chennai

Joint expert committee

As per R.C. No.JDO/AE/565/2023 dated 05.03.2023, the Department of Environment (DoE) and Climate Change, Government of Tamil Nadu, constituted an expert committee from the concerned research institutes and requested the committee members to inspect the site. Details of the nominated expert members from the various institutions are provided as follows:

S. No	Organization	Nominated member
1	National Centre for Coastal Research (NCCR), Ministry of Earth Sciences, Government of India	Dr. K. Ramu, Scientist E
2	National Centre for Sustainable Coastal Management (NCSCM), Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India	Dr. Hariharan G, Scientist C
3	National Centre for Sustainable Coastal Management (NCSCM), Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India	Dr. Subbareddy Bonthu, Scientist C

Mandate of the Committee

The Department of Environment (DoE) and Climate Change, Government of Tamil Nadu, directed the expert committee to inspect the crude oil spill site and submit a report on the impact and assessment of the site.

Background

Nagapattinam is situated about 400 km south of Chennai, and lies on the Coromandel Coast of the Bay of Bengal. The coastal zone starts from the north of the Kolidam River and ends at the Atirampattinam. It has a length of 150 kilometers and is located between 79° 37' 30" and 79° 50' 12" E and 10° 15' to 11° 2' 46" N. The coastal geomorphologic features are the subaerial delta, strand plain, crevasses, chennies, cusp bars, estuaries, and swamps. The flood basins are a large part of the delta, which is composed of brown and reddish-gray silty clay and fine sand. The orientation of the coastline is north-easterly. The coastal strip consists of narrow strips of sandy beaches, and the coastal climate has a minimum and maximum temperature of 20°C and 34°C respectively. It is a highly vulnerable area for cyclones.

M/s Chennai Petroleum Corporation Limited, (Cauvery Basin Refinery - CBR) Panangudi, Village, Nagapattinam Taluk, (Previously Thanjavur District) Nagapattinam District was granted with Consent to Operate in the year 1990 for its 1 MMTPA Refinery. The

unit has not been in operation since August 2019 and all the processing activities were completely stopped. At present, approximately 1250 KL/day of crude oil is being received from M/s ONGC Limited, Narimanam through pipeline (I) and it is being stored in the storage tanks in the premises of M/s CPCL – CBR, Nagapattinam district and the same is being transported to Karaikal Marg Port through pipeline (II) at a distance of 10.4KM and then transported to M/s CPCL, Manali, Chennai via ship once in 45 days. The Chennai Petroleum Corporation Limited (CPCL) laid the pipe line at a depth of one and a half meters along the shore of Thethi Nagar Beach, Nagore Coast, Nagapattinam, about 22 years ago, and now it is exposed to the sea due to coastal erosion (*information provided by CPCL*). This pipe line used to carry the crude oil from the CPCL's refinery to the Karaikal port for shipping once in 45 days and sent to the CPCL's refinery in Chennai. The crude oil was last shipped on 14th February 2023 and thereafter the pipe line was not in operation. The oil spill incident occurred on 2nd March 2023 at Pattimancherry, off the Nagapattinam coast with a spillage of **1000** litres of oil, (Figure 1) (*the quantity of spilled oil information is provided by CPCL authorities*), due to the leakage in the 10.4-kilometre-long pipeline. Thereafter, the leakage of the oil pipeline was plugged by the workers of CPCL on 5th March 2023 (Figure 2).

A team of experts from the National Centre for Sustainable Coastal Management (NCSCM) and National Centre for Coastal Research (NCCR), the sub-collector of Nagapattinam district, the officials of the Department of Environment (DoE) and Climate Change, Tamil Nadu, and the officials of CPCL visited the crude oil spill site at Thethi Nagar Beach, Nagore Coast, Nagapattinam, Tamil Nadu, on 6th March 2023 (Figure 3). The team conducted an intensive field investigation, such as physical characteristics of the coast, water sample collection along and across the coast, and observation of spill patches away from the spill location on the same day of the visit. The committee also discussed the occurrence of the incident and its first notification information at the site and discussed the spill impact on the local community and the fishing community.



Figure 1: Map of the oil spill incident area with field-collected sampling sites along the Nagore coast, Nagapattinam, Tamil Nadu.



Figure 2: Coastal water after plugging the leak of crude oil from pipeline at the Nagore coast, Nagapattinam



Figure 3: Committee inspecting the Crude oil spill site and discussing about the incident and mitigation measures with the officials of the DoE and CPCL.

