Coastal Monitoring methods: Oil Spill forecasting

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Discovery and Use of Operational Ocean Data Products and Services

18-22 June 2018

ITCOocean, INCOIS, Hyderabad

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OVERVIEW OF THE PRESENTATION

- SOURCES OF OIL SPILLS
- NEED FOR OIL SPILL TRAJECTORY PREDICTION SYSTEM
- TYPES OF OIL SPILL MODELS
- CASE STUDIES – SIMULATION AND VALIDATION
- ROLE OF EARTH OBSERVATION IN OIL SPILL MODELING/RESEARCH
- OIL SPILL TRAJECTORY PREDICTION WITH MULTIMODEL FORCINGS

WHAT IS AN OIL SPILL

- Release of liquid petroleum hydrocarbon into the environment especially in the water body.
- Form of pollution

Based on the quantity

Tier -1 < 700 Tonnes

Tier -2 >700 <1000 Tonnes

Tier - 3 > 1000 Tonnes

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Natural seepage from seabed

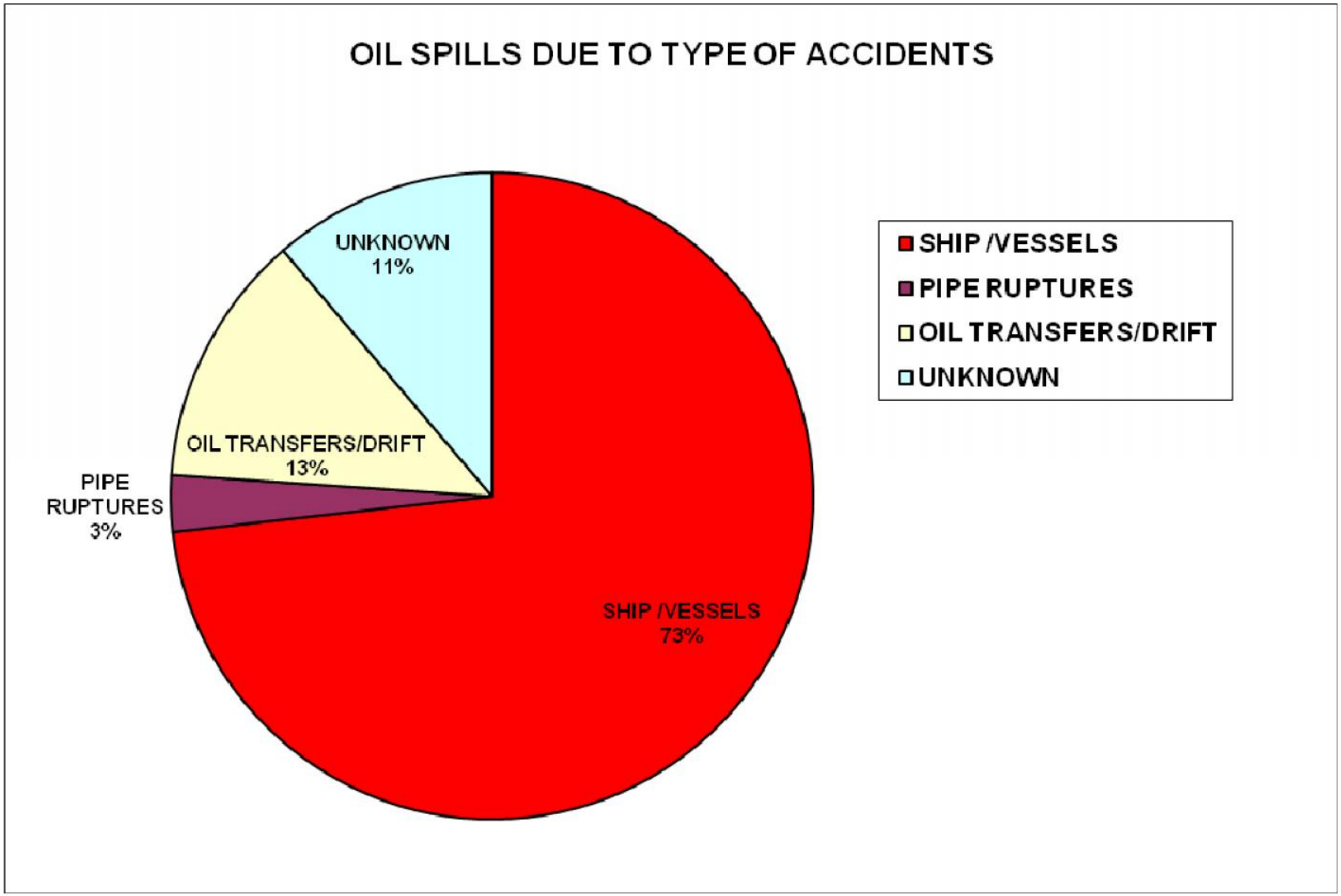
Ship-borne

SOURCES OF OIL SPILLS

Upstream Exploration and Production

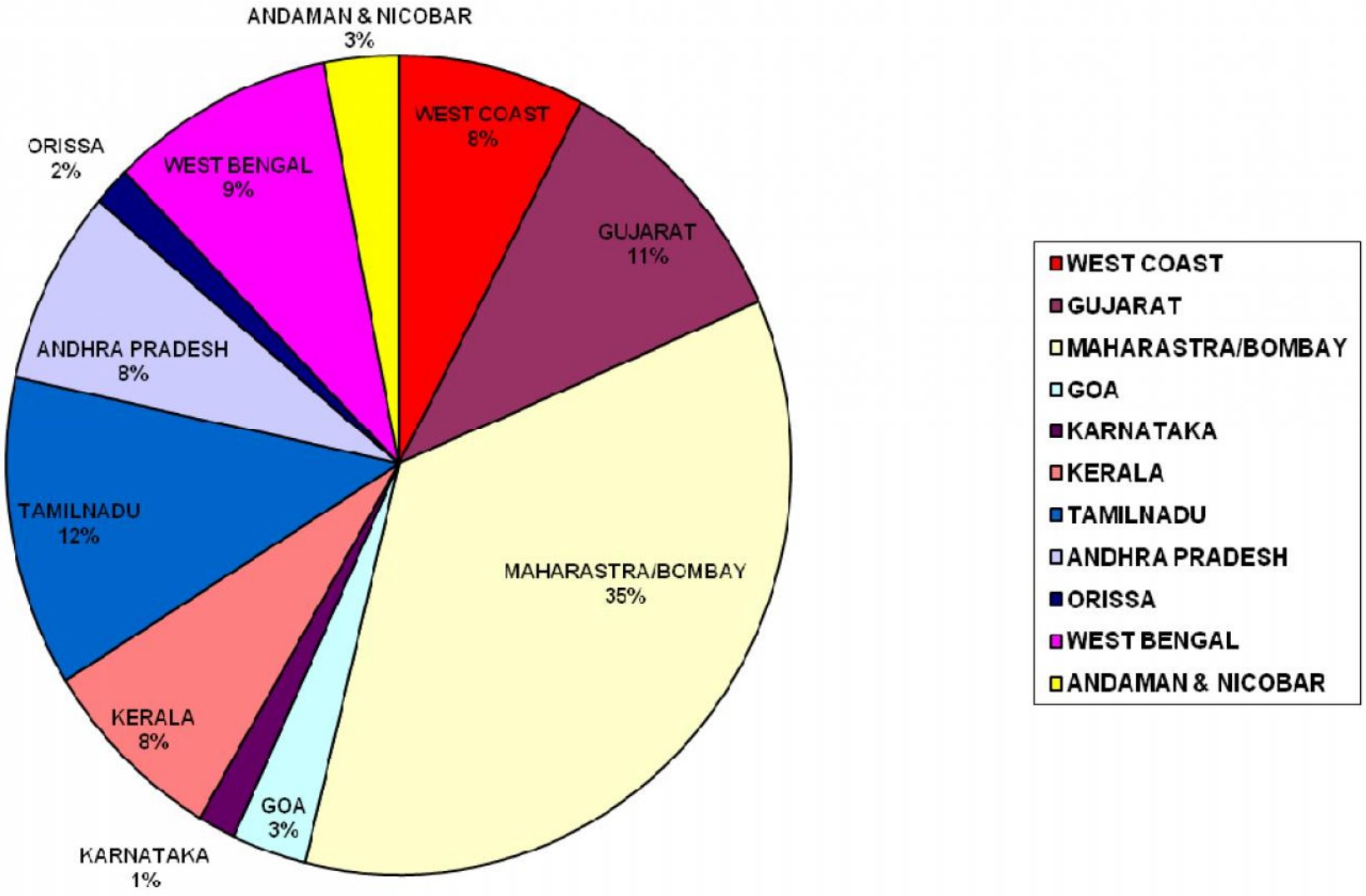
Transfer to Downstream

ICG STATISTICS ON INDIAN SCENARIO



Source : Indian coast Guard,2012

OIL SPILLS ALONG THE COASTAL ZONES



Source : Indian coast Guard,2012

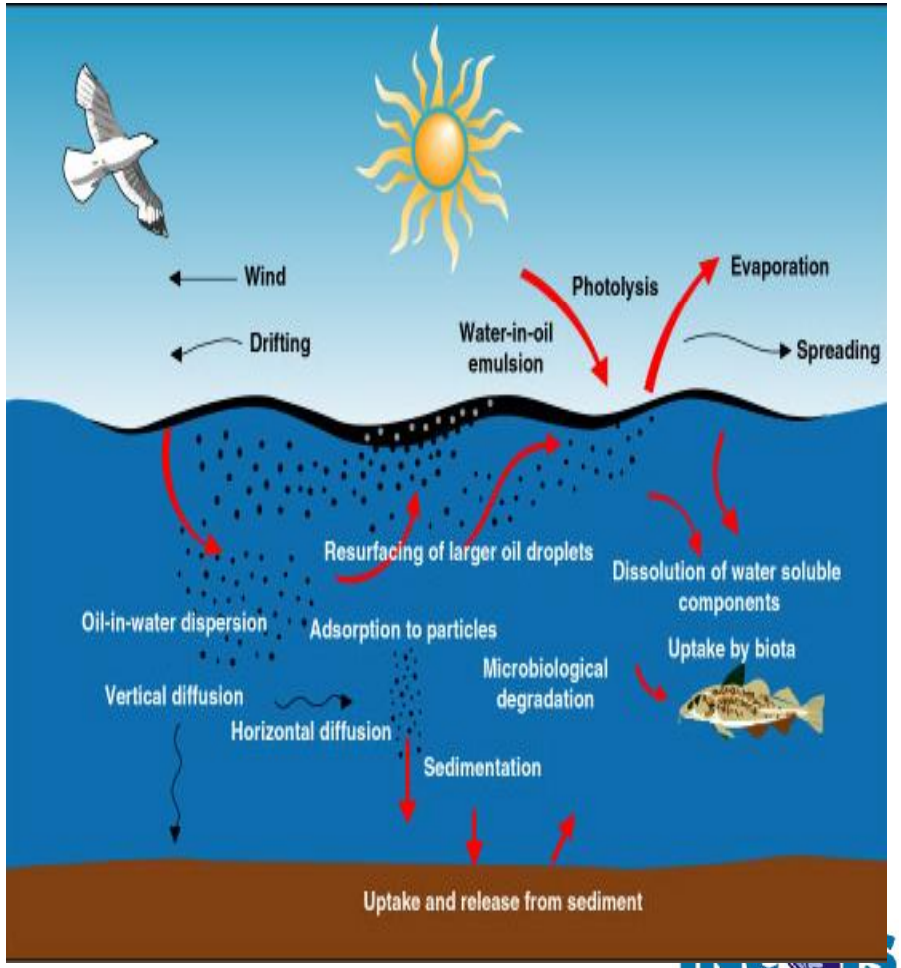
OIL WEATHERING PROCESS

OIL WEATHERING

Oil weathering is defined as the process that makes changes in chemical composition and physical characteristics over time.

