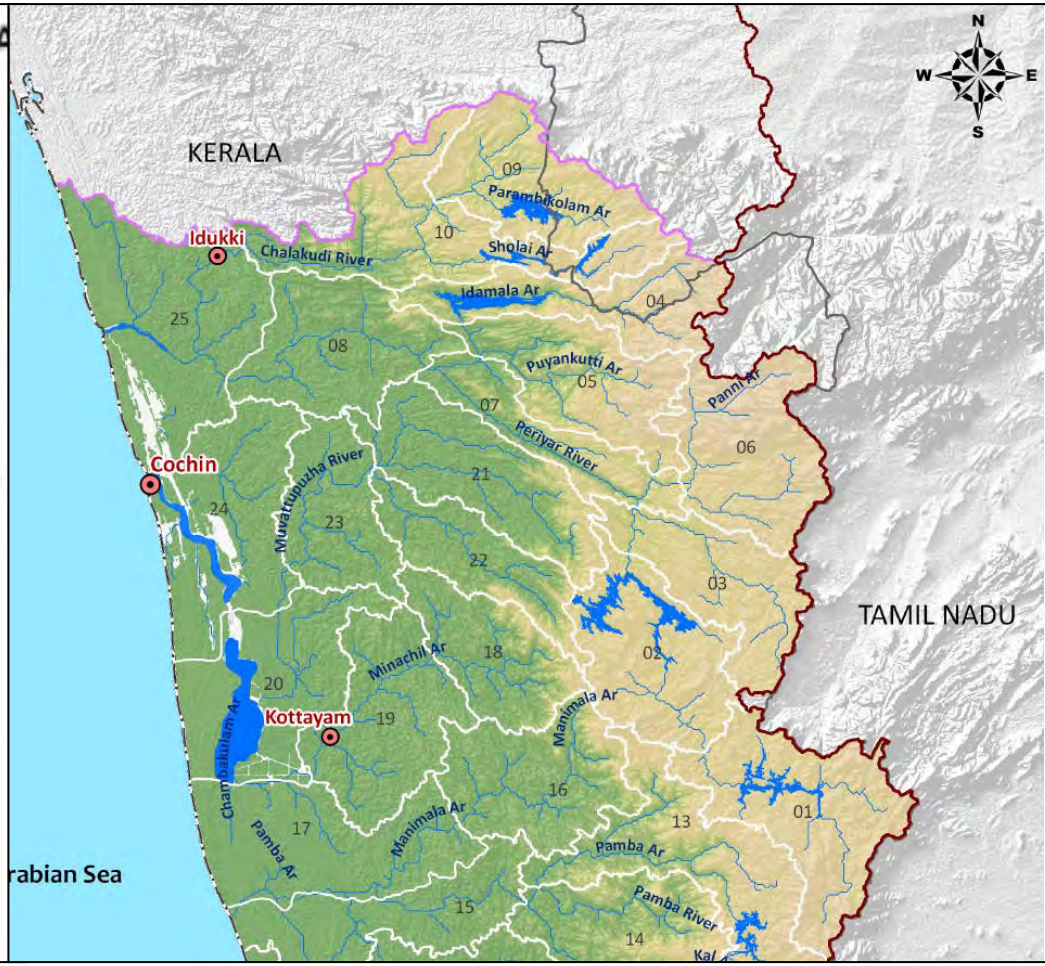
STUDY ON SILTATION AND IMPLEMENTATION OF THE NAUTICAL DEPTH CONCEPT IN THE PORT OF COCHIN, INDIA

WODCON XXI – Miami

June 15-2016

Bram Ferket

anteagroup



Monsoon (June-September):
>20 mln m³ siltation annualy

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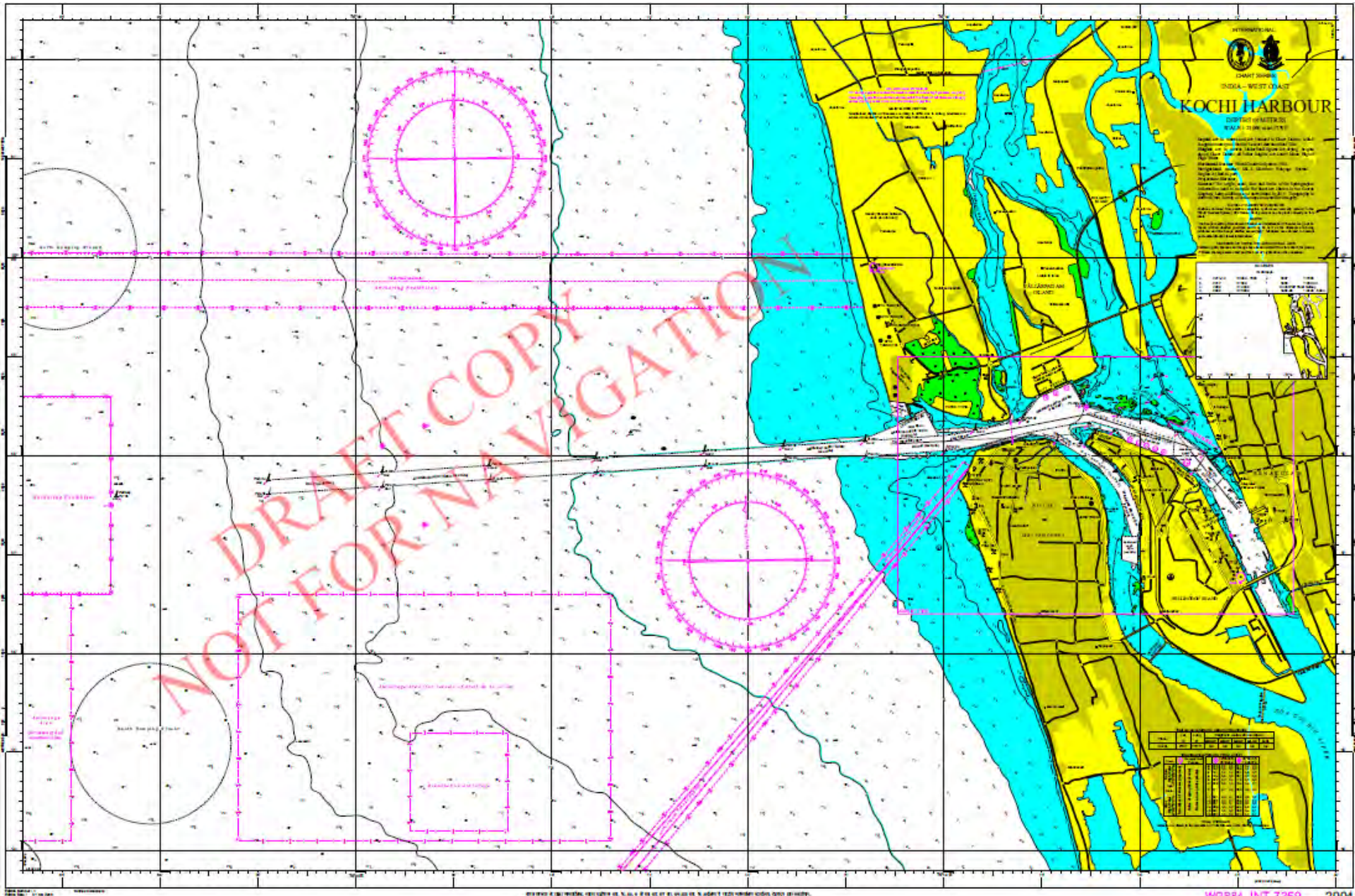

WGS84 INT 7359 2004

Introduction

Current practice

- Monthly 210 kHz survey
- Ad hoc 33 kHz + lead lines

→ Design depths not achieved

➔ Fluid mud penetration by ships!?

Dredging equipment (DCI):

- TSHD 7400 m^3 - 8/d
- TSHD 4500 m^3 - 8/d
- Grab dredger: ±4000 m^3/d
- Continuous
- Offshore disposal

Introduction

- **Project goals:**
  - Study the siltation processes
  - Methods to reduce and manage siltation
  - Nautical depth criterion + monitoring
  - Optimize dredging strategy

- **Methodology:**
  - Field monitoring
  - Hydrodynamic modelling
  - Nautical simulations
  - Assessment and decision support

IIC TECHNOLOGIES
NEW PATHS. NEW APPROACHES

stema systems

Flanders Hydraulics Research

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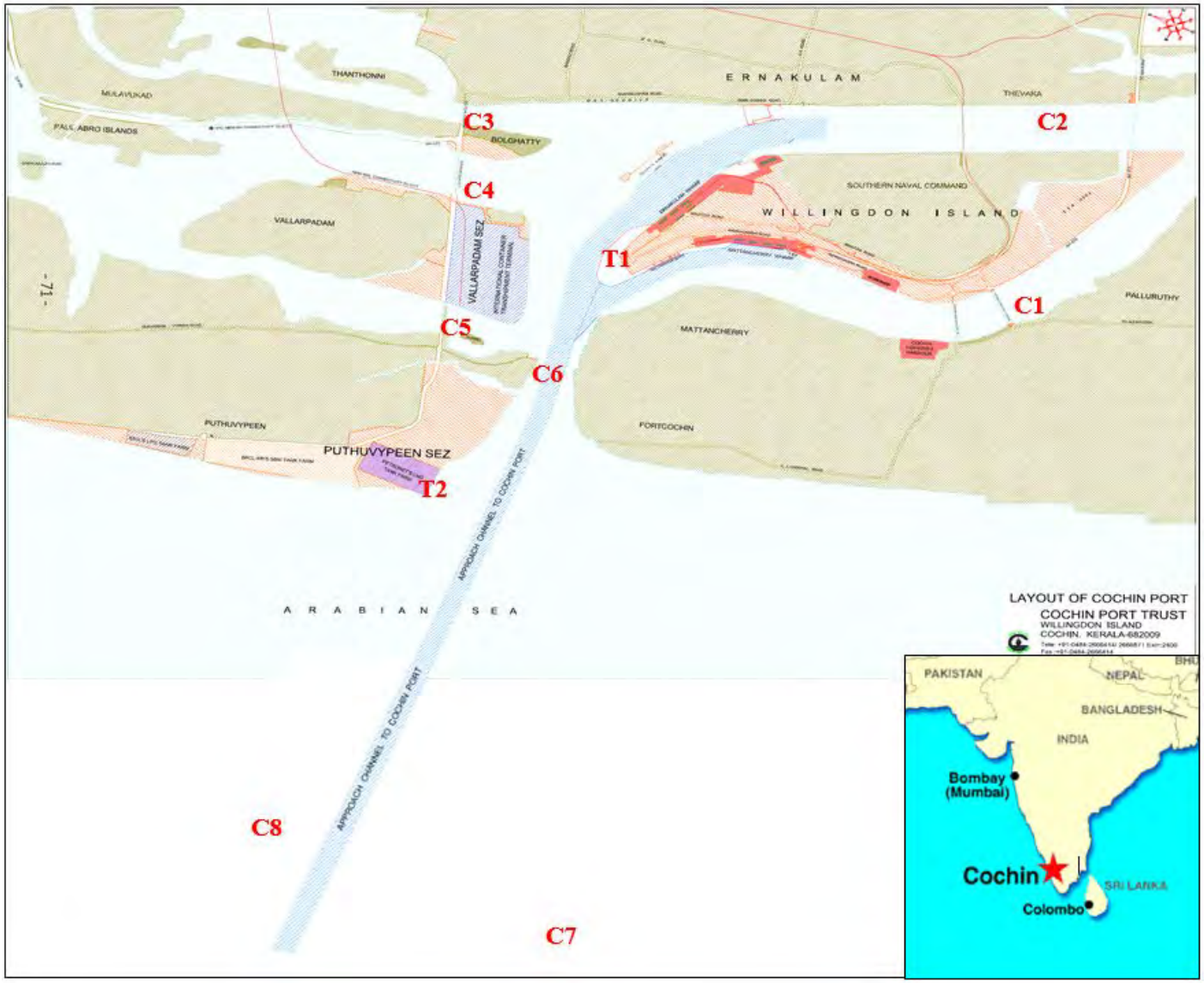
Monitoring

- Bathymetry
- Currents
- Waves
- Tides
- Discharges
- Weather
- Salinity
- Turbidity/TSS
- Bed composition
- Mud properties