Shoreline Characteristic of Nagore Coast

The Nagore coast is a sandy coast and has a gentle slope (1:200). It is observed that there are groynes and breakwaters of the Karaikal port on the northern side whereas sandy beach on the southern side where the crude oil pipeline is laydown. Physical observation of the shoreline clearly showed that the coast is under erosion and has been continuously eroding and accreting seasonally. The erosion of the coast where the spill incident occurred was analyzed using the satellite images during the years (1990-2021) and was found that the coast is continuously eroding due to the natural phenomenon/extreme events and human interventions. It is observed that the coast has eroded approximately from 60 to 70m across the coast for the past 32 years. The long-term and short shoreline change analyses indicated rates of shoreline change of about -2.32 m/yr and -4.17 m/yr along the Nagore coast, respectively (Figure 4). In the long term, the shore eroded about 63 m, whereas in the short term (10 years), it eroded about 48 m across the coast. It was found that the rate of erosion in recent years has increased gradually. It clearly indicates that the erosion could be the reason to expose the underground oil pipeline to the coast and is continuously influenced by the oceanic forces during the high tide period (Figure 5).

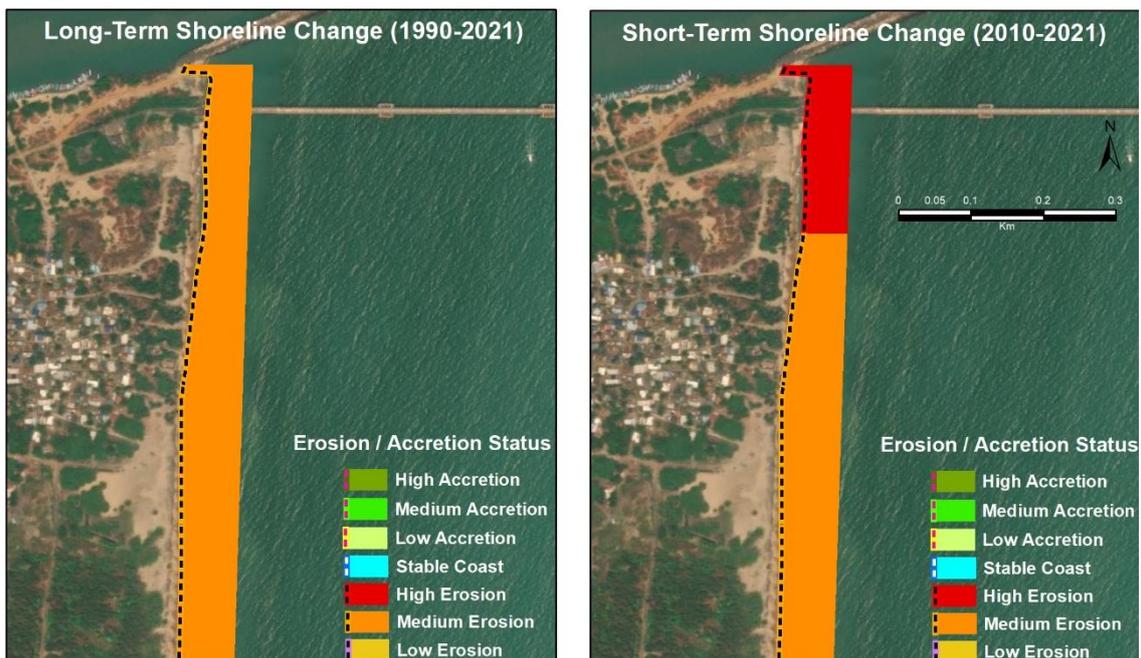


Figure 4: Shoreline change analysis for long-term and short-term during the period from 1990 to 2021 at Nagore coast, Nagipattinam, Tamil Nadu