Soon after an oil spill incident, the following process will happen

- **Emulsion (water in oil)**
- **Dispersion (Oil in water)**
- **Evaporation**
- **Spreading(diffusion)**
- **Photochemical oxidation**
- **Drifting (forcings)**
- **Biodegradation**



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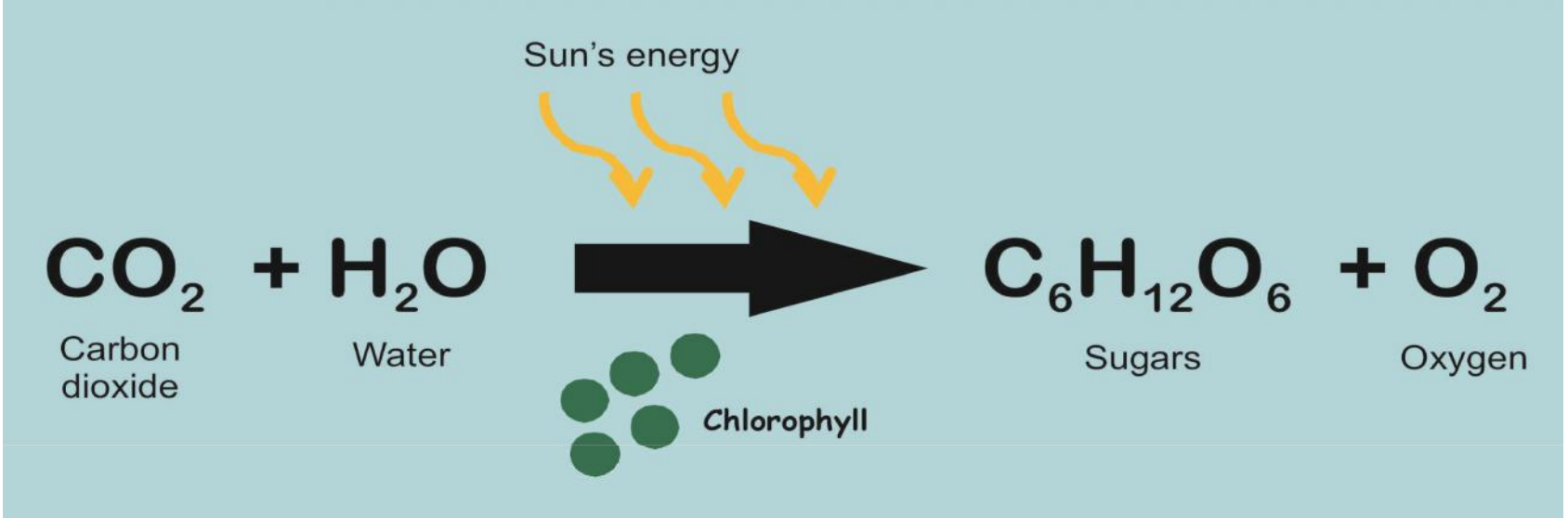
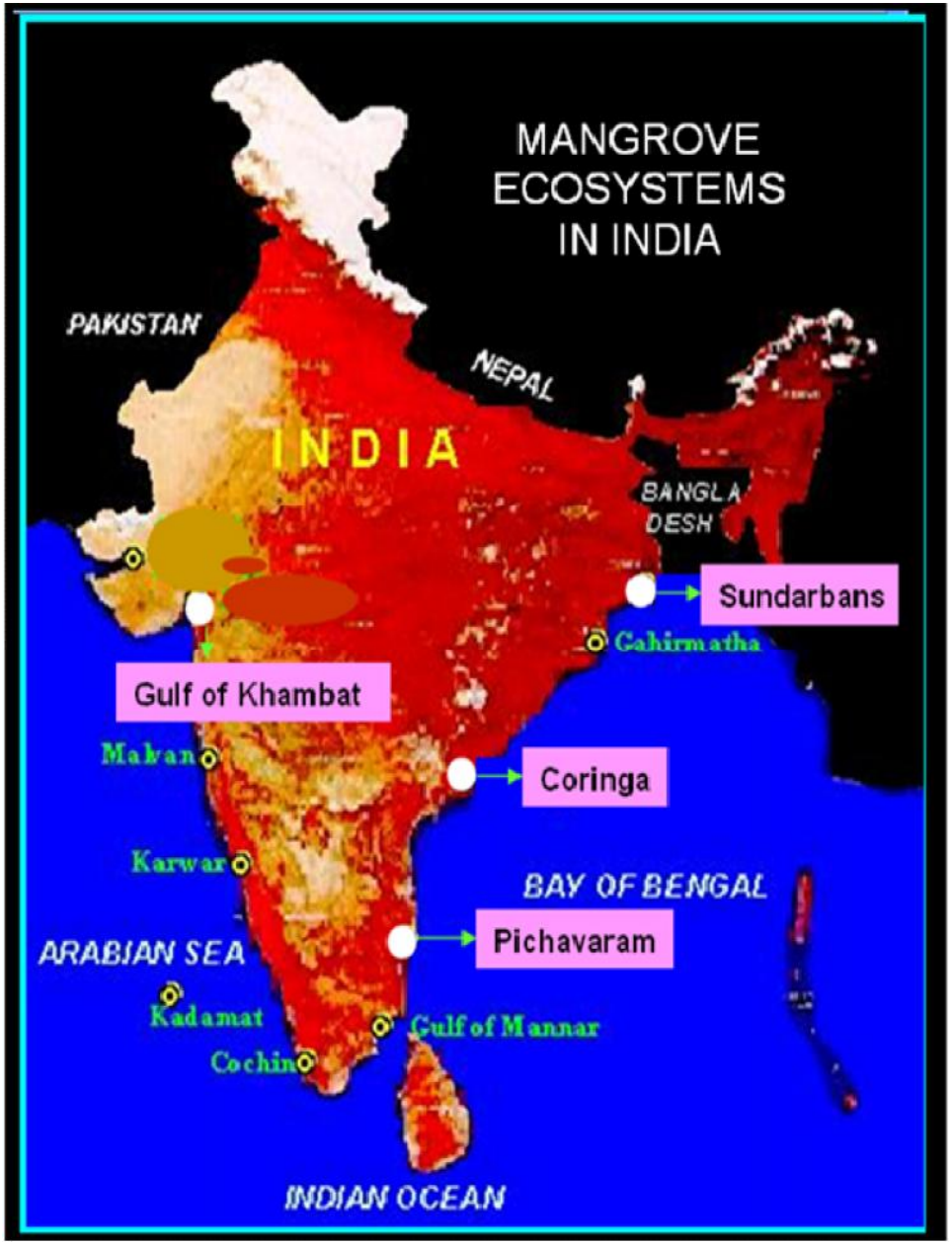
ENVIRONMENTAL IMPACTS OF OIL SPILLS

IMPACT ON PHOTOSYNTHESIS IN THE MARINE ENVIRONMENT



Phytoplankton can only carry out this process where there is sufficient light intensity penetrating the sea water. This area is called the ***photic zone*** and is often the top 100 metres of the ocean.

Heavier oils will cover the surface, thereby not allowing the sunlight to penetrate.



IMPACTOF OIL IN MANGROVES

- Light fuels oils can cause mortality in 24-48 hours in red mangroves and black mangroves.
- Crude oils – coat the prop roots and reduce the ability to exchange gases.
- Long term persistence – cause leaf loss and to death.

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SIGNIFICANCE OF CORAL REEFS

- Coral reefs - natural barriers that protect nearby shorelines from the eroding forces of the sea,
- Coral reefs cover less than 1% of the Earth's surface, they are home to 25% of all marine fish species.

IMPACT OF OIL IN CORAL REEFS

- Effect the health of the larger reef community
- Some of the more territorial fish will even remain in the area until death.

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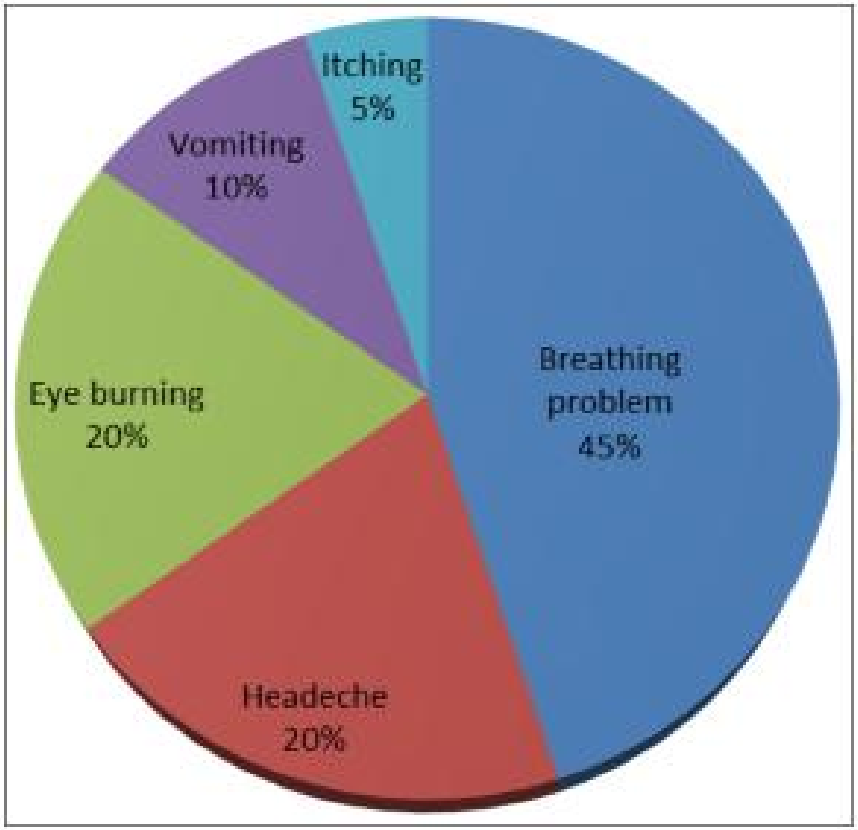
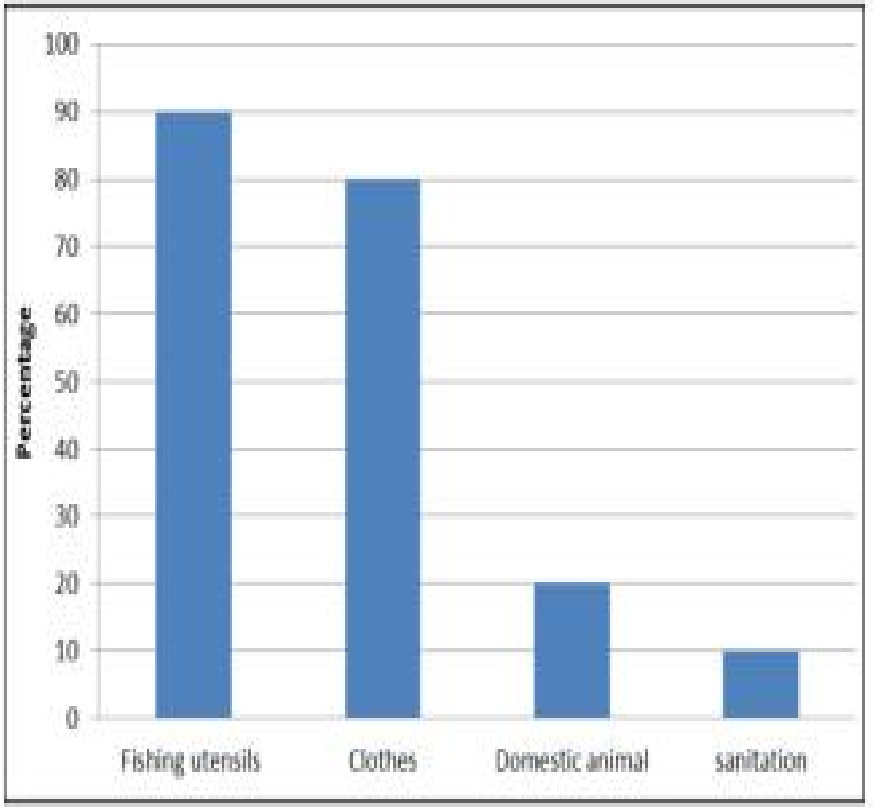
IMPACT ON HUMAN AND LIVELIHOOD



IMPACT ON HUMAN HEALTH



IMPACT ON LIVELIHOOD

Atiqur Rahman Sunny
Research Assistant, ECOFISH[BD]
Project, World Fish Bangladesh
and South Asia