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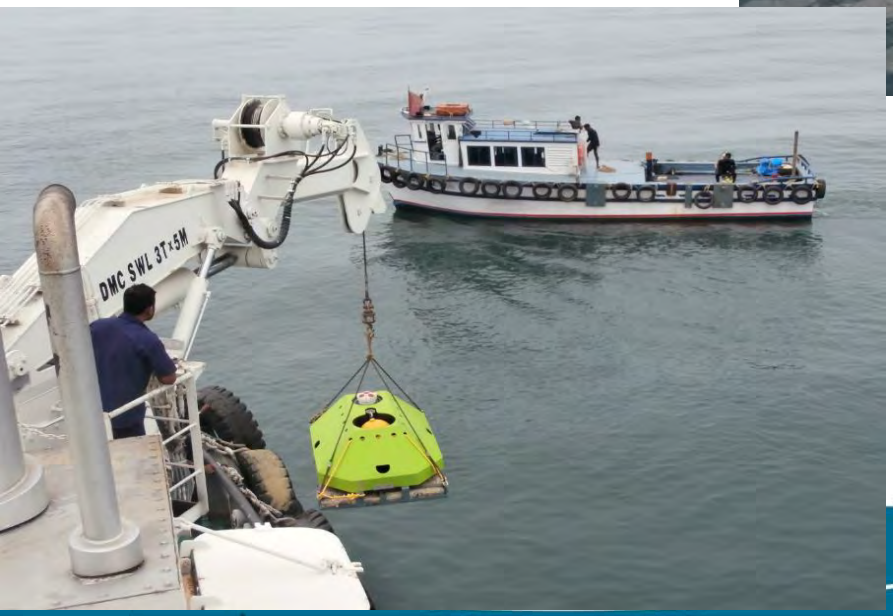
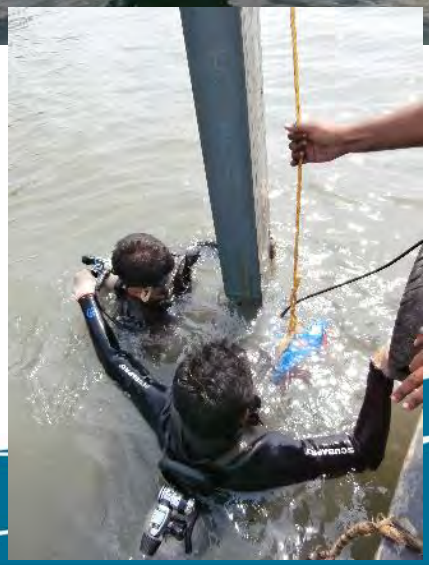
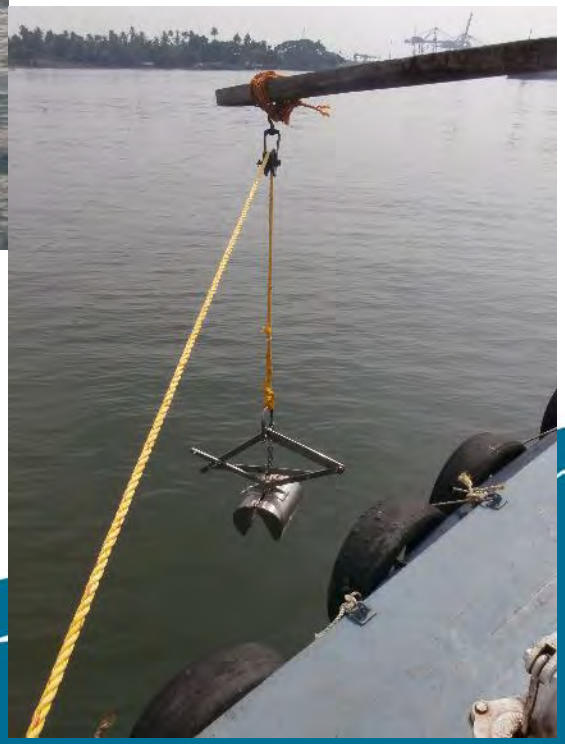
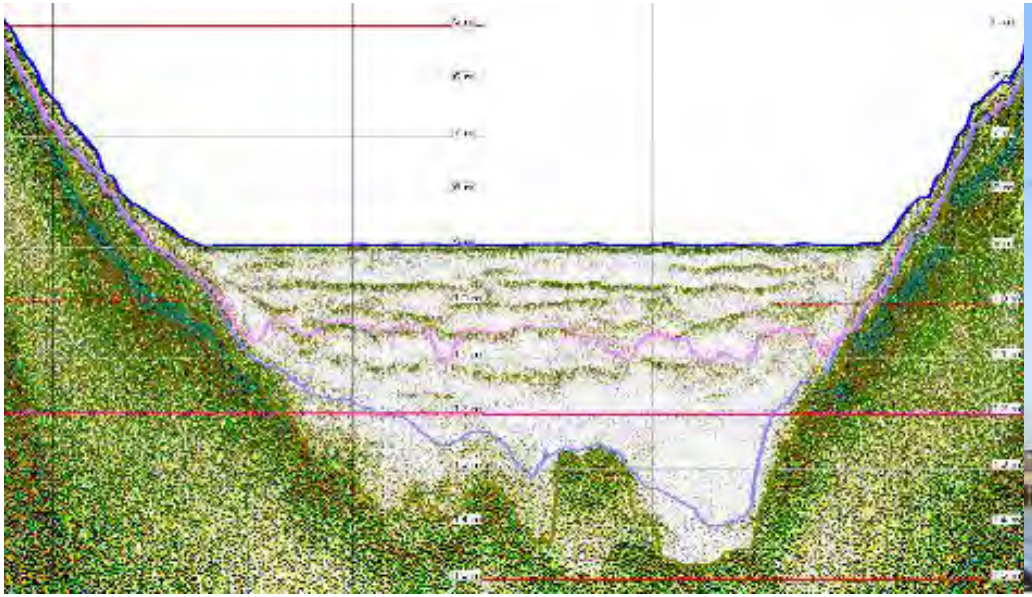

DMC SWL 3T×5M

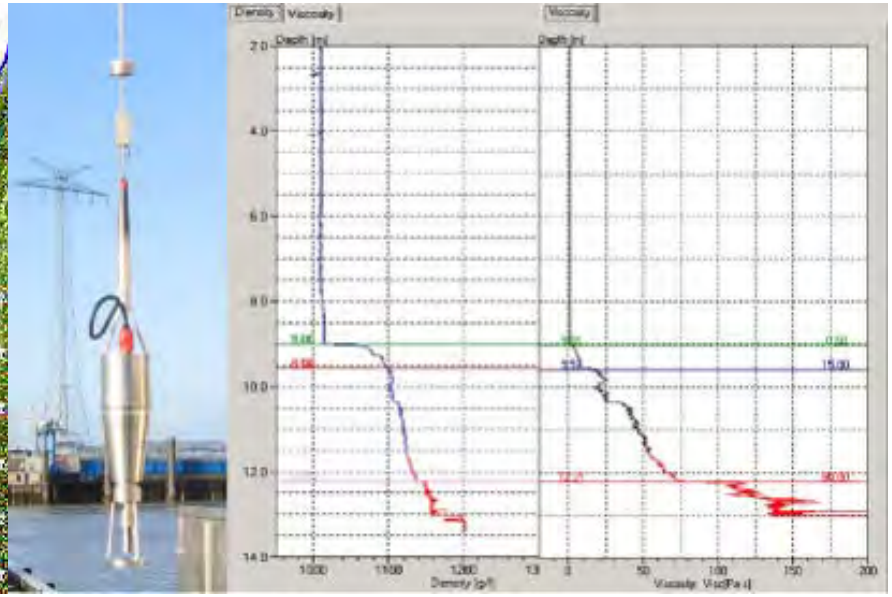




Acoustic profiling



In-Situ rheological measurements



stema systems

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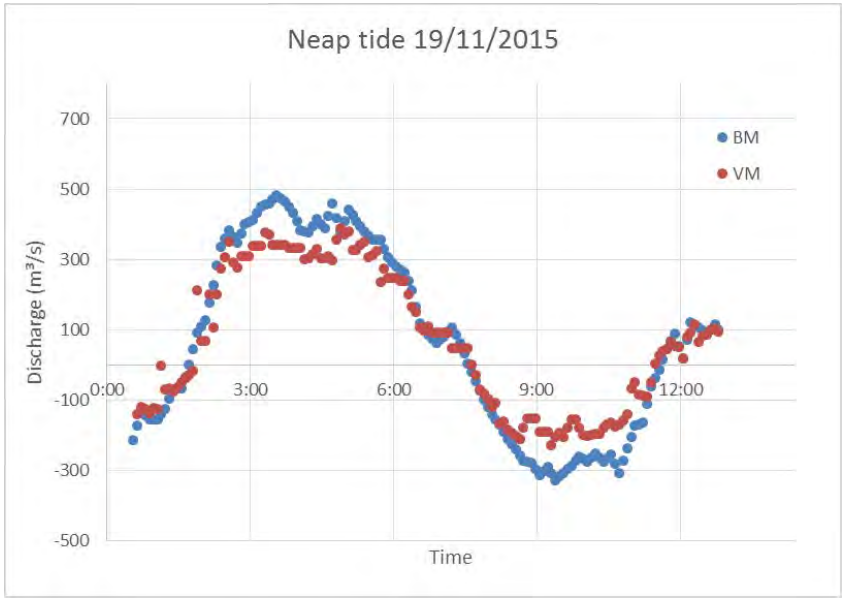