Figure 5: Coastal features of Nagar Beach, Nagore Coast, Nagapattinam

Prevailing wind and wave characteristics over the Nagapattinam coast

The coastal process parameters, such as wind, tide, and wave characteristics, play a vital role on the oil spill's dispersion, movement, and fate over the region. The wind fields, tides, and wave parameters were obtained from various open-access sources for the period (March 1–8, 2023) to understand the source and sink characteristics of the spilled oil over the region. Wave and wind field data were obtained from ERA-5, the fifth generation of ECMWF reanalysis hourly data, with a resolution of $0.25^\circ \times 0.25^\circ$ for atmospheric wind and $0.5^\circ \times 0.5^\circ$ for ocean waves. Details of the wind field and wave characteristics are presented in Table 1. The daily average wind speed varied between 4.4 m/s and 5.9 m/s with the direction between 24 and 36 degrees during March 1–8, 2023. The average wind speed was about 5 m/s, blowing over the region in a direction of 36 degrees from the east. The wind fields clearly indicated that there was no high wind speed in the direction of the offshore. Similarly, the significant wave height varied between 0.6 m and 1 m during the same period as above. The direction of the wave is observed in the northeast direction with an average angle of 66 degrees normal to the coast. During the same period, the tidal amplitude was found varying between 0.1 m and 0.9 m with respect to the chart datum (Figure 6). Therefore, with the analysis of the coastal processes data,

the movement of the oil spill could have minimal chances of spreading over the offshore region and be localized in the spill region.

Table 1: Wind fields and wave parameters over the Nagapattinam coast during March 1-8, 2023.

Average Daily wind speed (m/s) at 10m -March 2023								Average Wind Speed (m/s)
1	2	3	4	5	6	7	8	1-8
5.92	4.923	5.128	4.540	4.802	4.471	4.990	5.831	5.076
Average Daily wind direction (degree)-March 2023								Average Wind direction (degree)
1	2	3	4	5	6	7	8	1-8
36.055	40.091	40.344	43.468	38.639	24.67	30.675	35.533	36.185
Average Daily wave SWH (m)-March 2023								Average wave SWH (m)
1	2	3	4	5	6	7	8	1-8
1.077	0.977	0.945	0.820	0.737	0.685	0.681	0.825	0.844
Average Daily wave direction -March 2023								Average wave direction (degree)
1	2	3	4	5	6	7	8	1-8
66.293	69.706	68.397	66.551	64.562	66.182	67.728	66.103	66.941

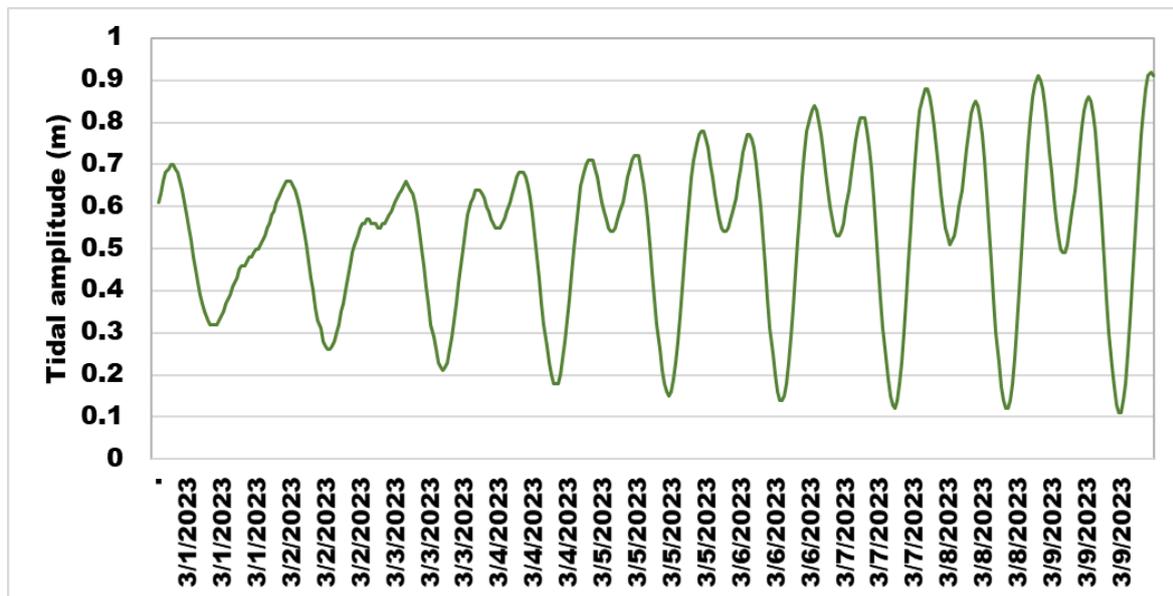


Figure 6: Time series of predicted tidal amplitude at the Nagapattinam coast during March 1-8, 2023

The meteorological wind fields and physical oceanographic parameters such as tides and significant wave height and direction over the region clearly indicated fair weather conditions which had limited impact on dispersion of the oil.