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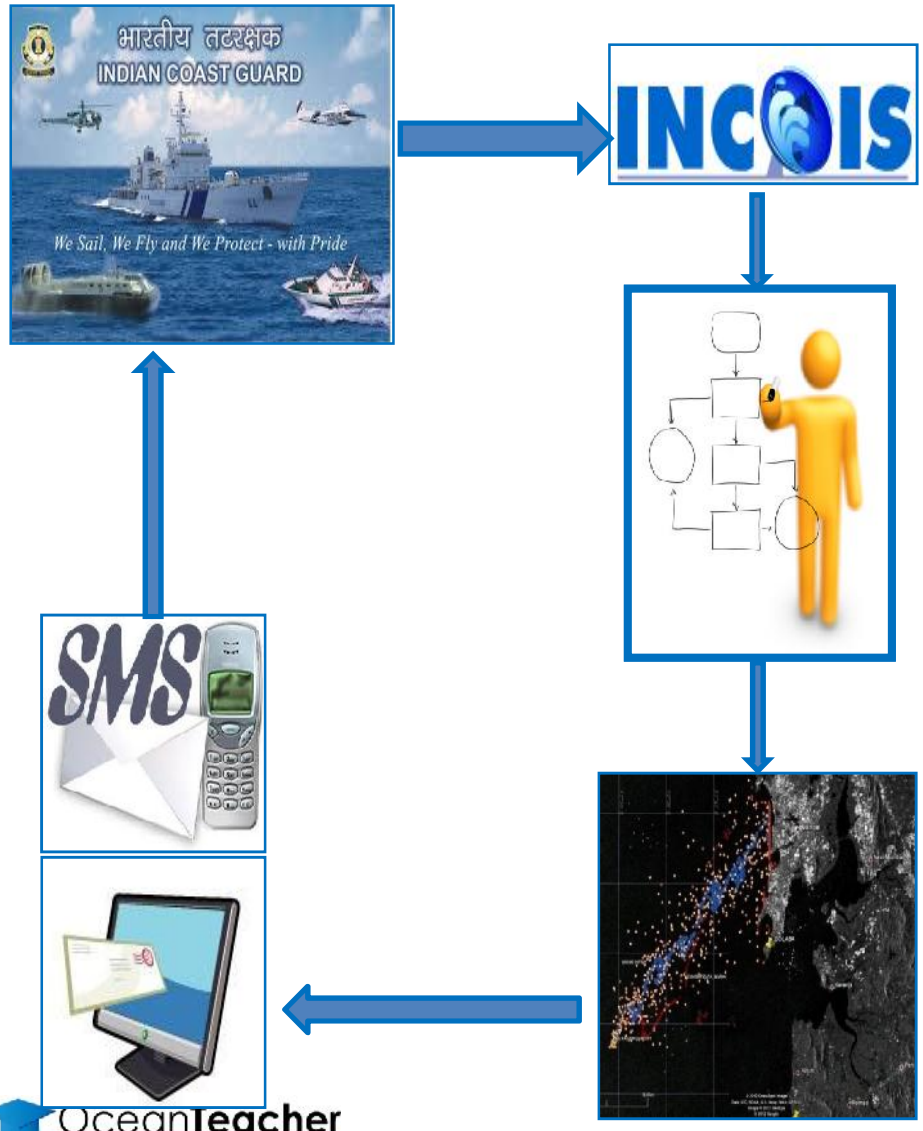
NEED FOR OIL SPILL TRAJECTORY PREDICTION SYSTEM

INCOIS AID IN OIL SPILL PREPAREDNESS AND RESPONSE

DISSEMINATION OF OIL SPILL ADVISORY TO THE USERS



SIGNIFICANCE OF OIL SPILL TRAJECTORY PREDICTION

India possessing sensitive ecosystems and aquatic organisms along its coastline comprising estuaries, lagoons, mangroves, backwaters, salt marshes, mudflats, rocky shores, sandy structures and known for its coastal and Marine biodiversity. The marine habitats are being affected due to the oil spills caused due to vessel collisions and illegal discharges. In order to prevent the impact of oil spills on the marine environment an oil spill trajectory prediction system is required, to provide the trajectory of an oil spill thereby protecting the Marine habitats.

In the event of oil spill, the direction and movement of the oil will be predicted in advance in our system and will be disseminated to the Regulatory Authority. The clean up and control measures will be planned and carried out accordingly.

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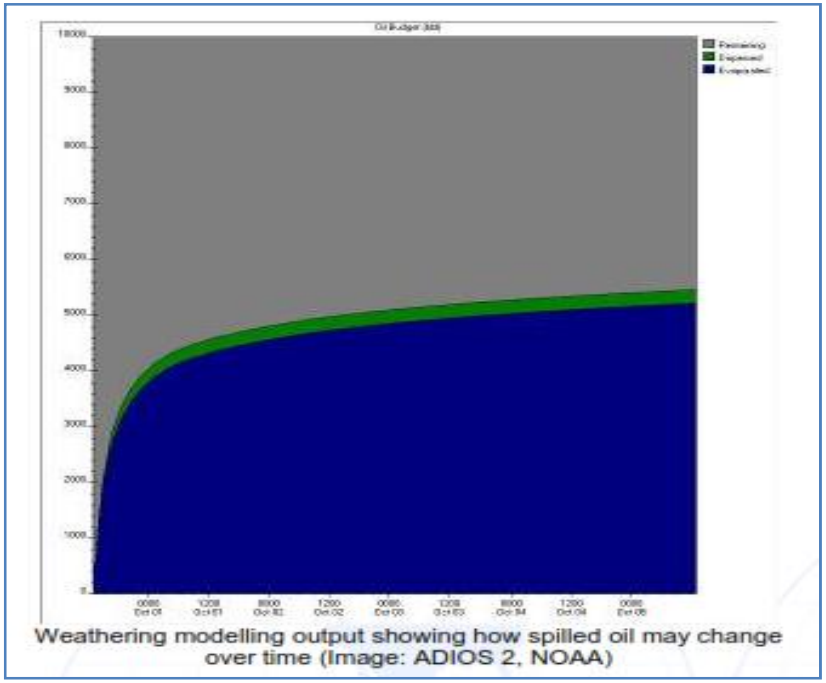
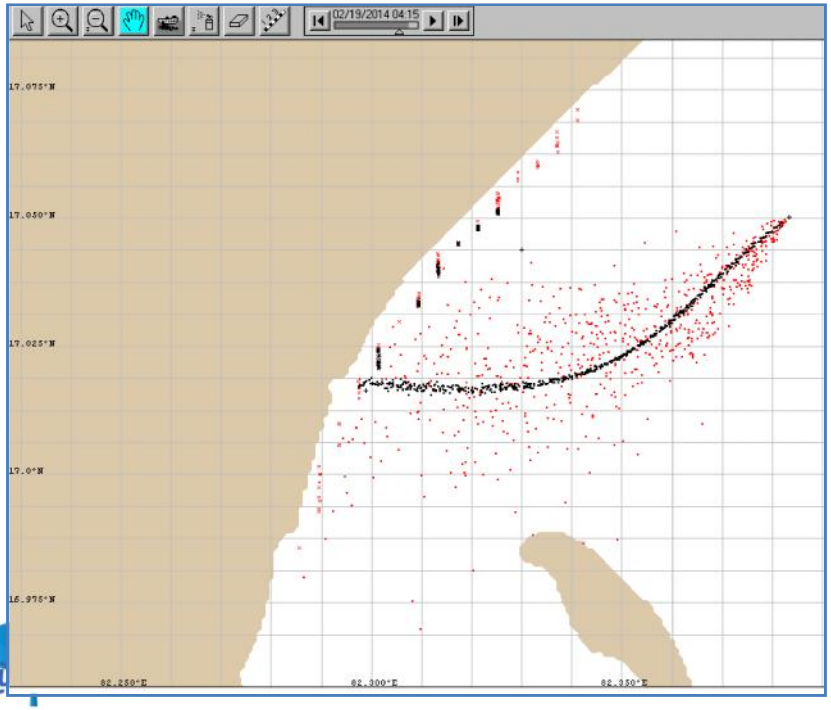
TYPES OF OIL SPILL MODELS



Weathering modelling output showing how spilled oil may change over time (Image: ADIOS 2, NOAA)



OIL WEATHERING AND TRAJECTORY MODELING

WEATHERING MODELS – Predicts the changes in the oil characteristics with respect to the time.

TRAJECTORY MODELS - Predicts the path of the spilled oil with respect to the time

USES OF OIL SPILL MODELS

1. **Contingency planning - to protect the marine organisms**
2. **Mock drills/ exercise - conducted by various offshore industries as a part of regulations**
3. **Oil spill response operations - to issue the advisory in the event of oil spills.**

GNOME BASED OIL SPILL TRAJECTORY PREDICTION

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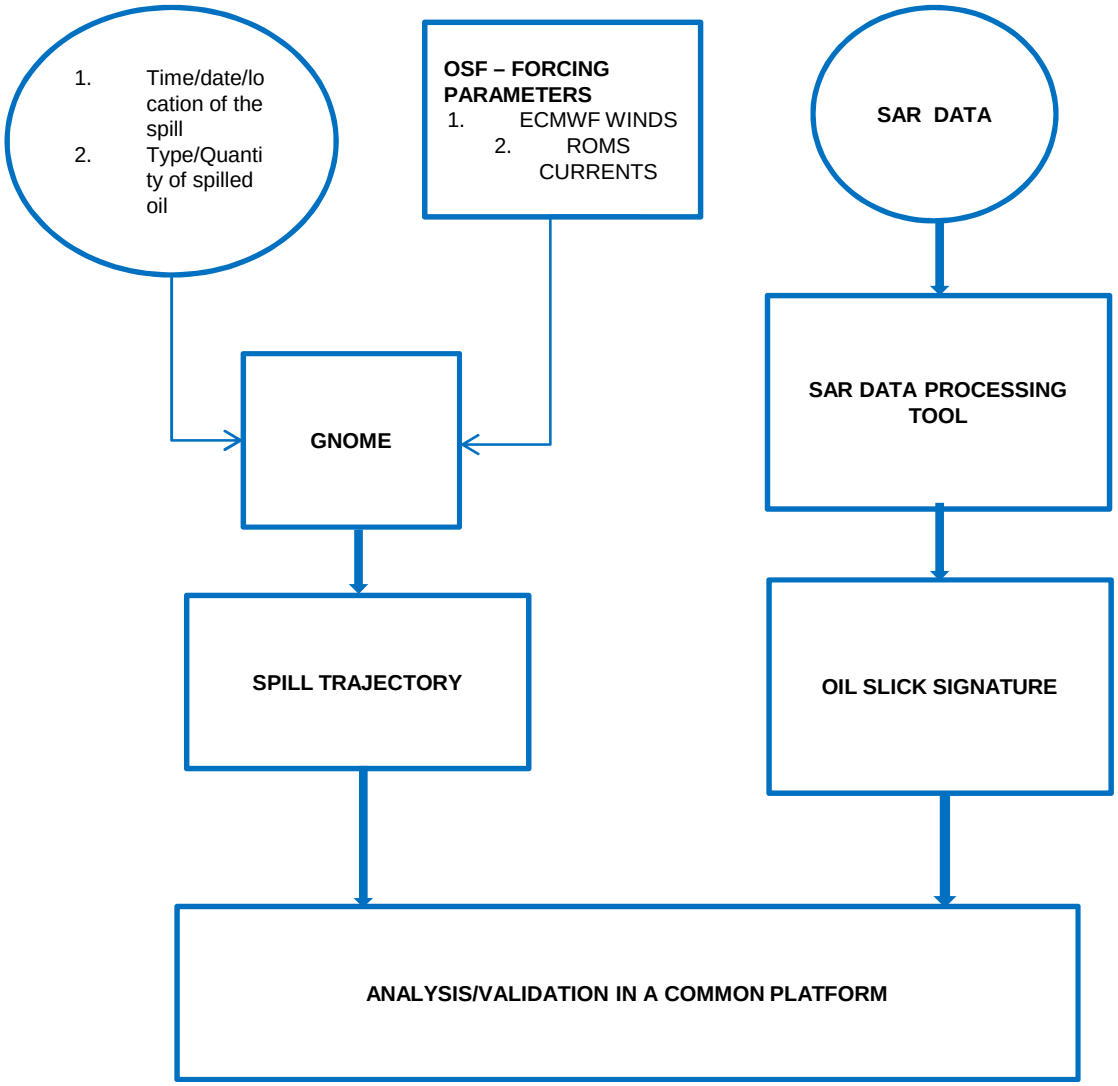
OIL SPILL TRAJECTORY PREDICTION- METHODOLOGY

METHODOLOGY



DESCRIPTION

- GNOME, an oil spill trajectory model developed by NOAA is used in this prediction system.
- The details such as time, date, location, type and quantity of the oil spilled will be obtained the Regulatory authority / users. The major forcings like ECMWF winds and ROMS currents are the driving parameters.
- The predicted trajectory will be disseminated to the users in movie, image and text formats.
- The available SAR data will be subjected to oil spill detection
- Both the observed and the predicted trajectory will be compared in a common platform.