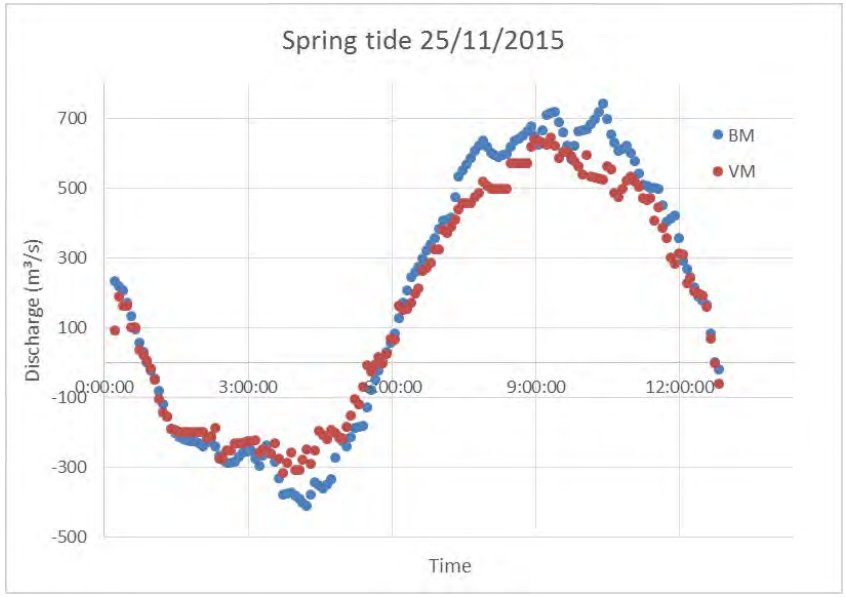

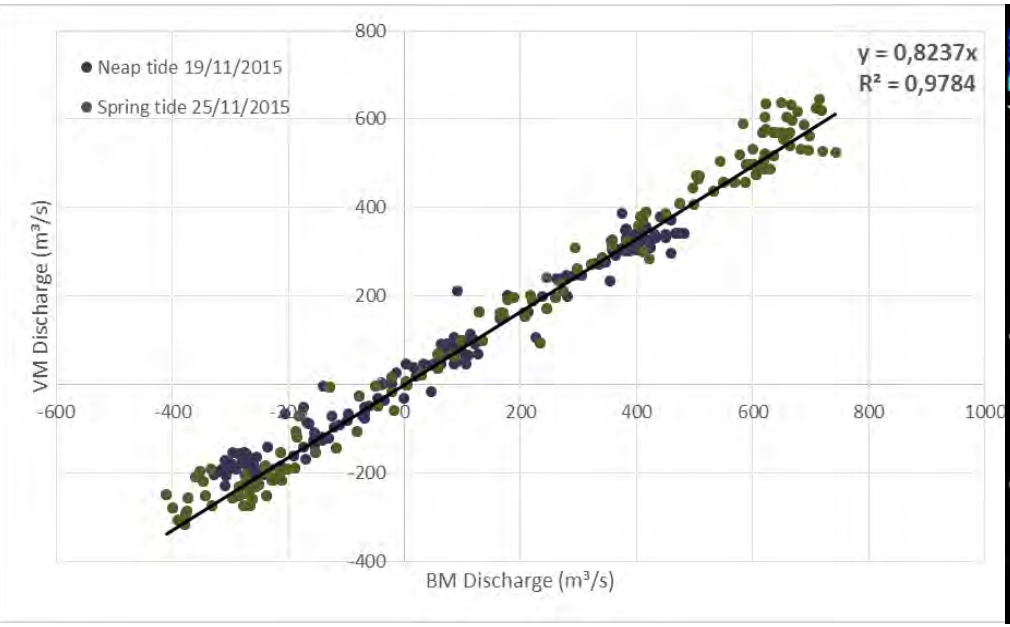

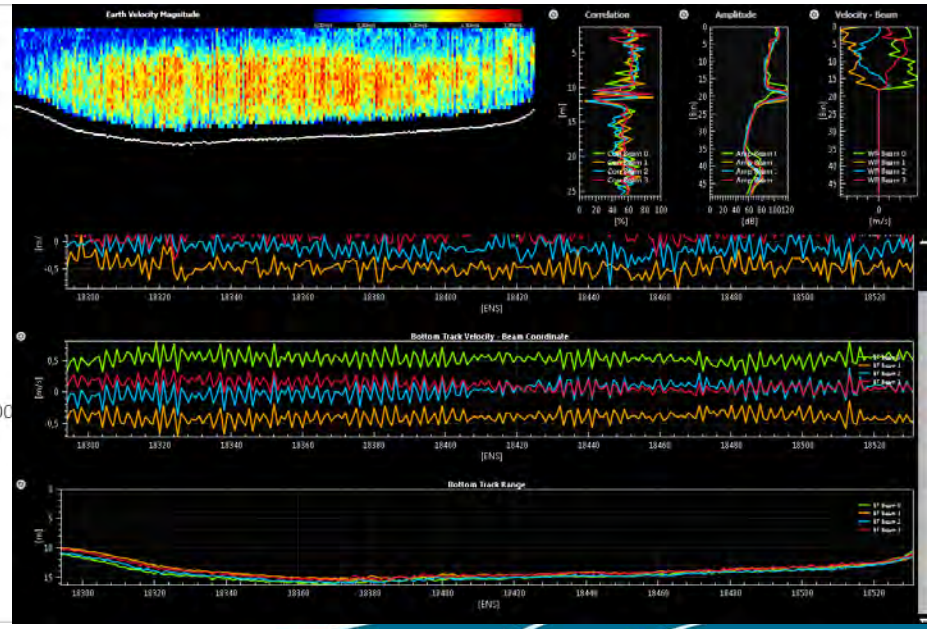

13h VM ADCP campaigns

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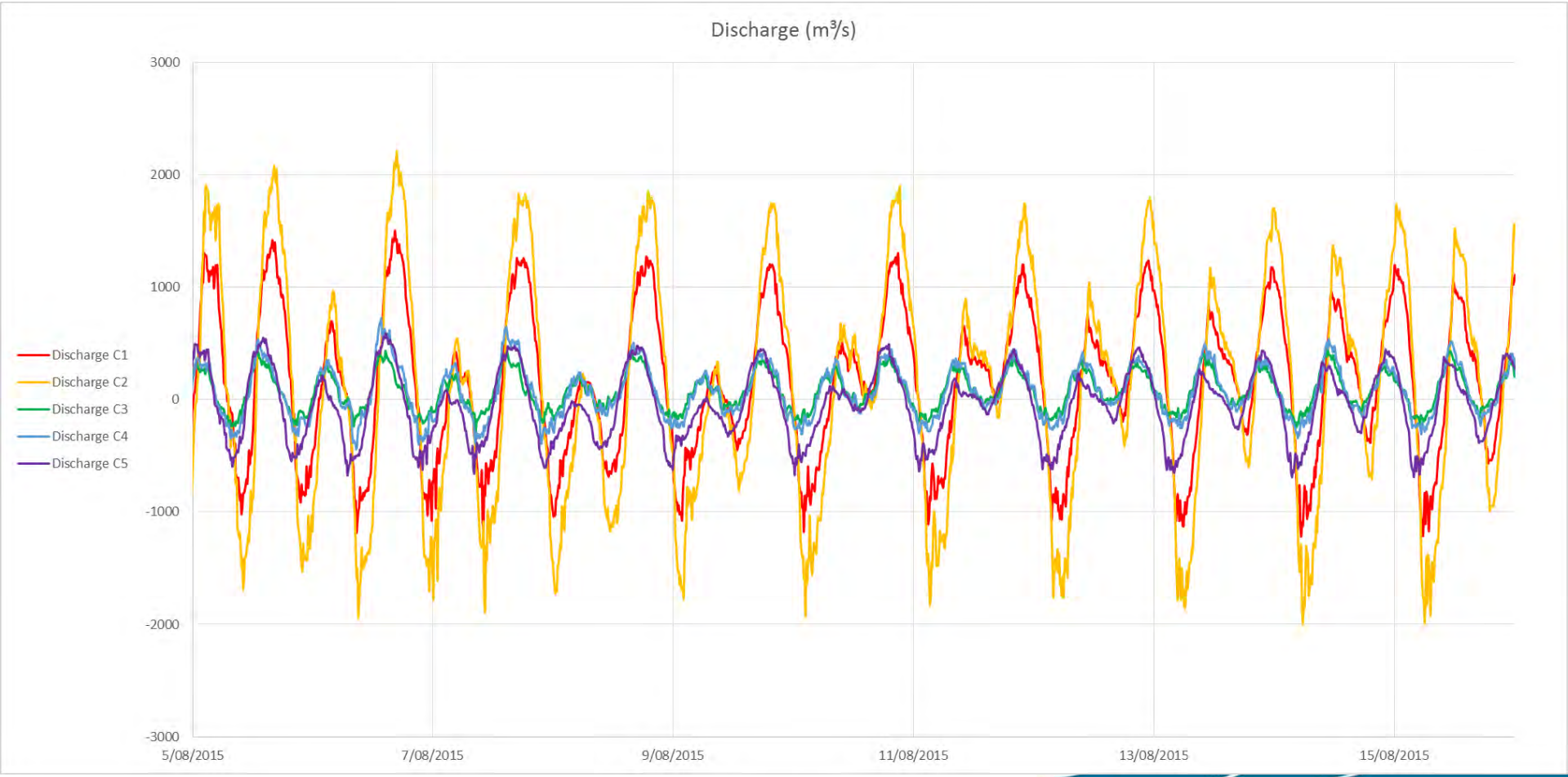
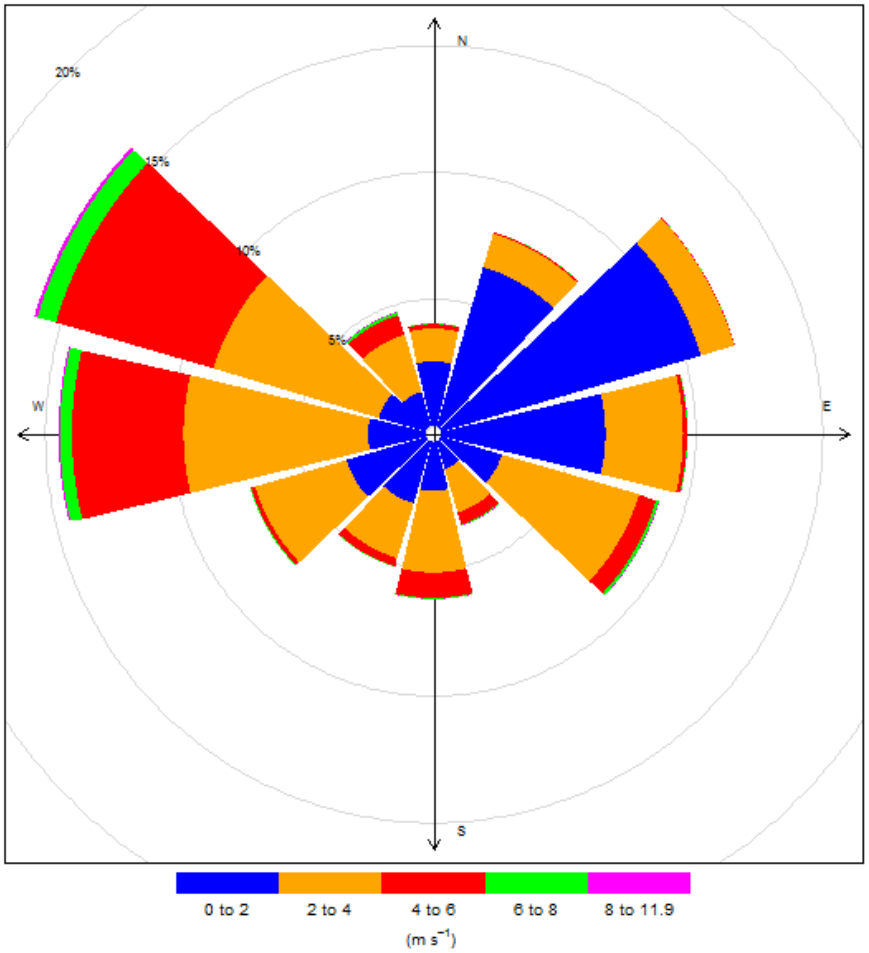
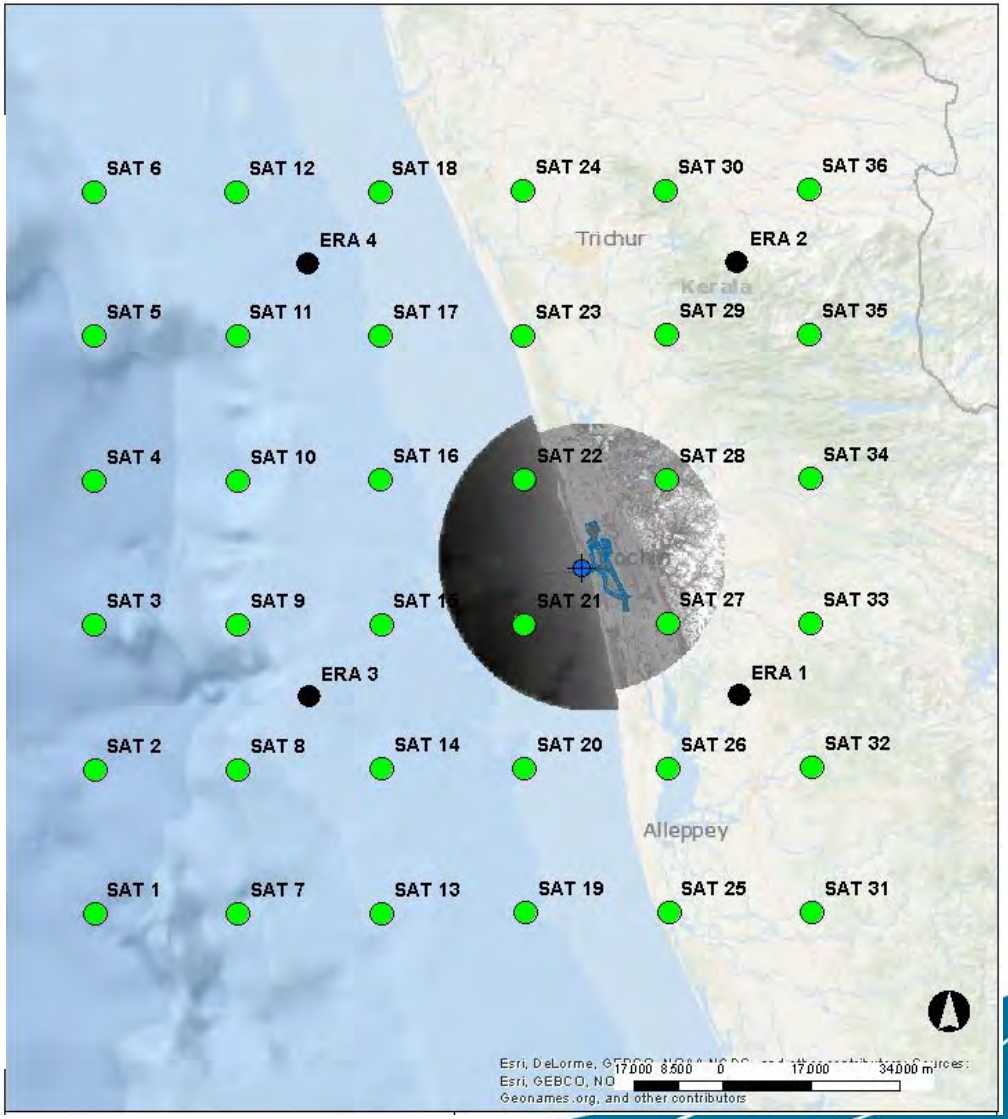
Discharge C1-C6: balance harbor in- and outflow

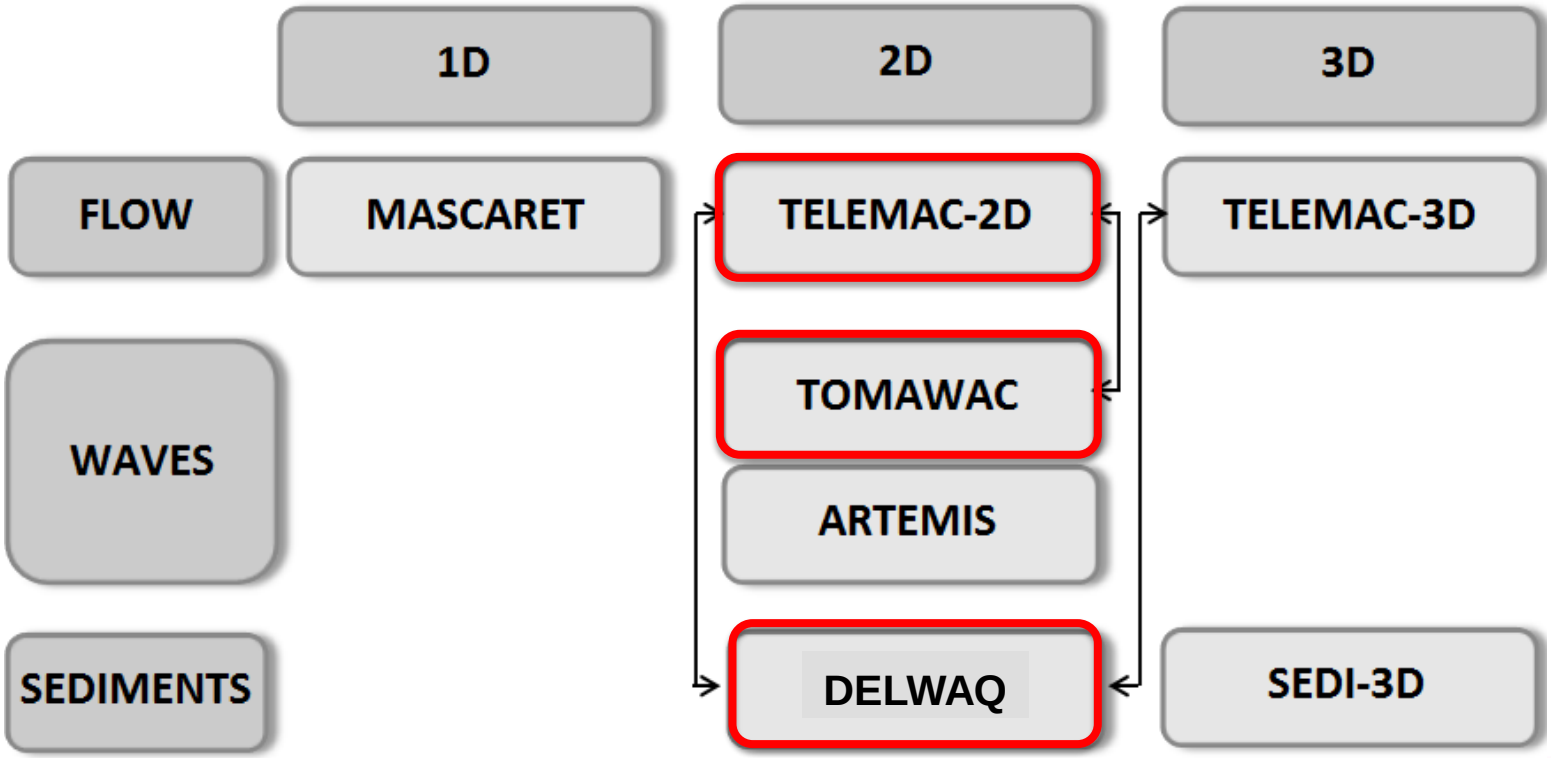



N
E
S
W
20%
15%
10%
5%
0 to 2
2 to 4
4 to 6
6 to 8
8 to 11.9
(m s⁻¹)