Ecological impacts of oil on shorelines

The impact of an oil spill on coastal ecology depends on a variety of factors, including the size and location of the spill, the type of oil that is spilled, and the characteristics of the affected ecosystem. It is important to take measures to prevent oil spills from occurring and to respond quickly and effectively when they do occur to minimize their impact on the environment. The impacts of oil spills on nearshore are most often caused by the exposure of flora and fauna to high concentrations of oil spillage. Generally, the natural dilution capacity of tidal flushing is adequate to keep the concentrations of oil spills below harmful levels however, when the tidal flushing is low the impacts on coastal flora and fauna can be high. Particularly, the benthic fauna are susceptible owing to their limited movement as well as their inability to avoid detrimental environmental changes. The major consequences are the threat to the survival of benthic communities including structural modification in habitat, growth retardation, and disorders in metabolism. Benthic communities play an important role in maintaining water and sediment quality and are widely considered as “ecological indicators” of environmental stress particularly aquatic pollution.

Generally, the intertidal area of Nagapattinam coast was divided into two classes namely the rocky and sandy shores. After the oil spill event, field surveys were undertaken by NCSCM and NCCR with DoE-Tamil Nadu along the intertidal area of the Nagore coast. Based on the observation, the Nagore coast (Nagapattinam District) is mostly sandy shore (Figure 7), except in the coastal areas such as Vettar Rivermouth, Karaikal Port, and CPCL Chidambaranar Oil Jetty have groyne and seawalls that have converted these sandy shores into rocky shores. The intertidal area of Nagore beach, mostly fine sand portion is more than the coarse sand portion, most importantly, the Nagapattinam coastal stretch is mostly black sand-enriched area.



Figure: 6. A clear sandy shore along the Nagore Beach (100m away from the spillage area- Panangudi- Village)

Sandy Shore

During the survey, the intertidal sediment sample was collected for analysis of Macrofauna species diversity following the quadrat method (Rabeni and Minshall, 1977¹). The collected samples were fixed with 4% buffered formaldehyde and transferred to the laboratory for further analysis. The intertidal zone represents the junction of terrestrial with coastal ecosystems, and explains the relationships between water quality and organisms. A total of 19 macrofaunal species belonging to seven major groups were found in the intertidal region from three sampling stations. Gastropod, Bivalvia, Polychaeta, and Crustacea were the major contributors of intertidal macrofauna. Overall, Gastropod was represented by 5 species, Bivalvia with 5 species, Crustacea with 3 species and Polychaeta with 3 species. Dominant individual species such as *Donax faba*, *Murex trapa*, *Macra mera* and Nemertea were present in intertidal sediments of all sampling stations (Figure 8). The distribution of macrofauna was less in the black sand regions of the Nagapattinam coasts, whereas in the white sand region the

¹ Rabeni, C.F. and Minshall, G.W., 1977. Factors affecting microdistribution of stream benthic insects. *Oikos*, pp.33-43.

macrobenthic fauna are highly notable². This study is carried out on benthos in terms of oil spill impact and apparently the spillage did not have effect on the intertidal macrofauna. Field observations along shoreline indicated that the sandy coasts are not much affected due to the oil spill.



Figure 8: Few representative **intertidal** organisms. a) *Donax scortum*, b) *Donax faba*, c) *Perna viridis*, d) *Anadara granosa*, e) *Volachlamys tranquebarica*, f) *Anadara antiquata*, g) *Mactramera*, h) *Umbonium vestiarium* and i) *Architectonica perspectiva*

² Chandrasekar, N., Saravanan, S., Jovivek, V. and Sivaperumal, M., 2012. Macrobenthic Diversity in Black Sand Enrichment Area along the Coast between Poompukar to Nagoor. *India. Journal of Marine Science Research and Development*, 2, p.111.

Rocky Shore

Groynes are commonly employed hard-engineering structures constructed to the shoreline, intercepting longshore transport of wave and sediment. The intertidal habitat of these artificial structures offers a new rocky habitat that is typically located in predominantly sandy shorelines (Figure 9). The groynes and the anti-sea-erosion boulders along Nagore beach did not show any traces of accumulation/markings of oil sludge. The bottom dwelling organisms (such as crabs and gastropods) which preferably inhabit in the algae and oysters beds for foraging, were mostly found in the crevices between rocks. Barnacles represented by *Cthamalus* sp., *Megabalanus* sp. and *Balanus* sp. were found to be above the algal zone. The gastropod species (*Purpura bufo*) were recorded in the algal zones containing barnacles and the green seaweed *Chaetomorpha* sp. and *Enteromorpha* sp. The key species to have a sensitivity response to the oil spill were the green algae *Chaetomorpha* sp. and *Enteromorpha* sp. The healthy algae species were observed along the study area and there was no mortality and bleaching recorded. Crabs and bivalves on the Groynes were found to be healthy and had no oil remains on their body. The overall diversity of the rocky shore was not affected due to the oil spill.