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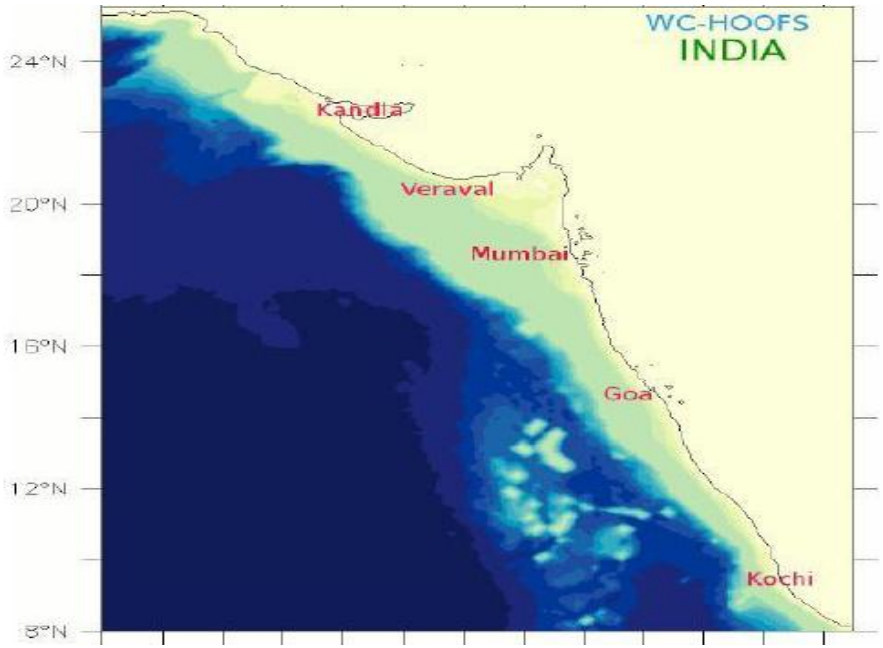
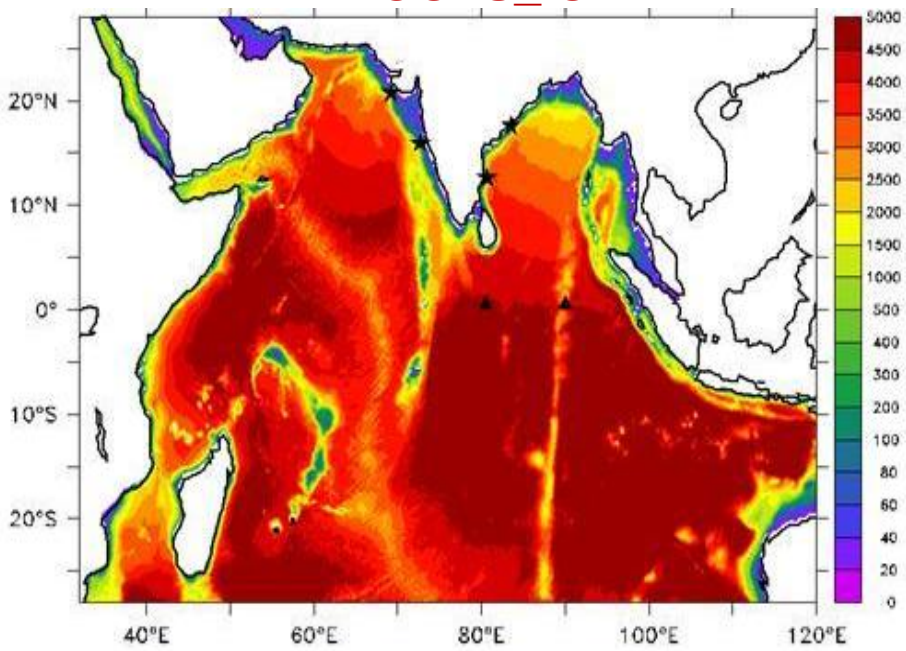
FORCINGS UTILISED FOR OIL SPILL TRAJECTORY PREDICTION

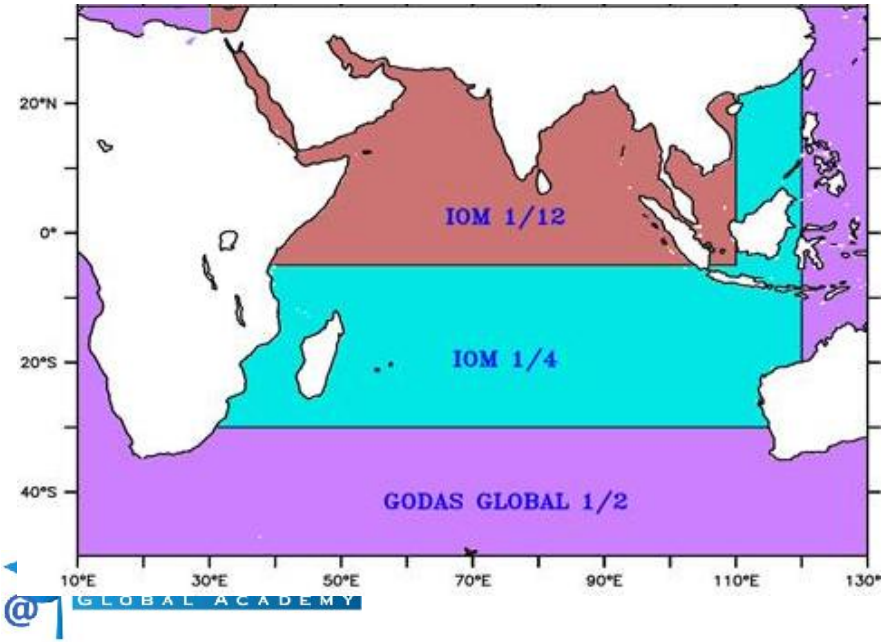
HOOFS_WC



HOOFS_IO



MOM



HYCOM

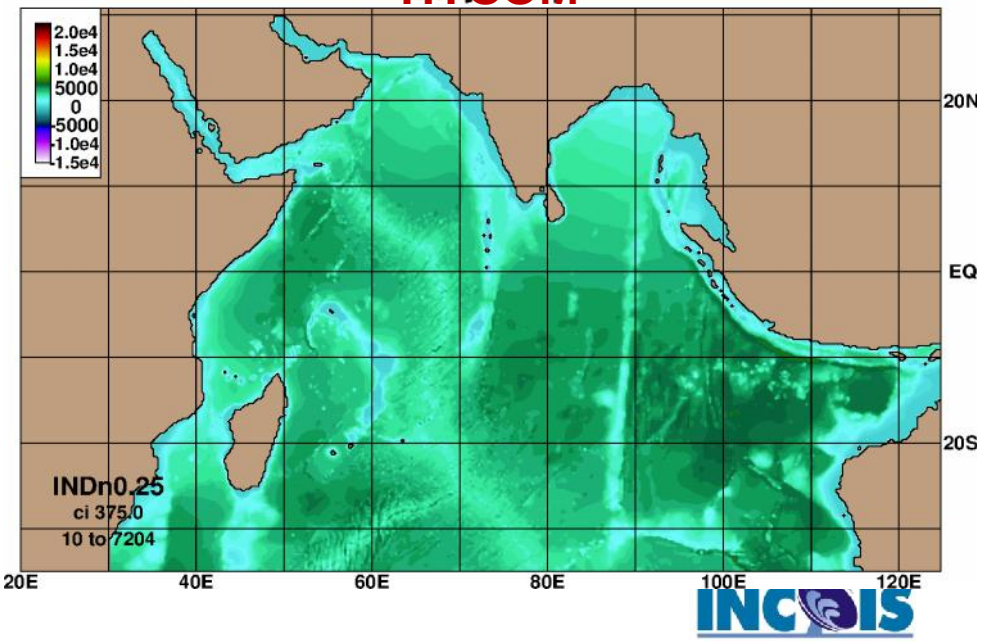
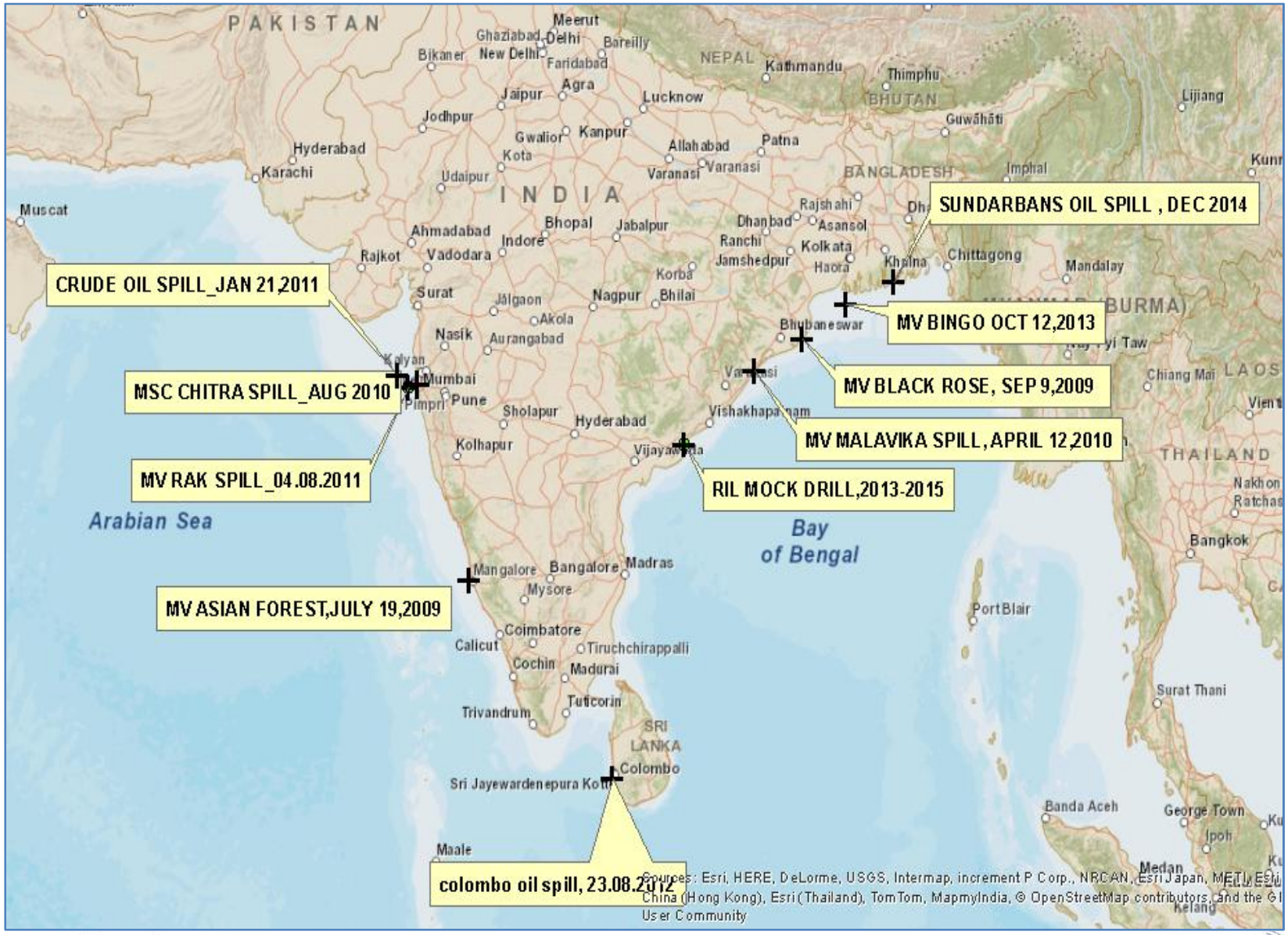