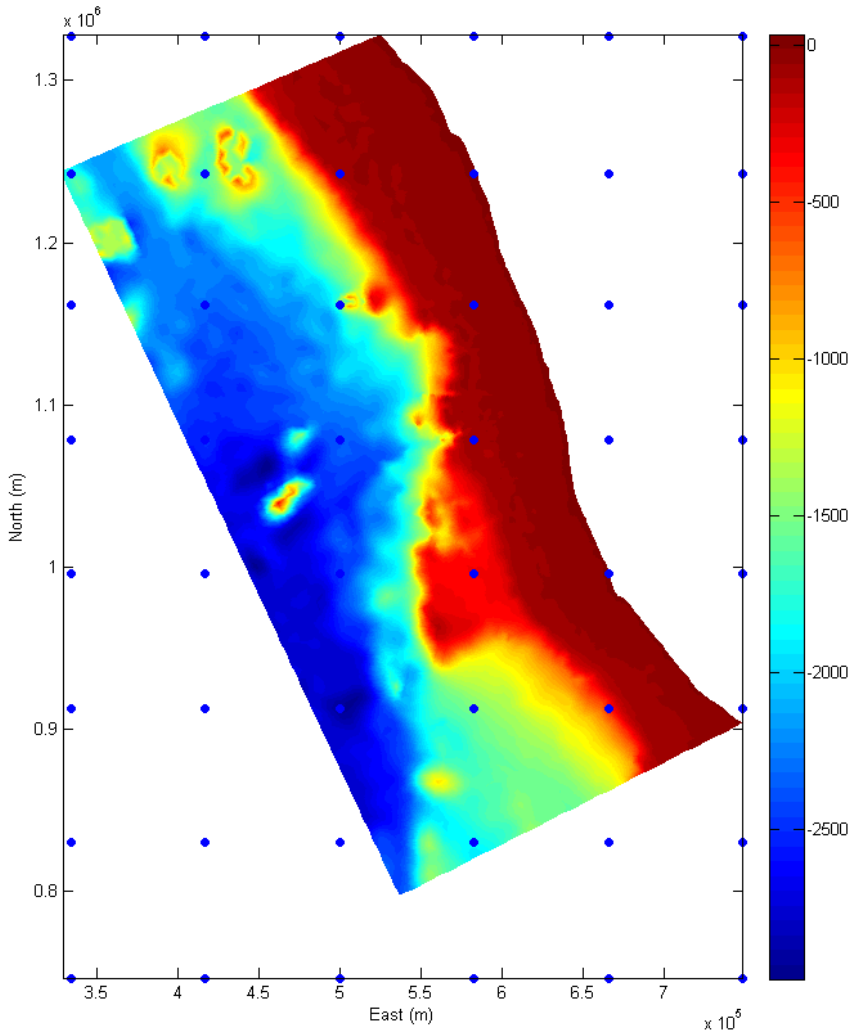

SAT 6
SAT 12
SAT 18
SAT 24
SAT 30
SAT 36
ERA 4
Trichur
ERA 2
Kerala
SAT 5
SAT 11
SAT 17
SAT 23
SAT 29
SAT 35
SAT 4
SAT 10
SAT 16
SAT 22
SAT 28
SAT 34
SAT 3
SAT 9
SAT 15
SAT 21
SAT 27
SAT 33
ERA 3
ERA 1
SAT 2
SAT 8
SAT 14
SAT 20
SAT 26
SAT 32
Alleppey
SAT 1
SAT 7
SAT 13
SAT 19
SAT 25
SAT 31
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Esri, GEBCO, NO
Geonames.org, and other contributors
17.000 8.500 0 17.000 34.000 m