Figure 9: Nagore Beach having small stretch of rocky shore made by groyne.

TPHs concentration in Water

A total of five surface samples were collected along the shore on 06th March 2023 (4th day of the oil spill). Organic contaminant free techniques were used throughout the sampling and the samples were collected in amber-coloured glass bottles, pre-cleaned with n-hexane and the bottles were rinsed with seawater before final sample collection. Extraction and concentrations of TPHs in the extracts were quantified by Cary Eclipse fluorescence spectroscopy (Agilent Technology) followed by ASTM D7066-4, (2017); IOC – UNESCO, (1984) with slight modifications based on the context of the present analysis.

TPH concentration in water samples along the Nagore coast varied between 123.4 and 144.8 µg/L with an average value of 127.8 µg/L (Table 2). No significant differences in TPH concentrations was observed for samples collected from offshore. Whereas a remarkable higher concentration (1507.4 µg/L) was observed in water sample collected adjacent to the shoreline that had been heavily affected due to the spill. The observed TPHs concentrations during the survey are comparable to previous studies along the southeast coast of Bay of Bengal³. The average TPH concentrations (127.8 µg/L) along the Nagore coast were marginally higher than the concentrations recommended for designated best use for salt pans, shell fishing, mariculture and ecologically sensitive zones (100 µg/l in terms of oil & grease) by the CPCB⁴.

Table 2. Spatial variation of TPHs concentration in water sample (µg/l) along the study area.

<i>S. No</i>	<i>Sampling Station (Lat; Long)</i>	<i>TPHs Concentration (µg/l)</i>	CPCB Permissible level for Class SW-1 (Salt pans, Shell fishing, Mariculture and Ecologically Sensitive Zone)
<i>S1</i>	Spillage area (10°49'15.49"N;79°51'3.35"E	1507.4	100 µg/l (Oil and Grease: including Petroleum Products)
<i>S2</i>	CPCL -Jetty 0.2 km 10°49'29.87"N;79°51'12.62"E	144.8	
<i>S3</i>	CPCL -Jetty 0.7 km 10°49'30.12"N;79°51'27.67"E	128.4	

³ Barathkumar, S., Savurirajan, M., Raja, P., Marigoudar, S.R., Sharma, K.V. and Murthy, M.R., 2022. Spatial distribution of total petroleum hydrocarbons in the seawater and sediment of Southeast coast of India.

⁴ https://cpcb.nic.in/wqm/coasteal_water_standards.pdf

<i>S4</i>	CPCL -Jetty 1.3 km 10°49'30.00"N;79°51'47.37"E	<i>123.4</i>
<i>S5</i>	0.5 km South 10°48'52.41"N;79°51'2.84"E	<i>114.6</i>

Key observation and recommendations

- **Physical characteristics of the coast:** the coast is under erosion, and the oceanic forces are continuously affecting the crude oil pipeline, the pipeline is exposed to the open ocean.
- **The amount of crude oil spilled:** The CPCL authorities informed that about 1000 liters of crude oil spilled over the area where the pipeline was damaged. It will be used to forecast and estimate the impact of crude oil on the marine ecosystem and its fate along and across the coast.
- **Prediction of the Spill:** Prediction of the crude oil spill is essential for assessing the impact on the adjacent coastal regions and ecosystems. It is recommended that impact studies through field surveys and model simulations on adjacent coastal ecosystems be carried out for two seasons.
- **Treatment and removal of oil slick:** The spill was completely removed from the beach by the CPCL authorities and the spread was controlled by applying the oil spill dispersant.
- The observed TPH concentration was slightly higher than the concentrations recommended for designated best use for Class SW-1 (salt pans, shell fishing, mariculture and ecologically sensitive zones) by the CPCB.
- **Physical and Biological impacts:** From intertidal observation along the study area it was observed that the diversity of intertidal organisms remained good and healthy. There is no oil sludge evidence/ marking on the groynes and boulders along the intertidal rocky shore. The organisms of the intertidal area consists of burrowing crabs, gastropods, bivalves, and tubicolous polychaetes etc.