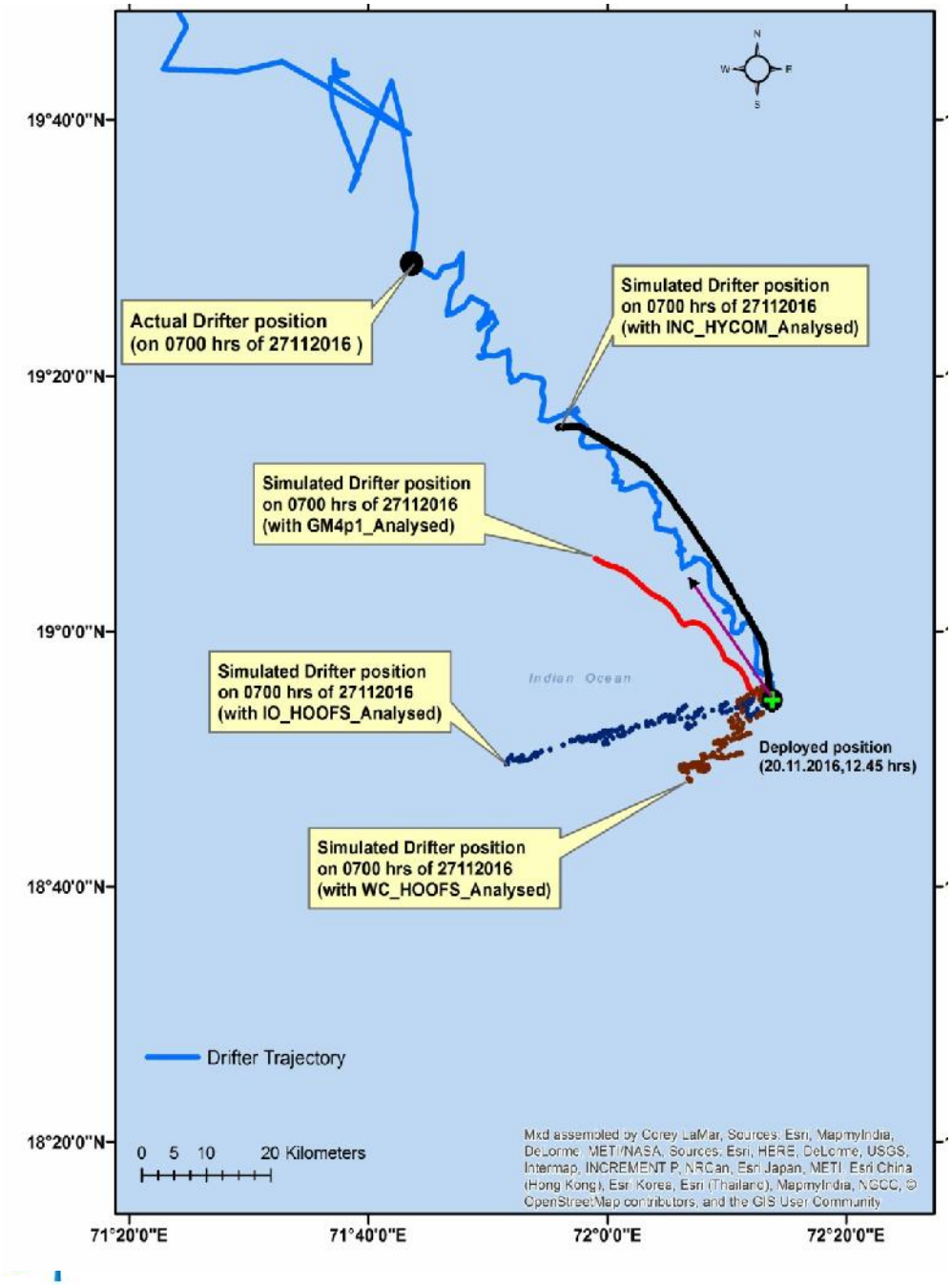
ILLUSTRATION OF CASE STUDIES

LOCATION MAP OF OIL SPILL INCIDENTS



EXPERIMENTS WITH MULTIMODEL FORCINGS

SVP DRIFTER EXPERIMENT (1245hrs20112016-1243hrs03.12.2017)



Surface Velocity program (SVP) drifter was deployed off mumbai on 1245 hrs of 20112016 by INCOIS & ICG to evaluate the performance of oil spill trajectory model GNOME. Various drift patterns were obtained while forcing with the currents of Ocean General Circulation Models. The obtained drift positions were compared with actual drifter track on 0700hrs of 27112016. The simulated drifter's track while forcing with HYCOM currents fits best to the actual path travelled by drifter, but an underestimation in the magnitude exist. Second better fit was obtained while forcing GNOME with GM4p1 currents, with an underestimation in the magnitude.

Technical Report

Prasad, S.J., Balakrishnan Nair, T.M., Rahaman, H., Joseph, S., Yatin, G., Evaluation of oil spill trajectory model with the observed SVP drifter track. Report No.: ESSO-INCOIS-ISG-MOG-TR-03 (2017), pp. 1-14.

ROLE OF EARTH OBSERVATION MISSIONS IN OIL SPILL MODELING/MONITORING AND RESEARCH

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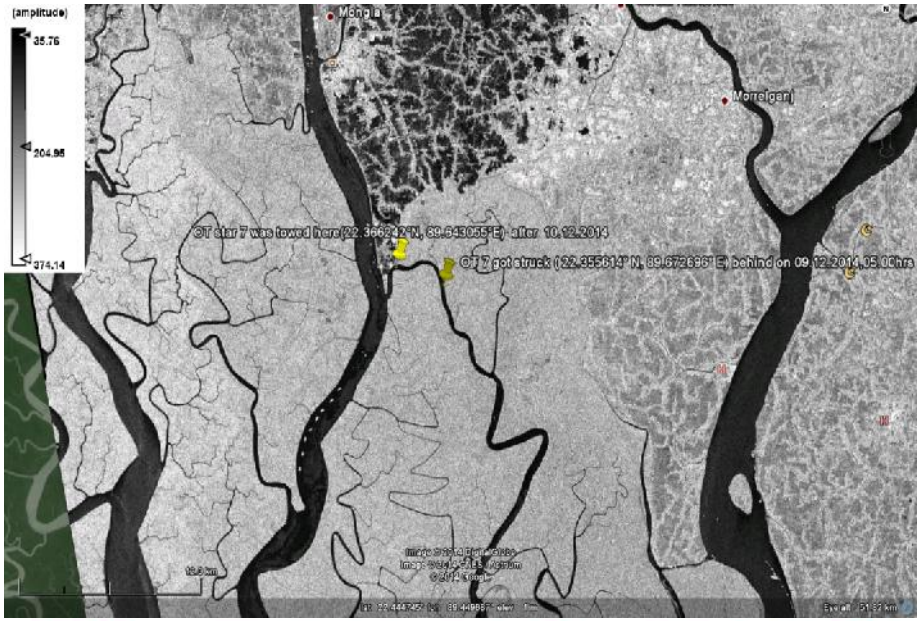
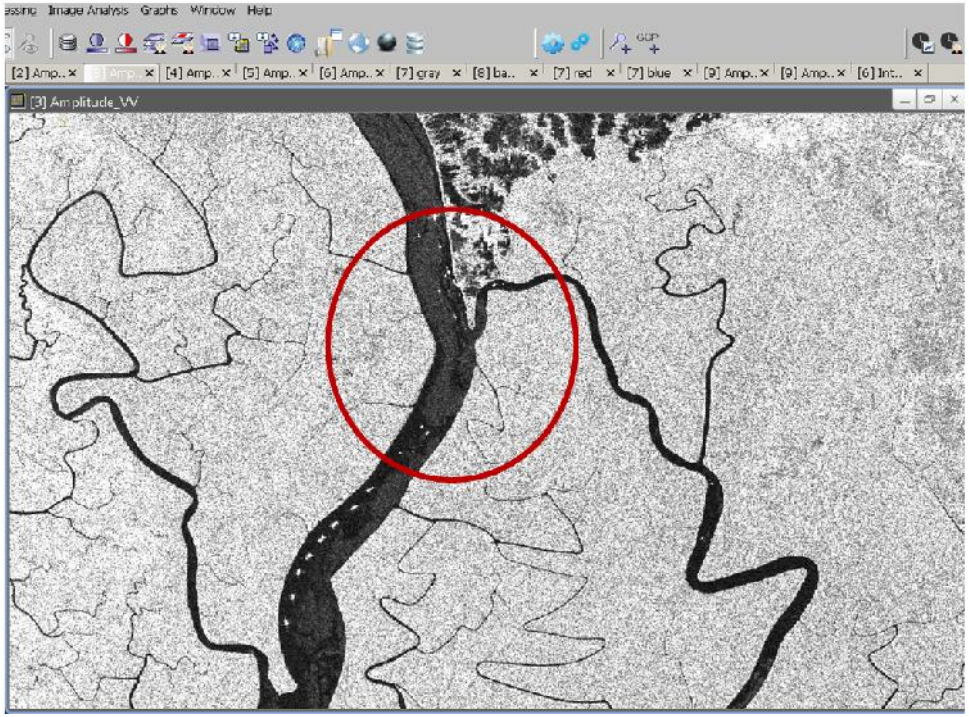
ROLE OF EO SENTINEL MISSIONS – INDIA ON ALERT DUE TO SUNDARBAN OIL SPILL- 09.12.2014 to 15.12.2014

HISTORY OF THE INCIDENT

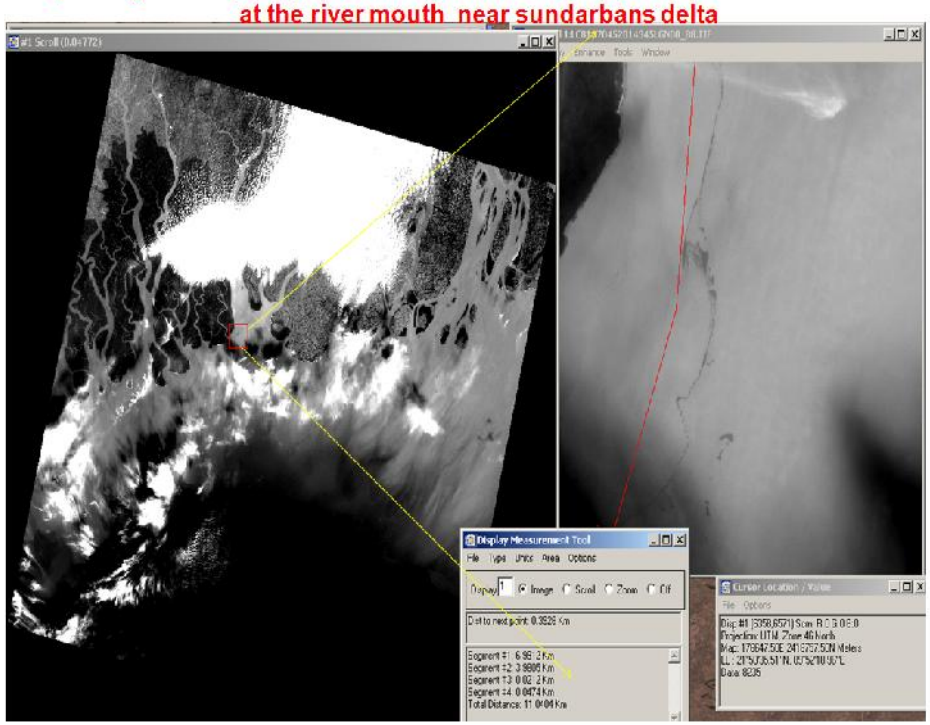
- OT SOUTHERN STAR 7 was anchored in sela river at 22.355614° N, 89.672696° E and was struck behind by another vessel on 09.12.2014, 05.00 hrs.
- The spill has covered the upstream and entered Pasur river.
- On 11.12.2014, spill signatures (from landsat 8 data)were noticed near sundarbans delta
- It was towed a 4 km upstream in sela river on 12.12.2014 at (22.366242°N, 89.643055°E) and was shown in sentinel -1 A dataset
- Sentinel – 1 A dataset has shown the bright signature of the towed vessel and oil spill in the sela and pushpa river streams on 12.12.2014