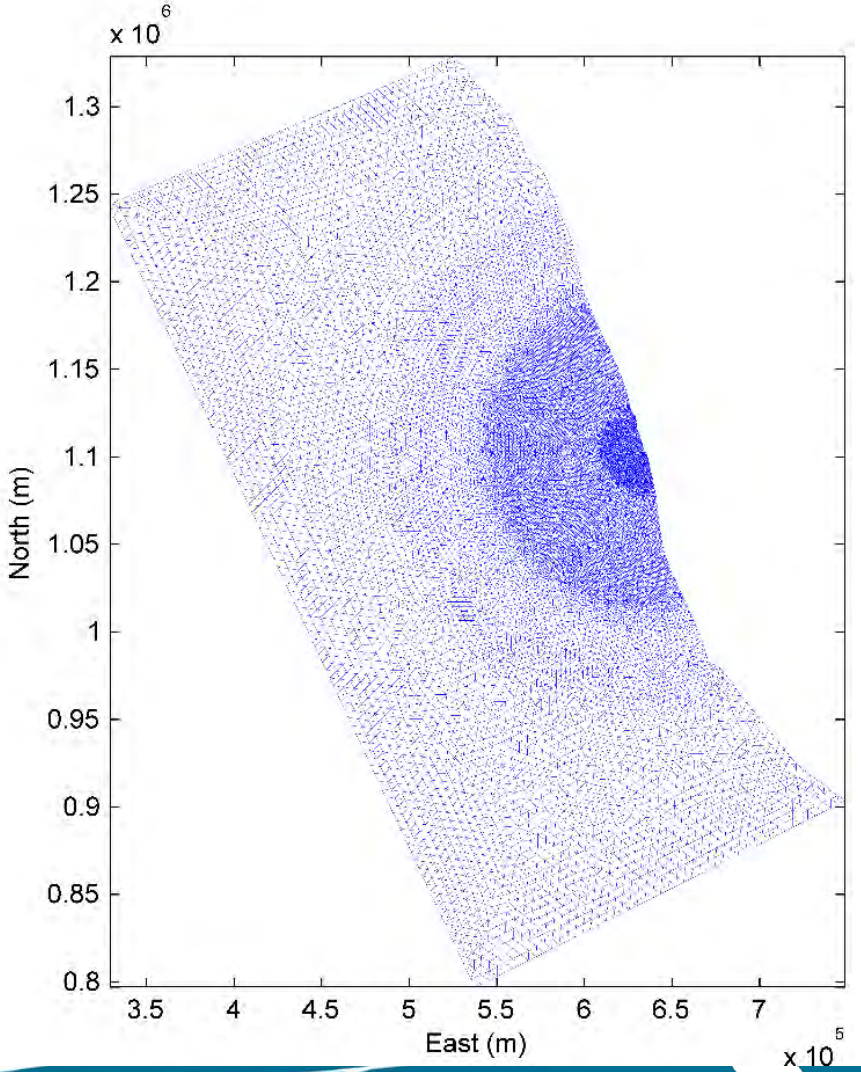
Hydrodynamic modelling

TELEMAC-MASCARET numerical platform

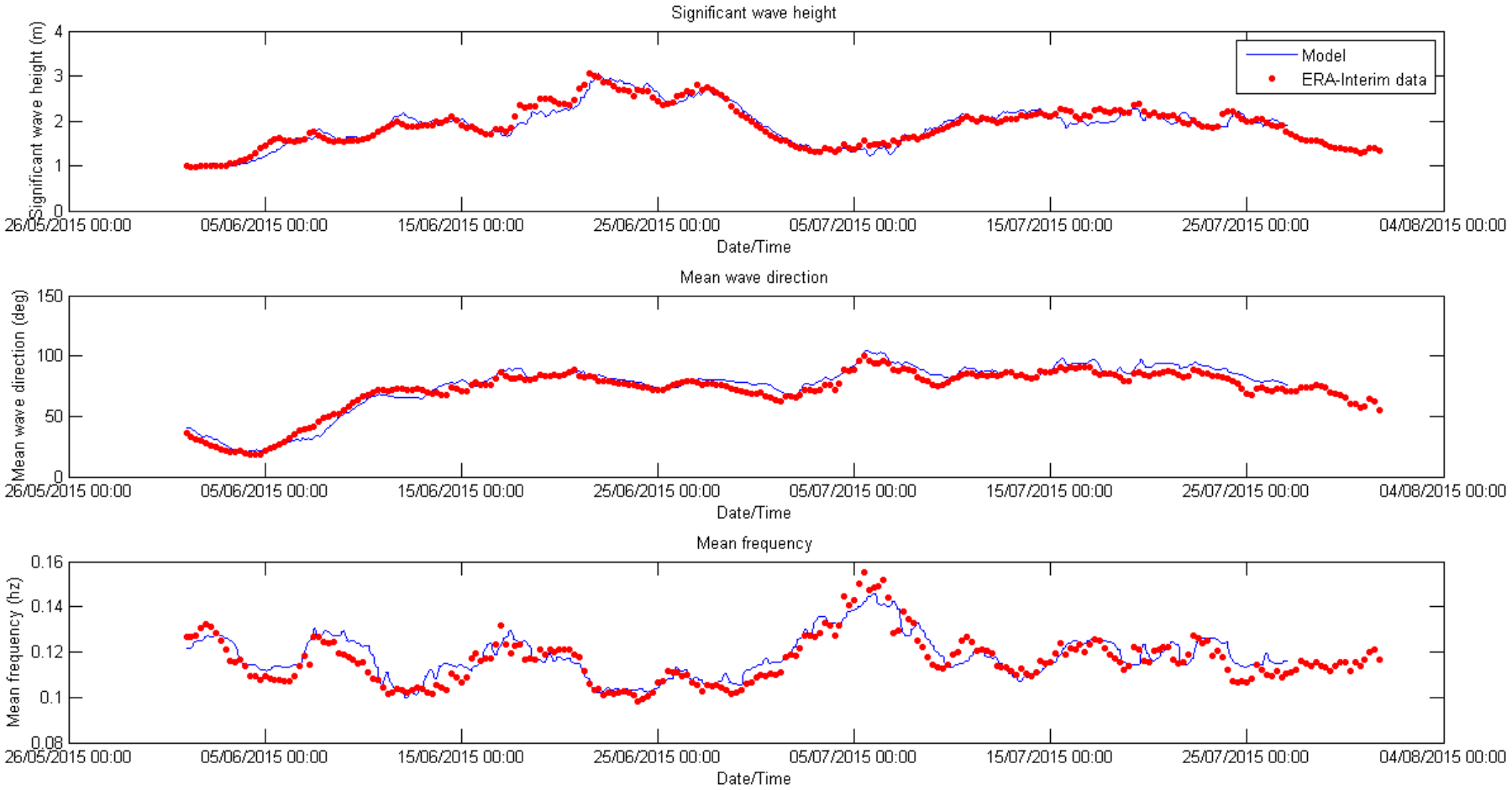


Large wave model (TOMAWAC) – 200km x 500km

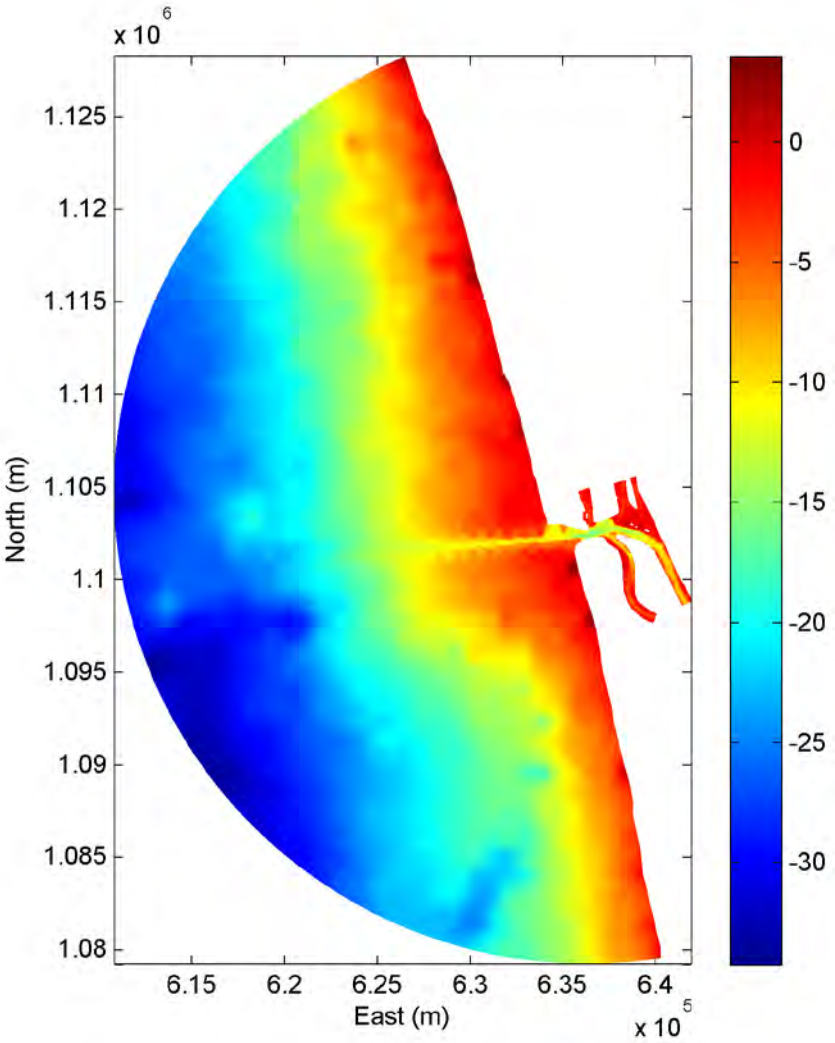


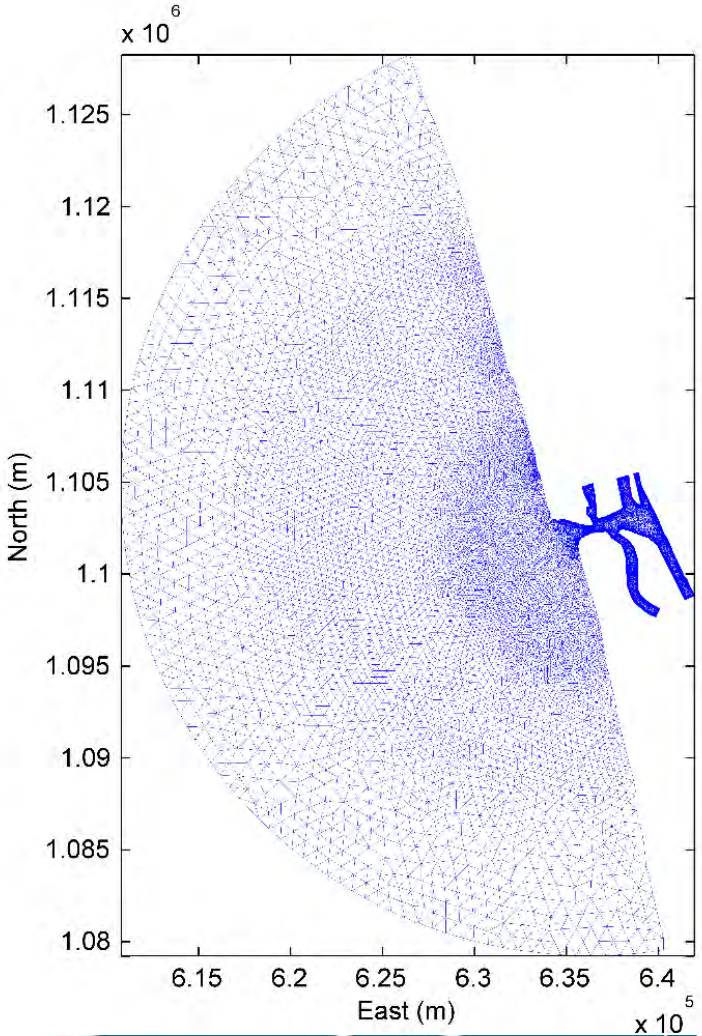


Wave model – Validation



Detailed wave (TOWAWAC) and Current (TELEMAC) model – 25km radius





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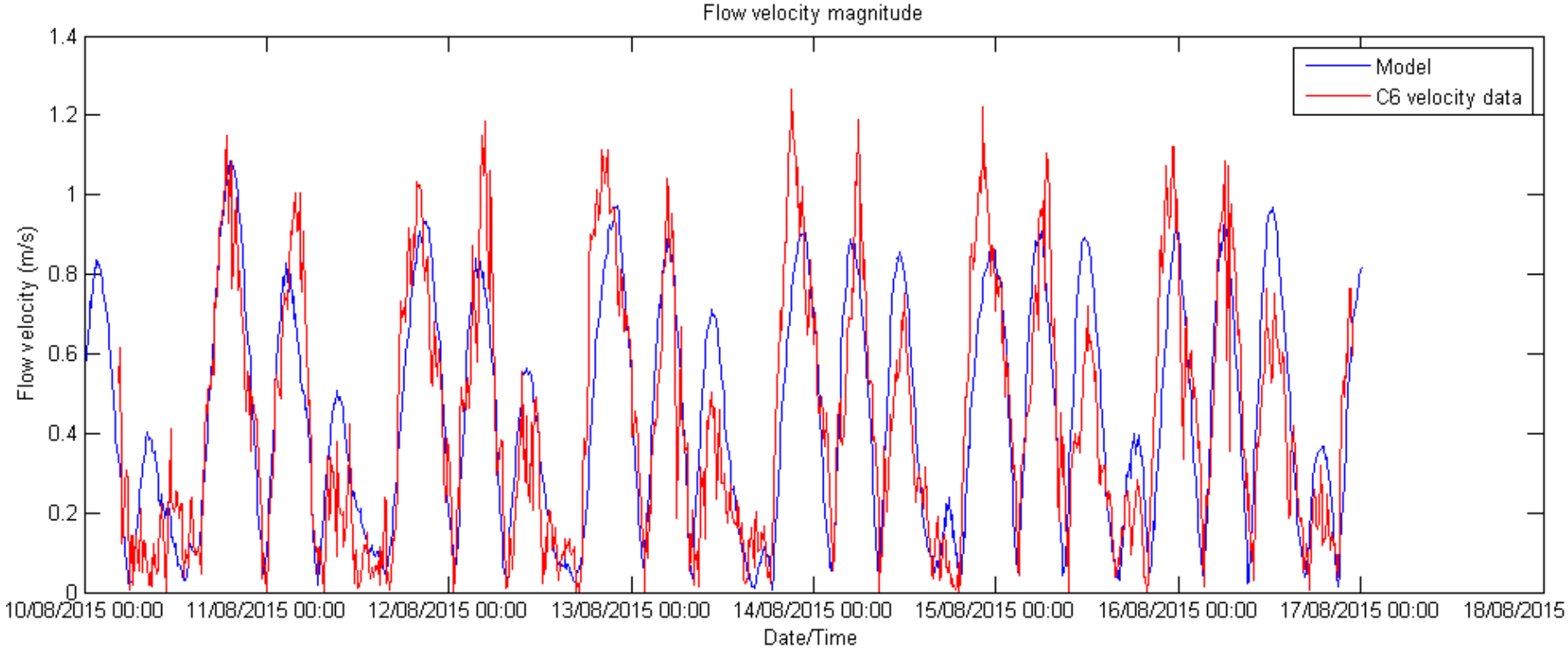
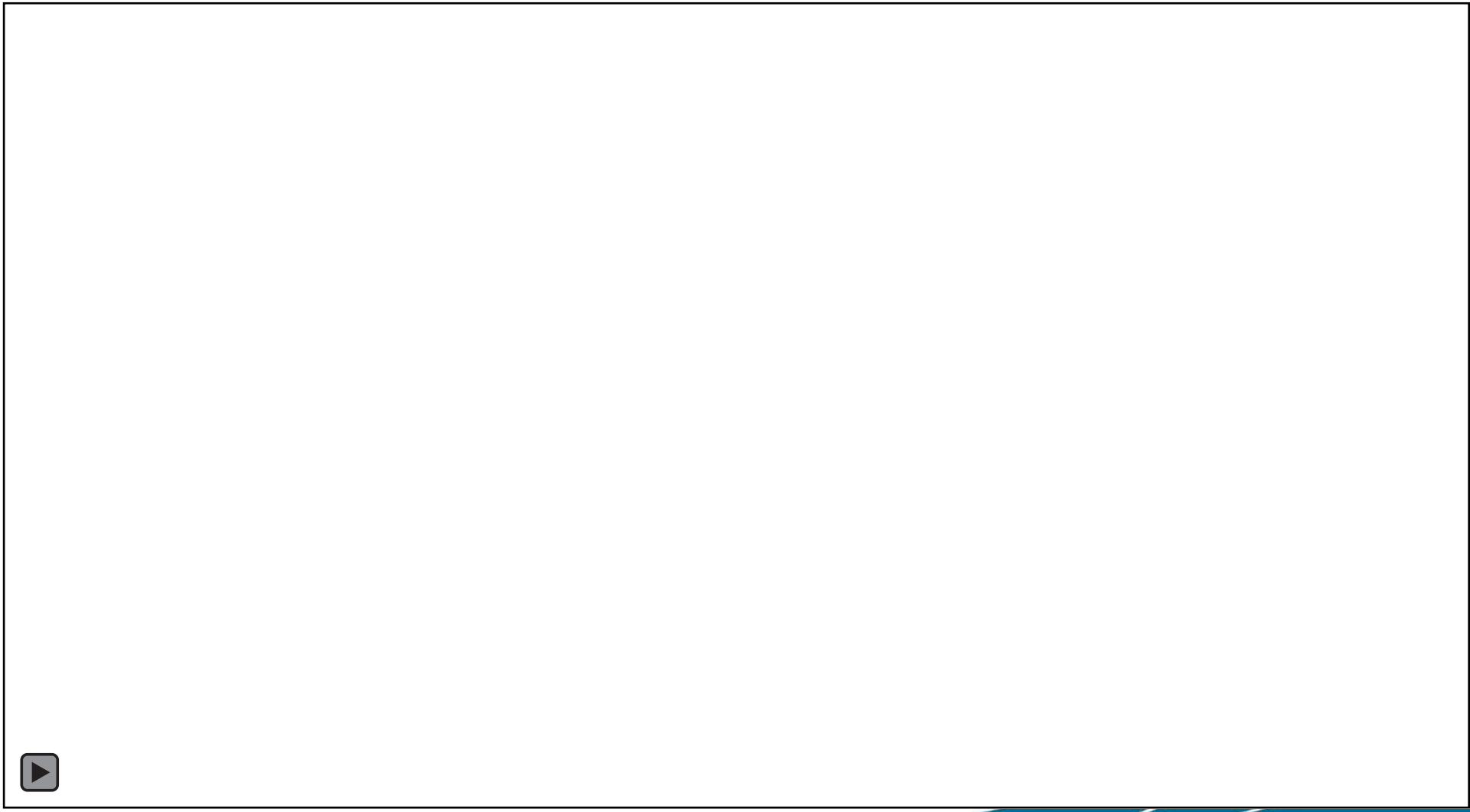
Detailed model – Validation



Detailed model – Results



Assessment and decision support

- **Siltation quantities**
- **Bed characteristics**
- **Origin of siltation**

- Slope stability
- Long shore sediment transport
- Dynamics of dredge spoil at disposal sites
- Nautical depth monitoring
- Semi-empirical methods for schematization of siltation
- Methods for arresting siltation
- Dredging requirements
- Outer harbour scenarios

Siltation quantities

Assessment of Siltation and Establishment of Nautical Depth Concept in Cochin Port

Depth Map:
Approach Channel

Depth (m)

- < 2
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 7.0
- 7.1 - 8.0
- 8.1 - 9.0
- 9.1 - 10.0
- 10.1 - 11.0
- 11.1 - 12.0
- 12.1 - 13.0
- 13.1 - 14.0
- 14.1 - 15.0
- 15.1 - 16.0
- 16.1 - 17.0
- 17.1 - 18.0
- > 18

0 500 1,000 2,000 m

Source: Depth maps derived from survey data (210 kHz). Basemap from ArcGIS Online.