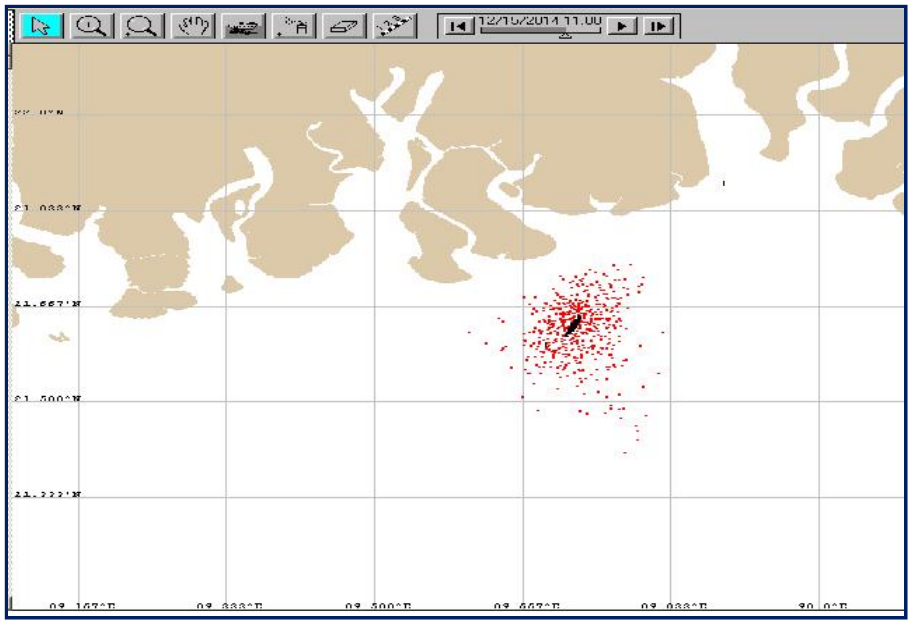
Signature of the spill in Sela /Pushpa river on 12.12.2014- Sentinel-1 A, ESA

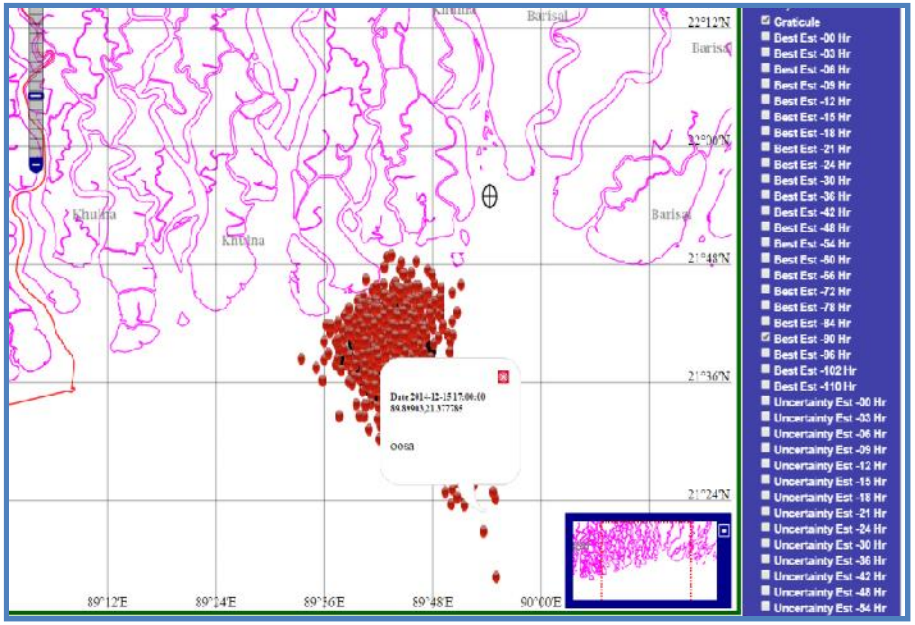


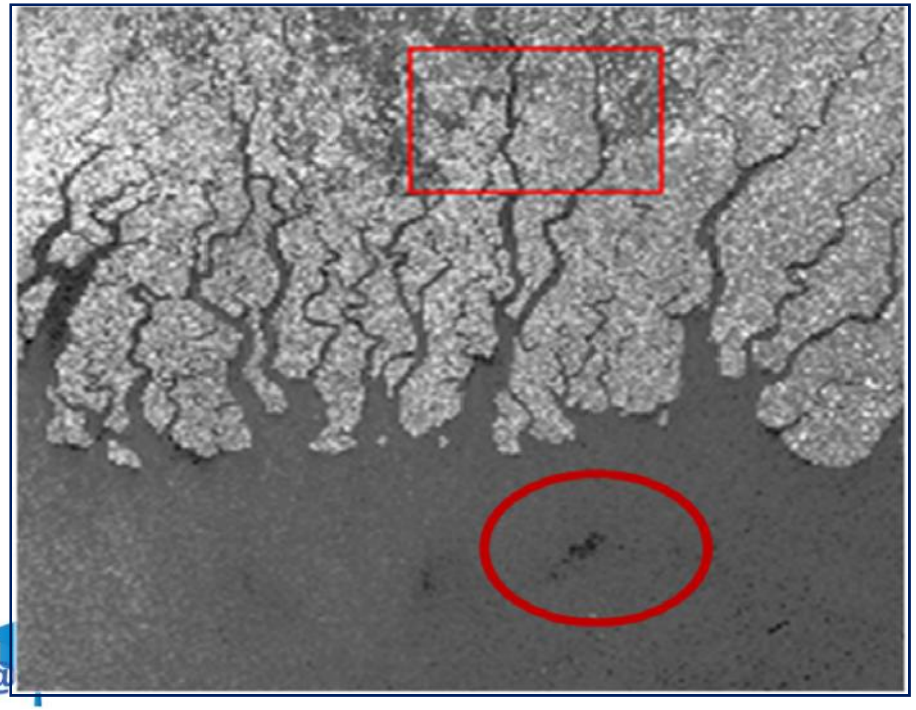
Spill Signature (11km) obtained on Landsat 8 image obtained on 11.12.2014 at the river mouth near sundarbans delta

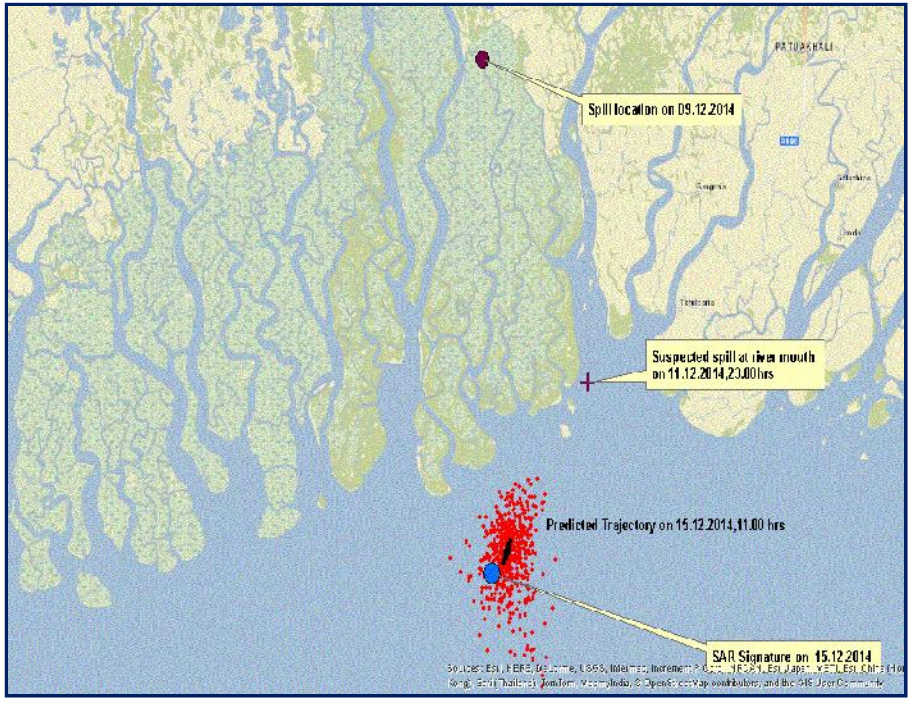


ROLE OF RADARSAT IN VALIDATING SUNDARBAN OIL SPILL TRAJECTORY PREDICTION - 15.12.2014





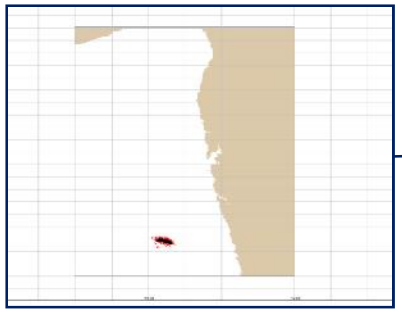


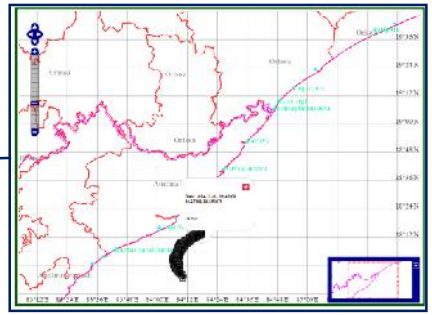


ONLINE OIL SPILL ADVISORY ARCHITECTURE

AUTOMATIC TRIGGER OF THE BATCH VERSION OF GNOME IN WINDOWS SERVER

(With the necessary details and the forcing parameters)





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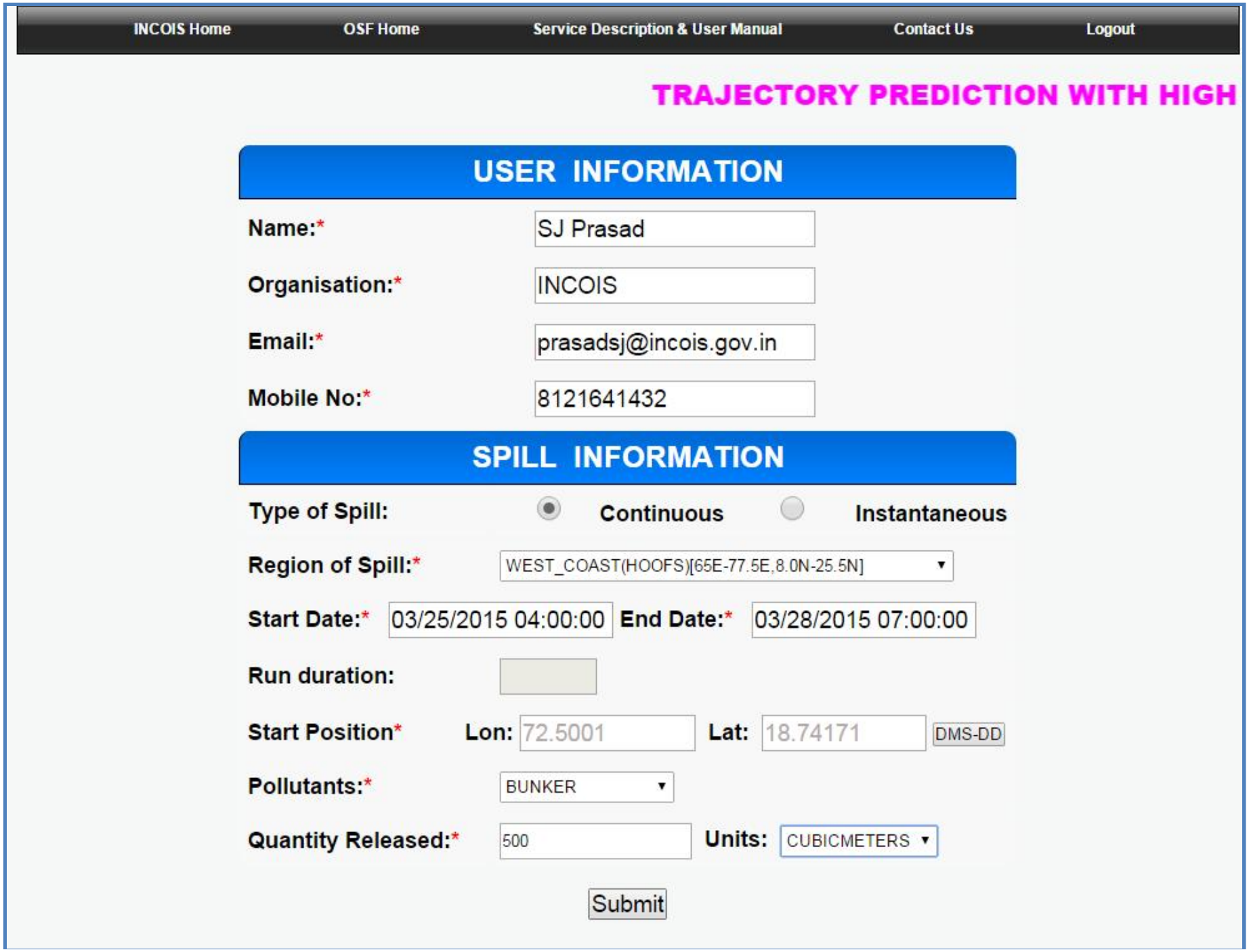
INCOIS Home
OSF Home
Service Description & User Manual
Contact Us
Logout
TRAJECTORY PREDICTION WITH HIGH
USER INFORMATION
Name:*
SJ Prasad
Organisation:*
INCOIS
Email:*
prasadsj@incois.gov.in
Mobile No:*
8121641432
SPILL INFORMATION
Type of Spill:
Continuous
Instantaneous
Region of Spill:*
WEST_COAST(HOOFS)[65E-77.5E,8.0N-25.5N]
Start Date:*
03/25/2015 04:00:00
End Date:*
03/28/2015 07:00:00
Run duration:
Start Position*
Lon:
72.5001
Lat:
18.74171
DMS-DD
Pollutants:*
BUNKER
Quantity Released:*
500
Units:
CUBICMETERS
Submit

OIL SPILL TRAJECTORY PREDICTION SYSTEM

Oil Spill Information	Logout
Spill Type:	Continuous
Start Date:	03/25/2015 04:00:00
Start Longitude	72.5001
Start Latitude	18.74171
Pollutants	BUNKER
Quantity Released	500 CUBICMETERS
Trajectory Prediction for	75 Hours

Your process is completed successfully

Download Output View output in Web Map Back to OOSA Home

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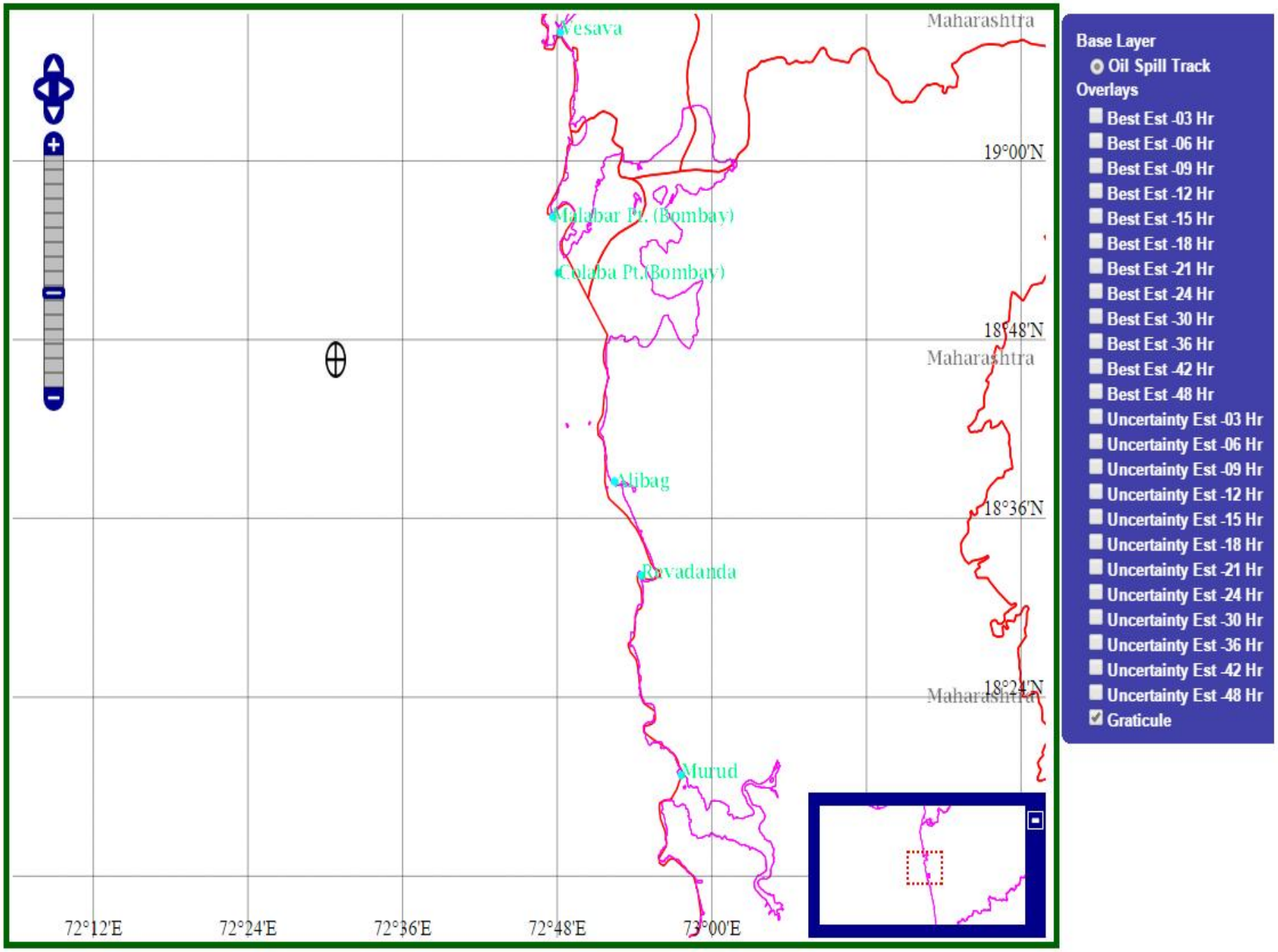
Maharashtra
Vesava
19°00'N
Malabar Pt. (Bombay)
Colaba Pt.(Bombay)
18°48'N
Maharashtra
Alibag
18°36'N
Revadanda
18°24'N
Maharashtra
Murud
72°12'E
72°24'E
72°36'E
72°48'E
73°00'E
Base Layer
Oil Spill Track
Overlays
Best Est -03 Hr
Best Est -06 Hr
Best Est -09 Hr
Best Est -12 Hr
Best Est -15 Hr
Best Est -18 Hr
Best Est -21 Hr
Best Est -24 Hr
Best Est -30 Hr
Best Est -36 Hr
Best Est -42 Hr
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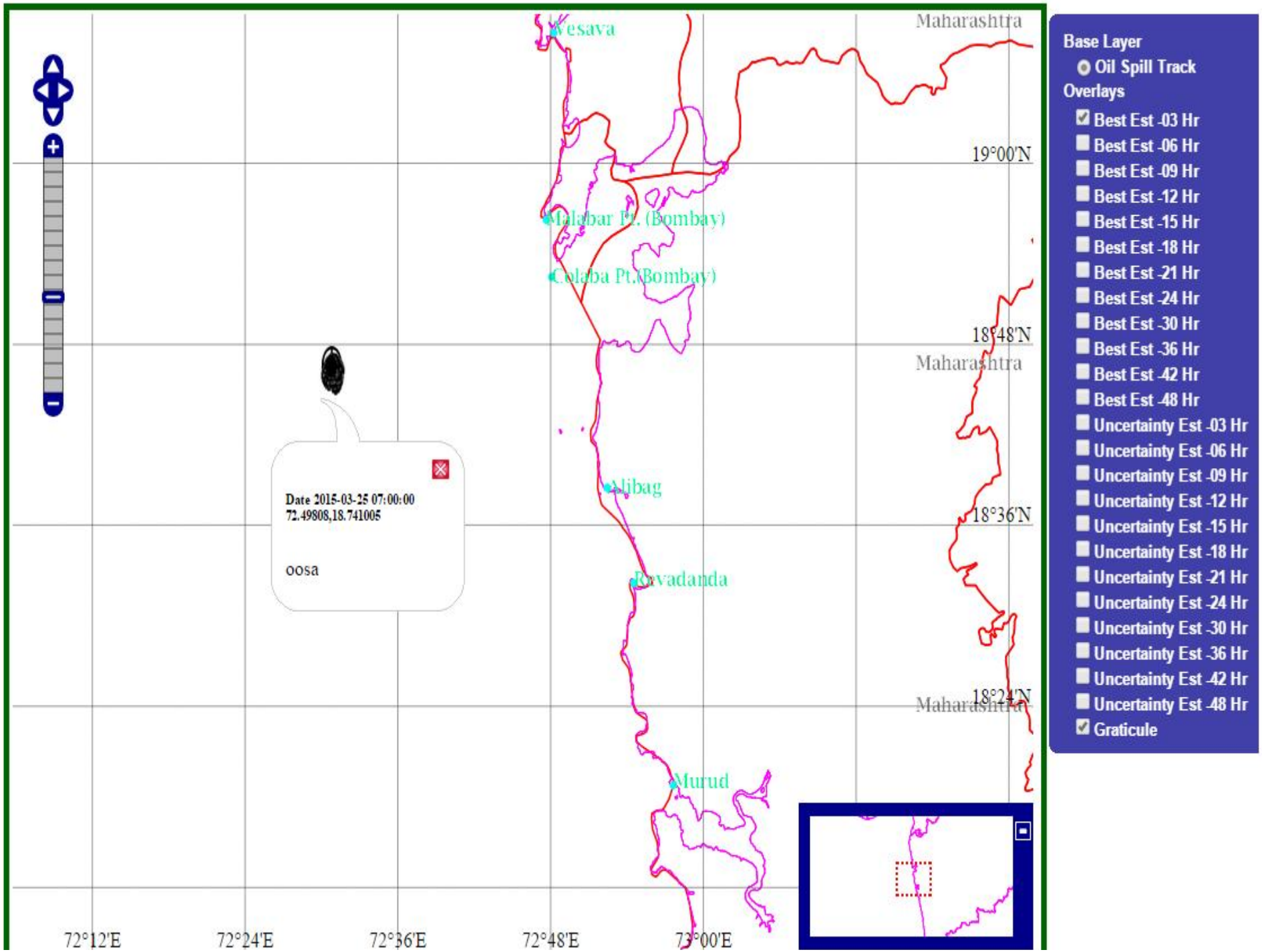
Uncertainty Est -42 Hr
Uncertainty Est -48 Hr
Graticule


Maharashtra
Vesava
19°00'N
Malabar Pt. (Bombay)
Colaba Pt.(Bombay)
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Maharashtra
Alibag
18°36'N
Revadanda
18°24'N
Maharashtra
Murud
72°12'E
72°24'E
72°36'E
72°48'E
73°00'E
Date 2015-03-25 07:00:00
72.49808,18.741005
oosa
Base Layer
Oil Spill Track
Overlays
Best Est -03 Hr
Best Est -06 Hr
Best Est -09 Hr
Best Est -12 Hr
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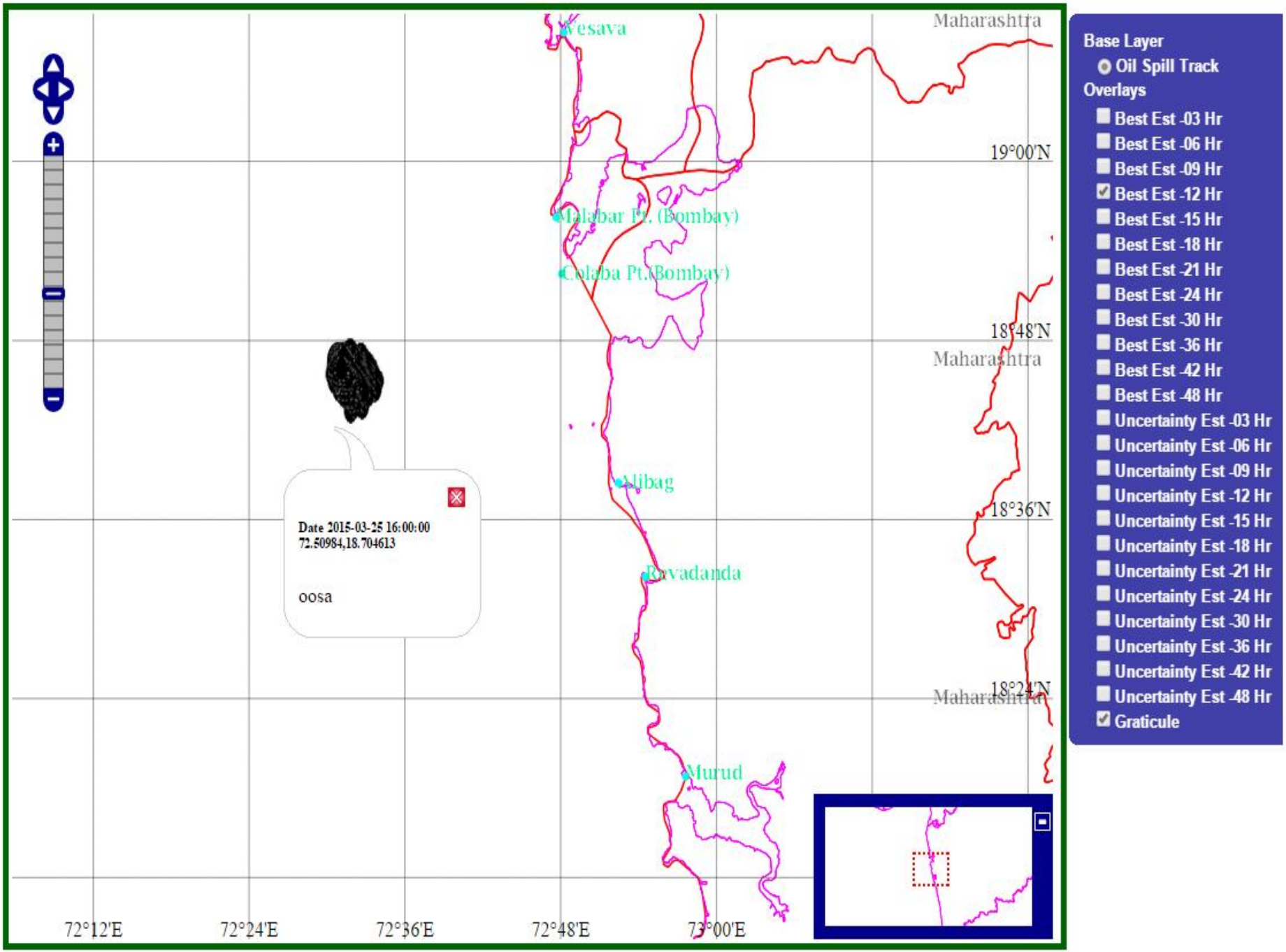
Uncertainty Est -42 Hr
Uncertainty Est -48 Hr
Graticule