227819 8009/eva
Date: 3/06/2016
Map #: xx/xx
Format: A4
Scale: 1:63,287

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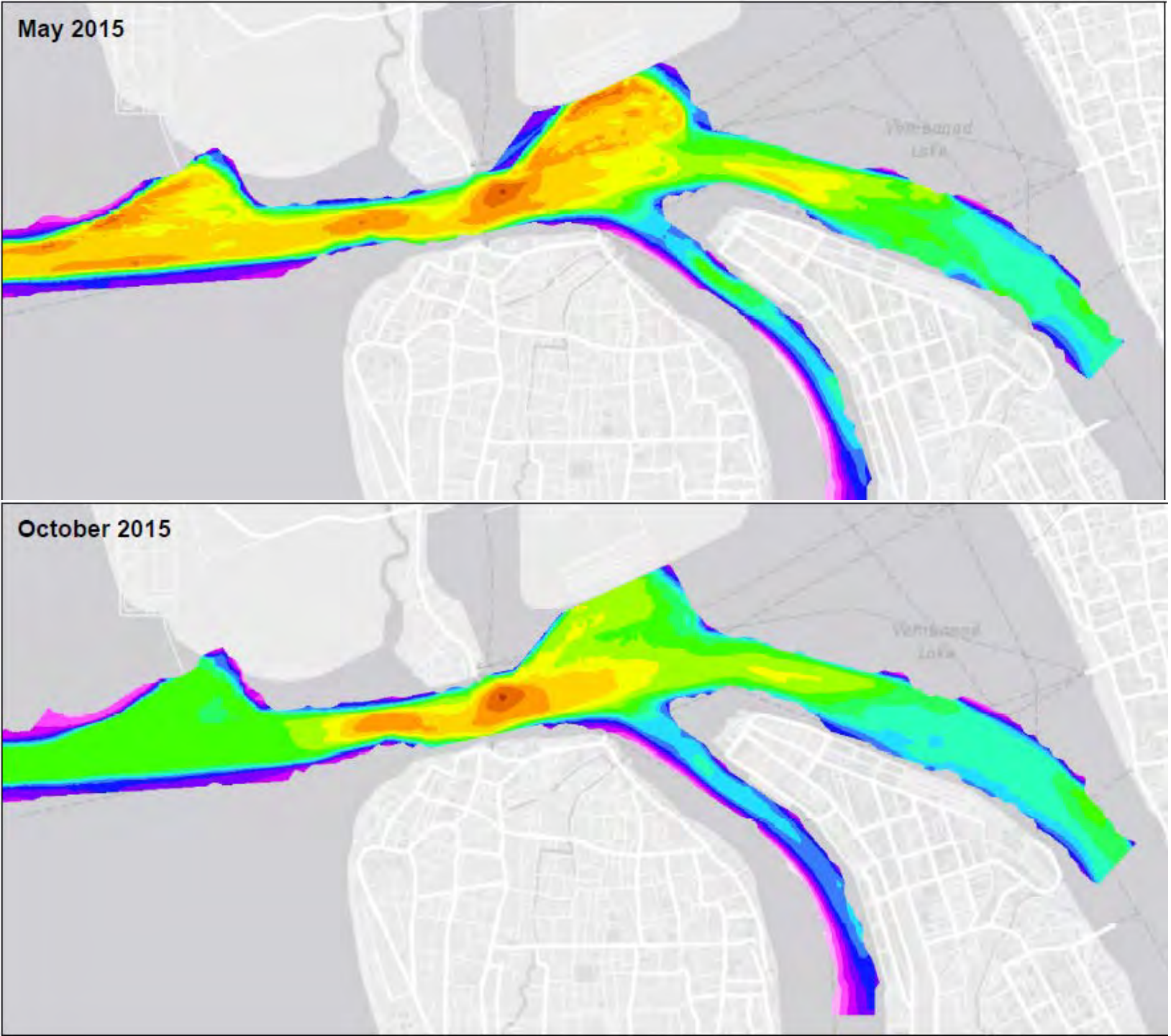
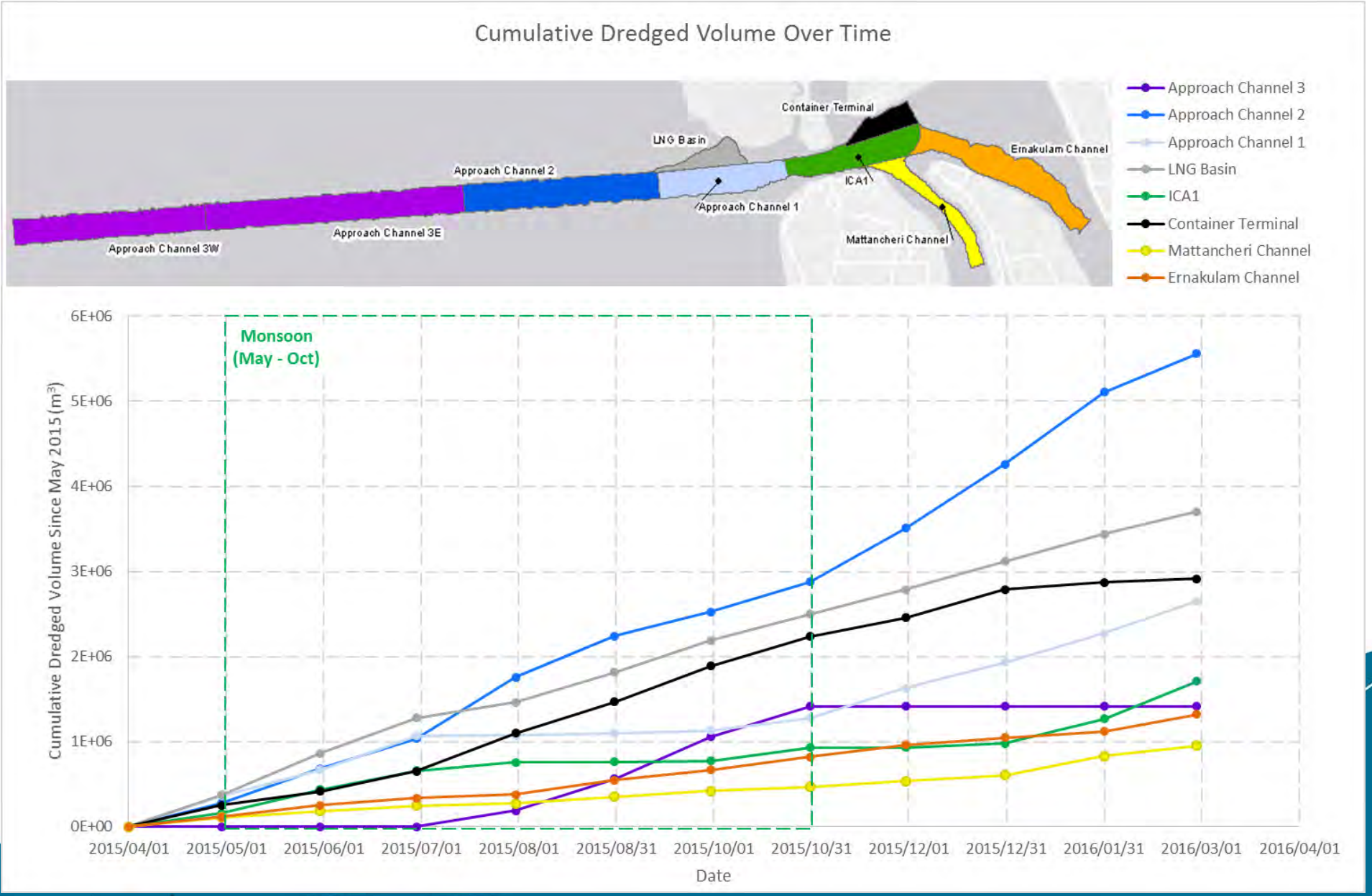
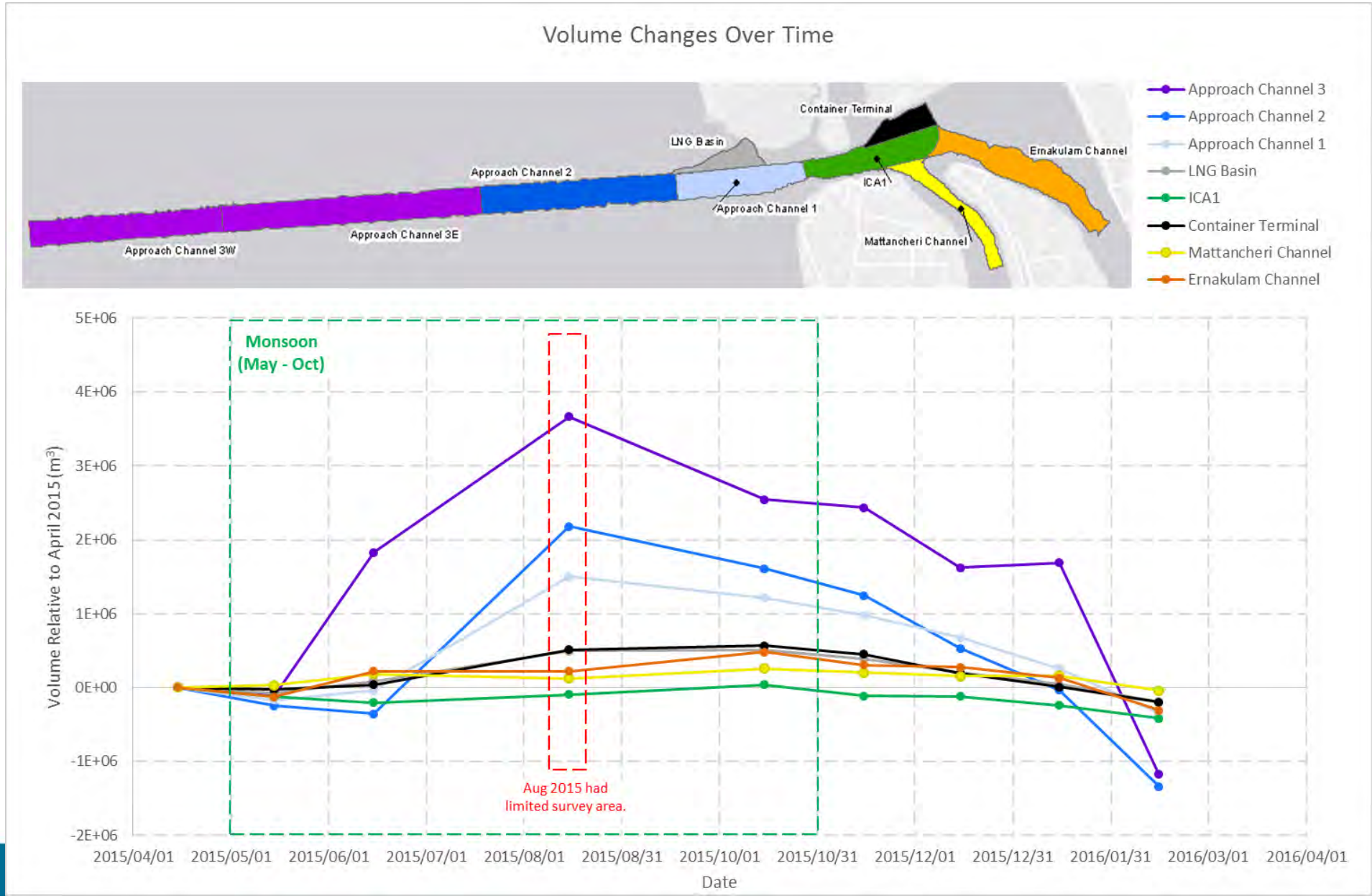

May 2015
October 2015
Depth (m)
< 2
2.1 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
6.1 - 7.0
7.1 - 8.0
8.1 - 9.0
9.1 - 10.0
10.1 - 11.0
11.1 - 12.0
12.1 - 13.0
13.1 - 14.0
14.1 - 15.0
15.1 - 16.0
16.1 - 17.0
17.1 - 18.0
> 18

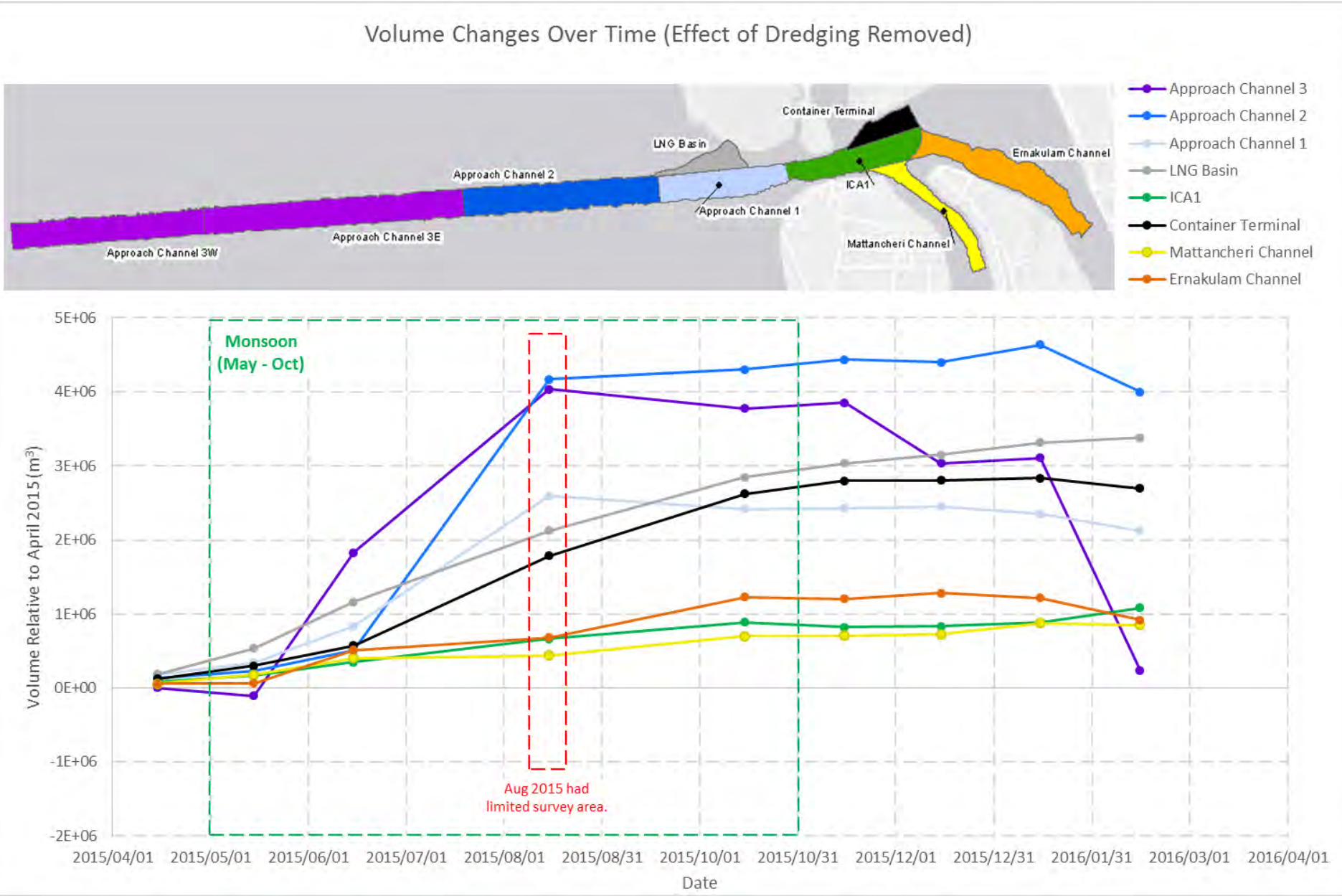
Siltation quantities



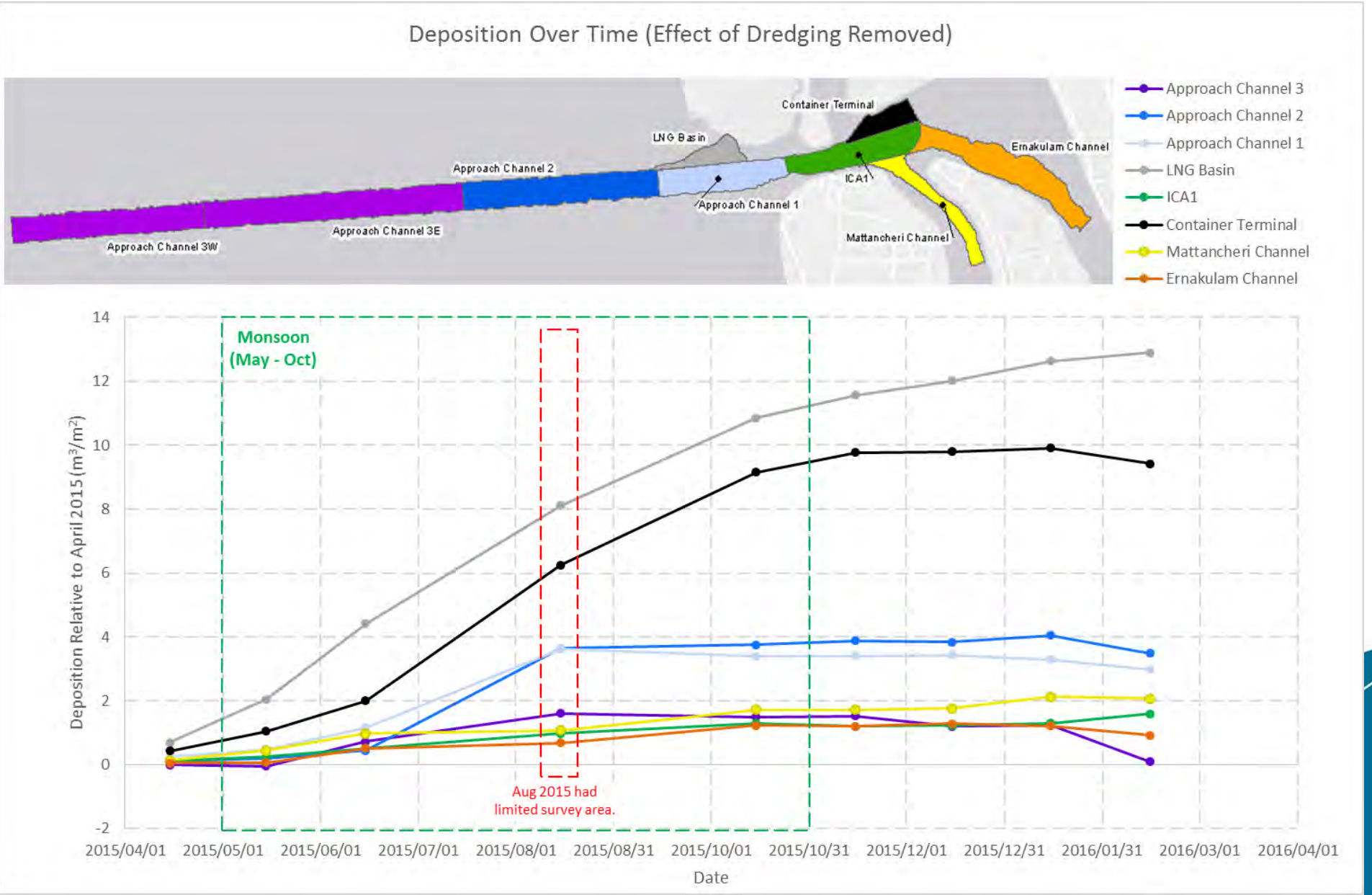
Siltation quantities



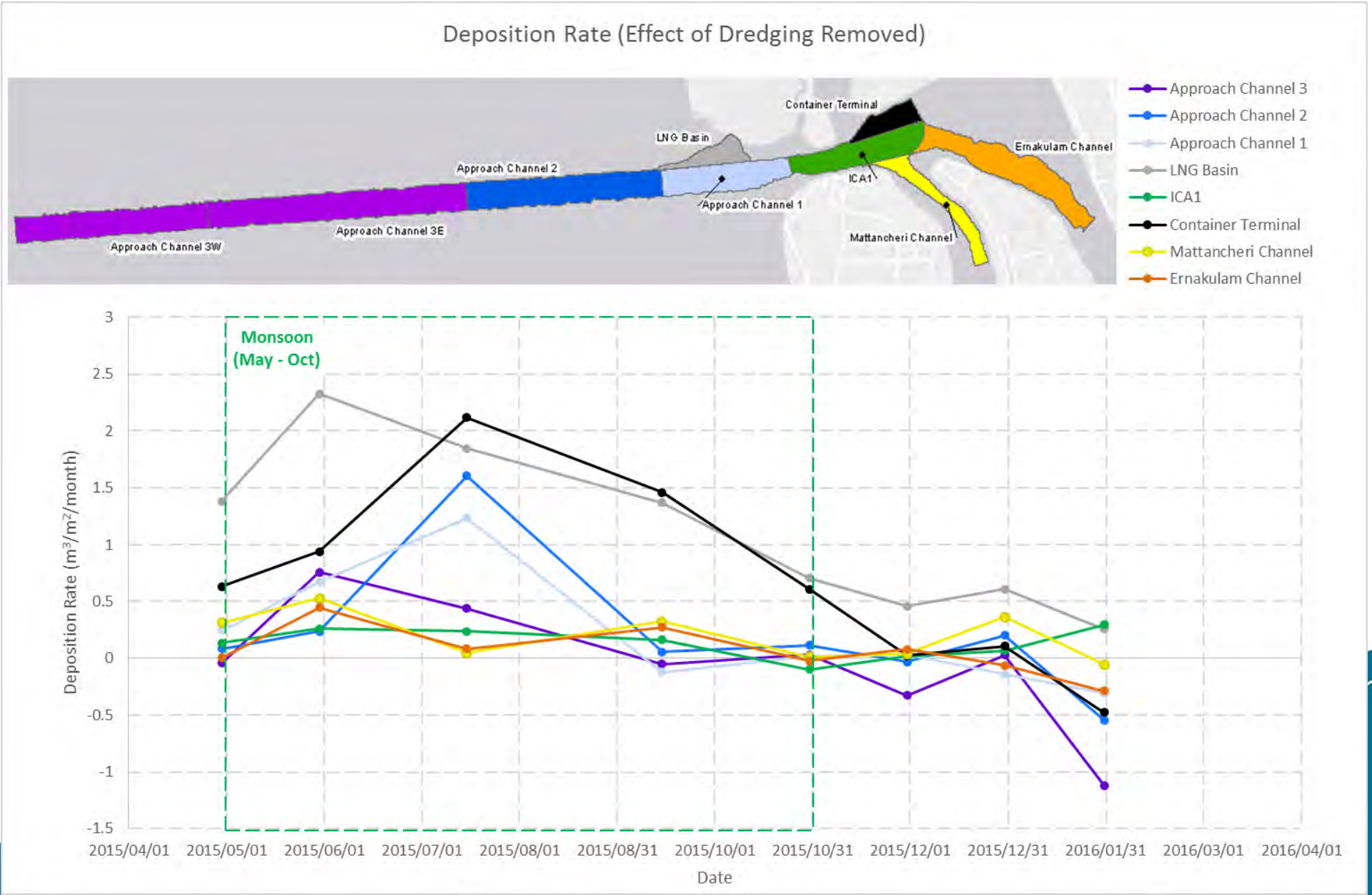
Siltation quantities



Siltation quantities



Siltation quantities



Fluid mud thickness

Assessment of Siltation and Establishment of Nautical Depth Concept in Cochin Port

Mud Layer Thickness Approach Channel

Mud Layer Thickness
meters

- -1,7 - -0,1
- 0 - 0,1
- 0,2 - 0,5
- 0,6 - 1
- 1,1 - 2
- 2,1 - 3
- 3,1 - 5
- 5,1 - 10

0 500 1,000 2,000 m

Source: Mud layer thickness derived from 33 and 210 kHz survey data. Basemap from ArcGIS Online.

227819 8009/eva
Date: 18/05/2016
Map #: xx/xx
Format: A4
Scale: 1:63,287

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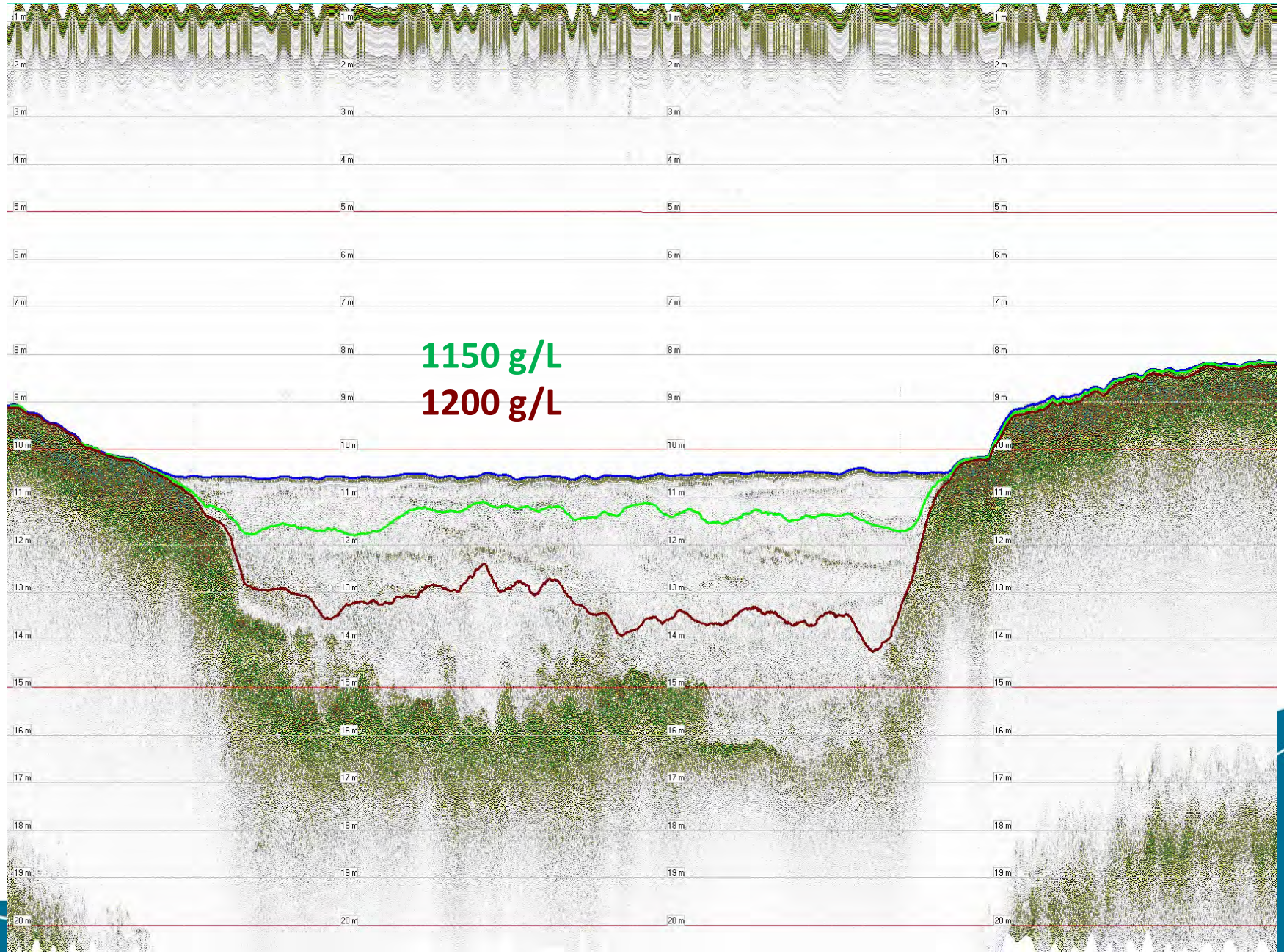
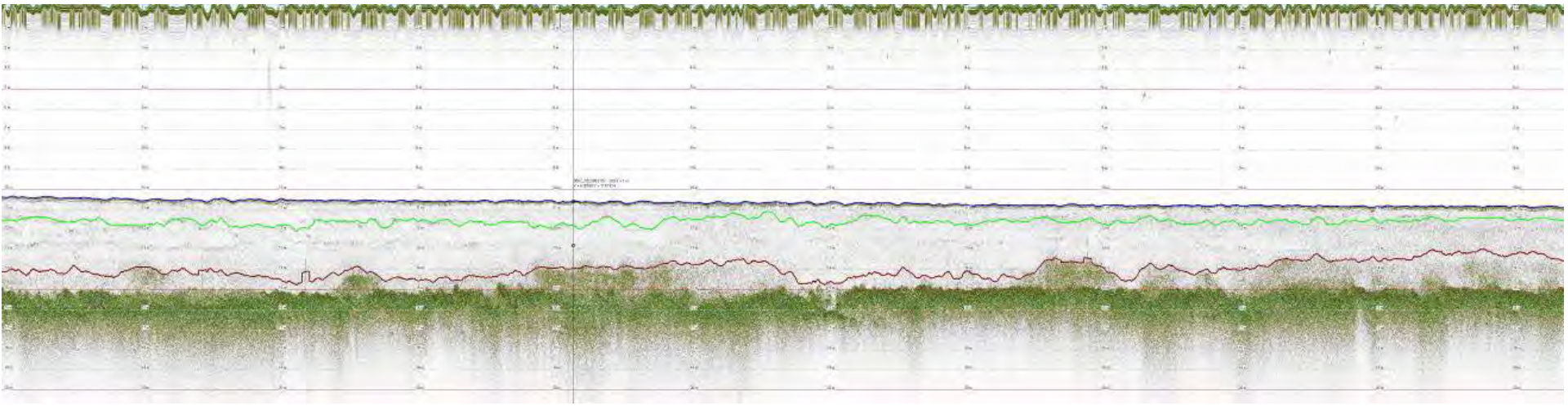
Fluid mud thickness