Maharashtra
Vesava
19°00'N
Malabar Pt. (Bombay)
Colaba Pt.(Bombay)
18°48'N
Maharashtra
Alibag
18°36'N
Revadanda
18°24'N
Maharashtra
Murud
72°12'E
72°24'E
72°36'E
72°48'E
73°00'E
Date 2015-03-25 16:00:00
72.50984,18.704613
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Base Layer
Oil Spill Track
Overlays
Best Est -03 Hr
Best Est -06 Hr
Best Est -09 Hr
Best Est -12 Hr
Best Est -15 Hr
Best Est -18 Hr
Best Est -21 Hr
Best Est -24 Hr
Best Est -30 Hr
Best Est -36 Hr
Best Est -42 Hr
Best Est -48 Hr
Uncertainty Est -03 Hr
Uncertainty Est -06 Hr
Uncertainty Est -09 Hr
Uncertainty Est -12 Hr
Uncertainty Est -15 Hr
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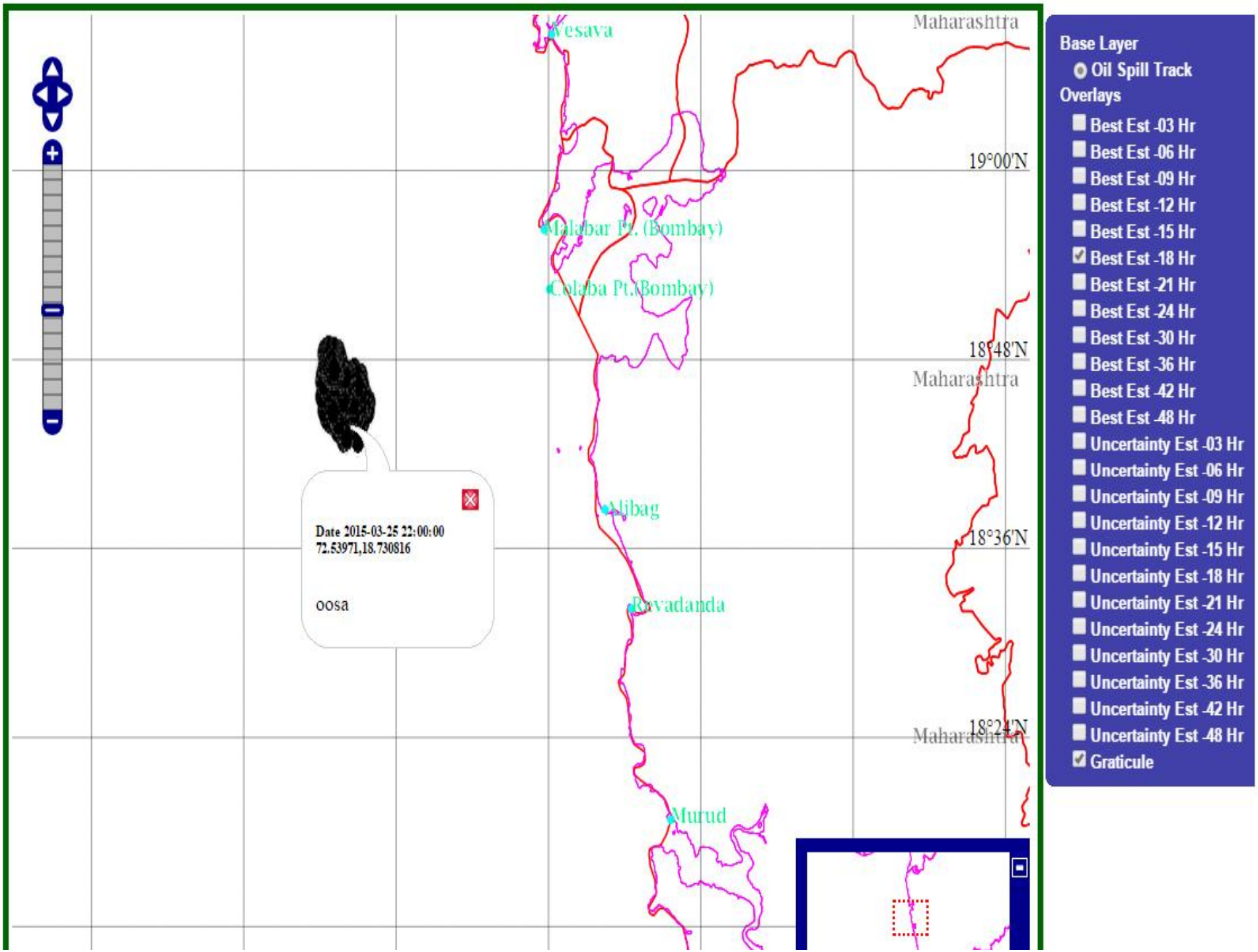
Uncertainty Est -36 Hr
Uncertainty Est -42 Hr
Uncertainty Est -48 Hr
Graticule


Maharashtra
Vesava
19°00'N
Malabar Pt. (Bombay)
Colaba Pt.(Bombay)
18°48'N
Maharashtra
Aljbag
18°36'N
Revadanda
18°24'N
Maharashtra
Murud
Date 2015-03-25 22:00:00
72.53971,18.730816
oosa
Base Layer
Oil Spill Track
Overlays
Best Est -03 Hr
Best Est -06 Hr
Best Est -09 Hr
Best Est -12 Hr
Best Est -15 Hr
Best Est -18 Hr
Best Est -21 Hr
Best Est -24 Hr
Best Est -30 Hr
Best Est -36 Hr
Best Est -42 Hr
Best Est -48 Hr
Uncertainty Est -03 Hr
Uncertainty Est -06 Hr
Uncertainty Est -09 Hr
Uncertainty Est -12 Hr
Uncertainty Est -15 Hr
Uncertainty Est -18 Hr
Uncertainty Est -21 Hr
Uncertainty Est -24 Hr
Uncertainty Est -30 Hr
Uncertainty Est -36 Hr
Uncertainty Est -42 Hr
Uncertainty Est -48 Hr
Graticule

Search and Rescue Aid Tool **(SARAT)**

- SARAT service launched by the Hon'ble Minister of Science and Technology and Earth sciences, ***Dr. Harsh Vardhan***, During the XV National Maritime Search And Rescue Board Meeting held on 27 July 2016 at Vigyan Bhavan,Delhi.

- To reach common people, SARAT service portal is available in all the coastal languages of India. Android app also developed for mobile users to get SARAT service.

- Coast guard and Navy people are actively using SARAT service for their Search and rescue operations in the oceans.

SARAT

Search and Rescue Aid Tool

English

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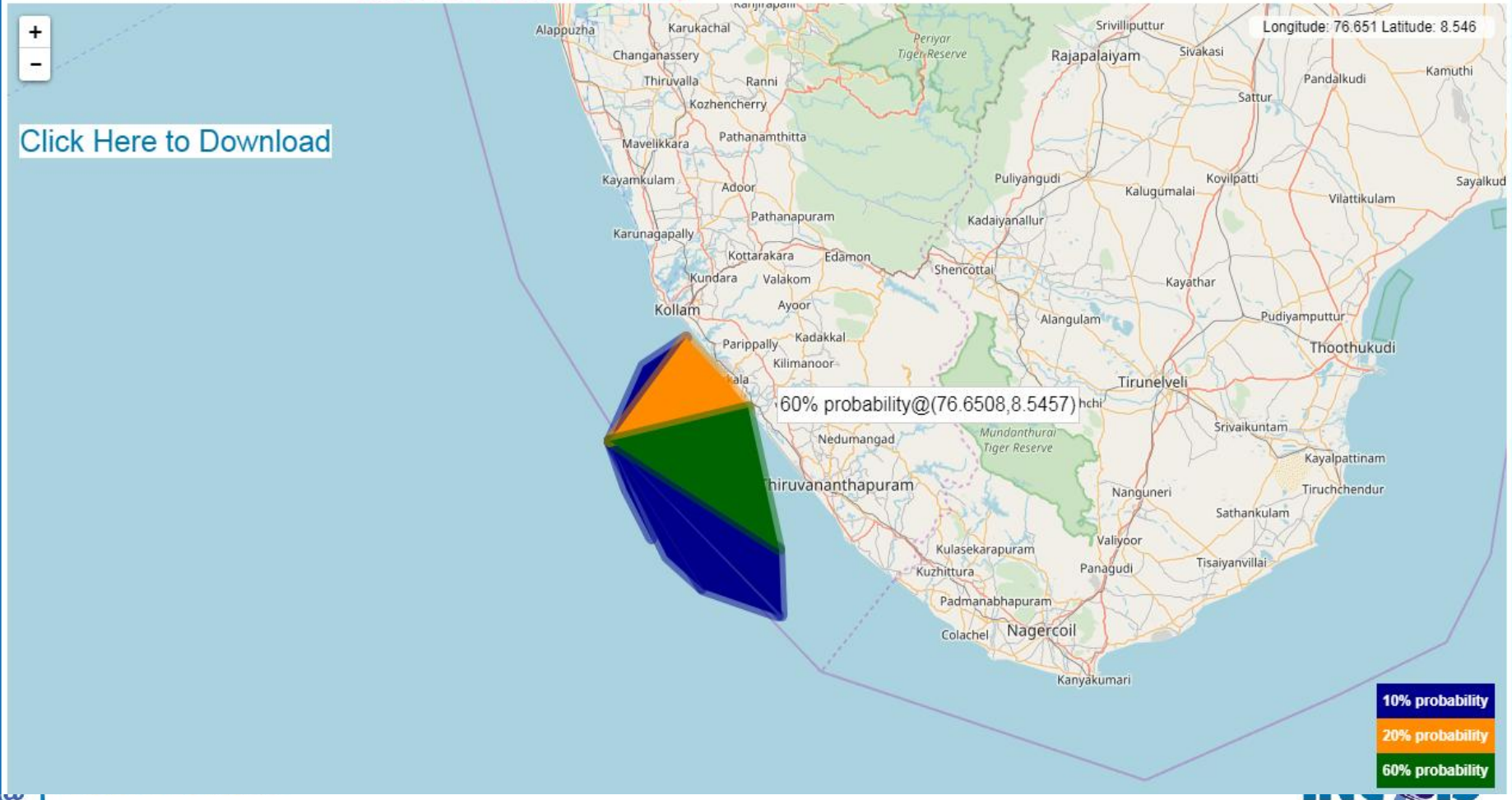

THANK YOU

"Environmental protection is a fundamental duty of every citizen of this country under Article 51-A(g) of our Indian Constitution"

(http://115.113.76.60/OilSpill/Login.jsp)