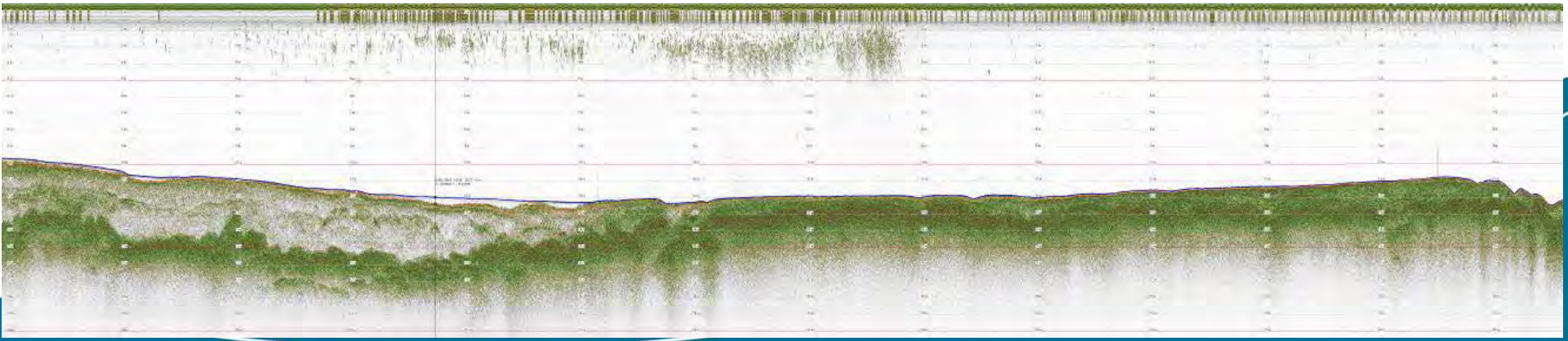


Fluid mud thickness

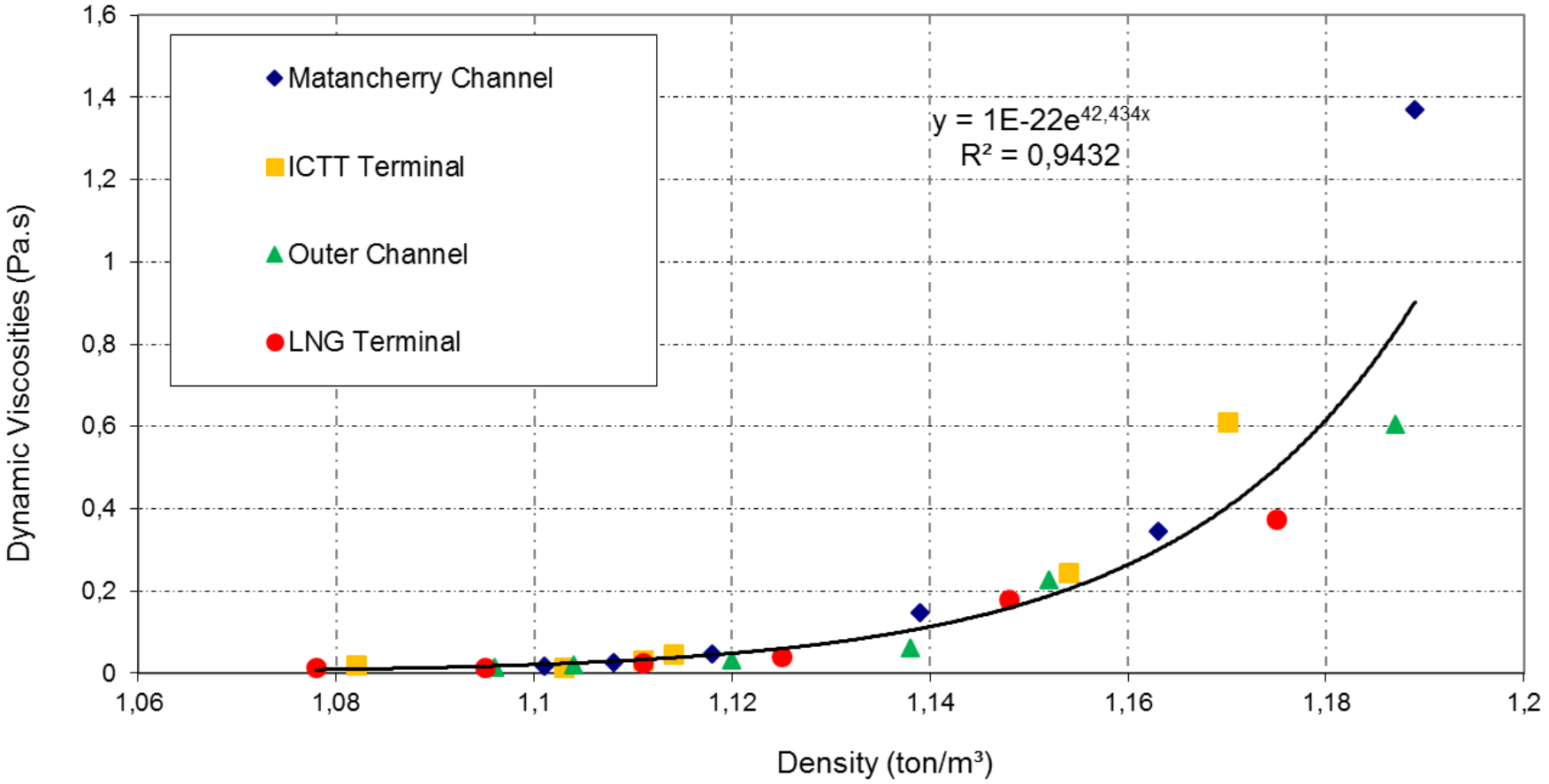
Outer channel



Ernakulam channel



Bed characteristics



stema systems

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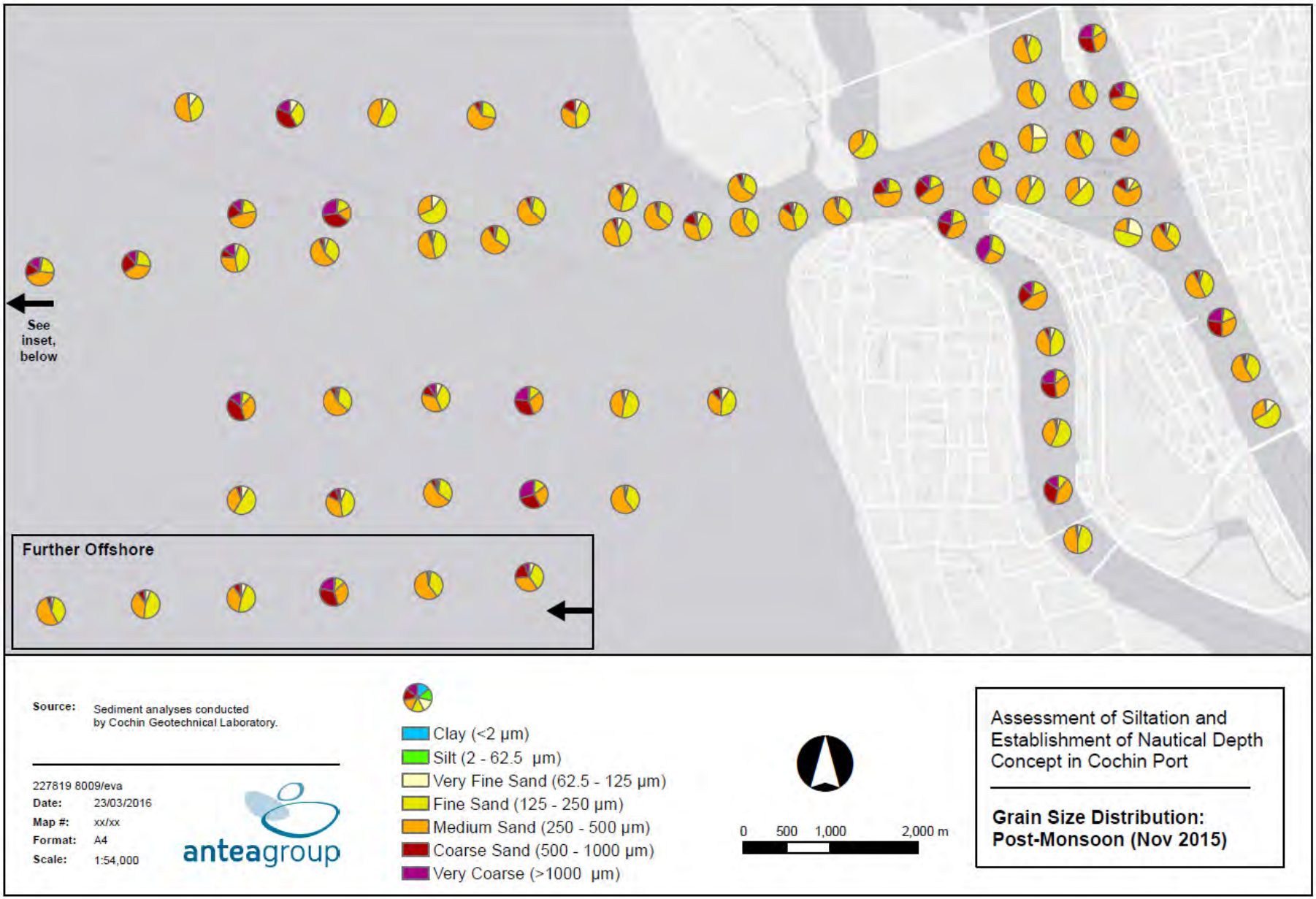
Bed characteristics

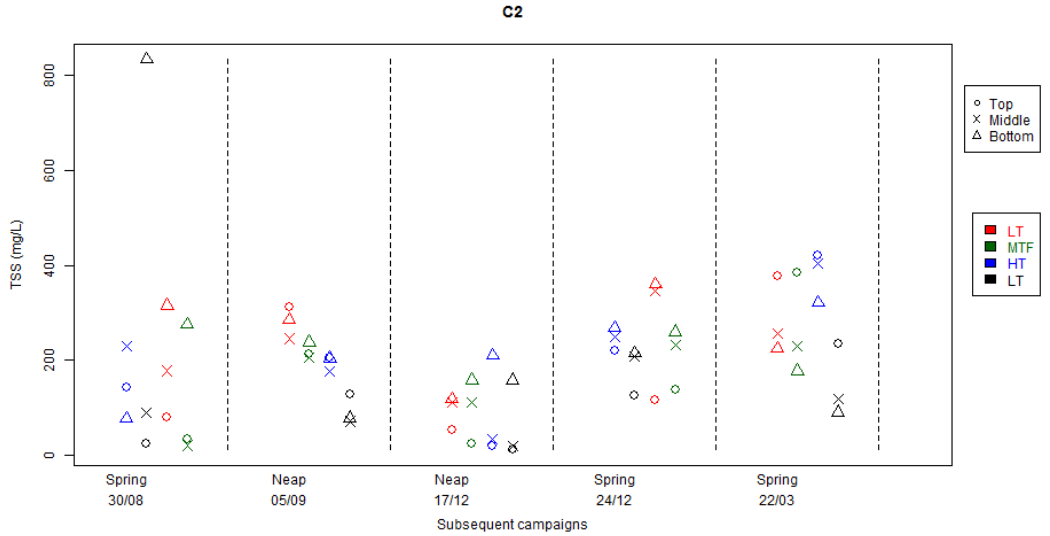
Bed characteristics

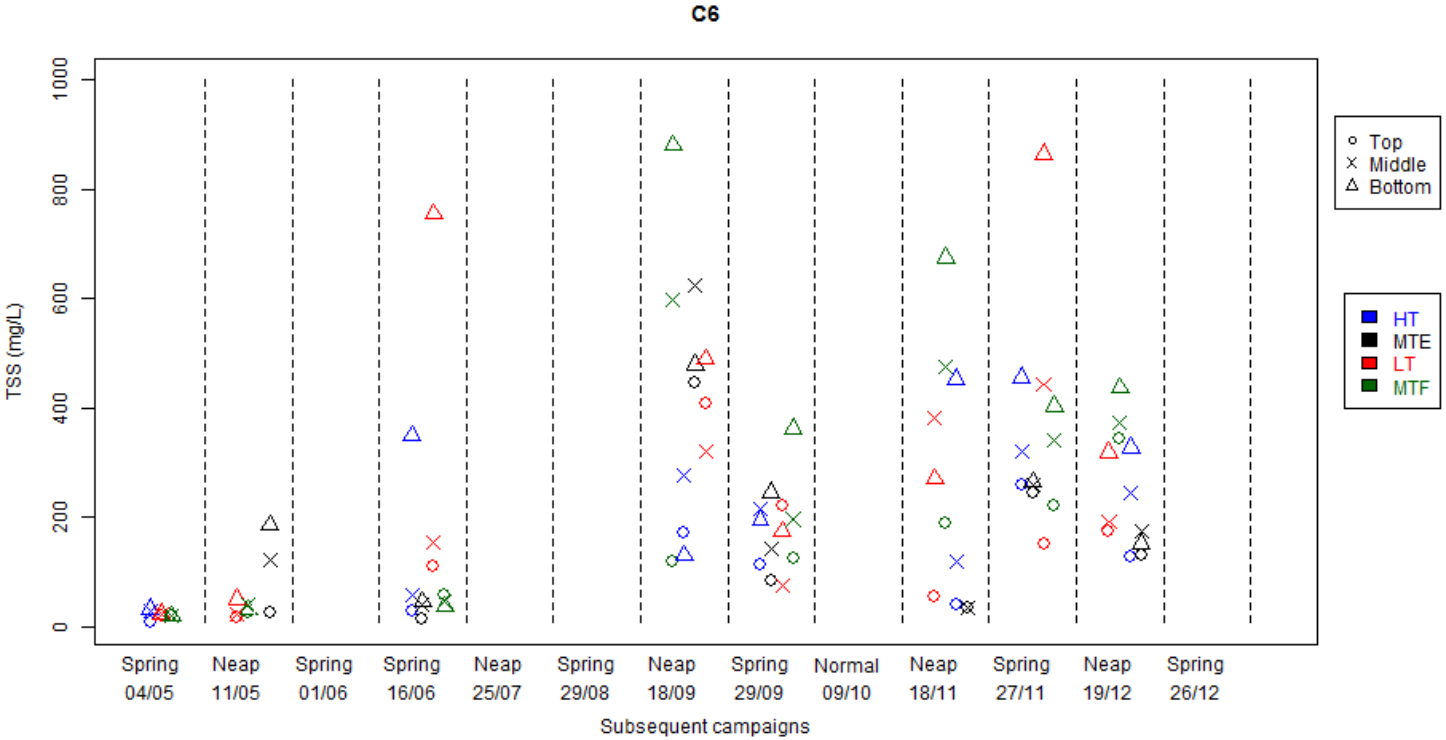


Origin of siltation

Bed load or susp. mat. from inland or sea?

- Grain size
- TSS levels





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Nautical simulations

Ship maneuvring simulator 3D

2 sessions:

- May 10-12 2016
- June 28-30 2016

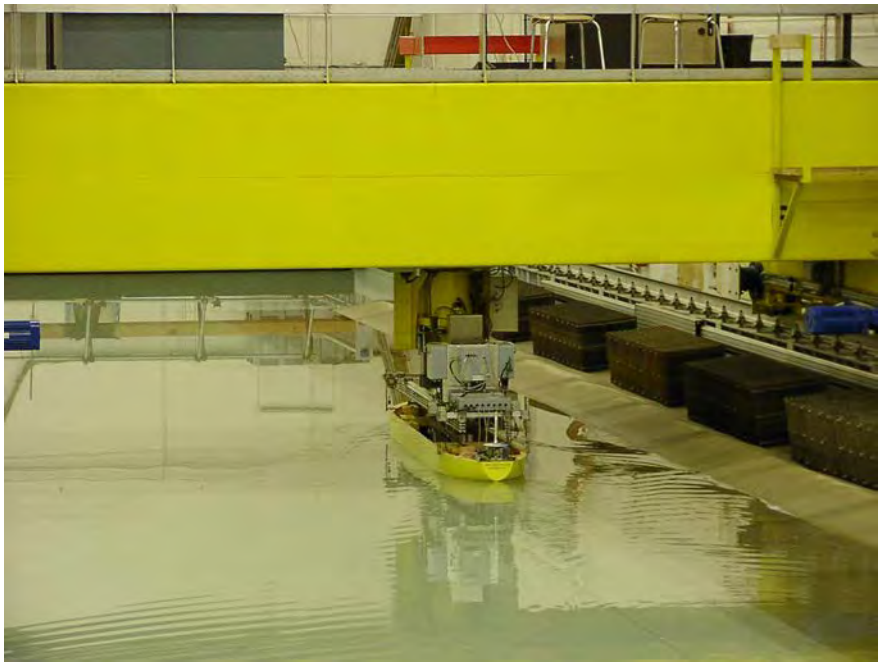
Cochin pilots

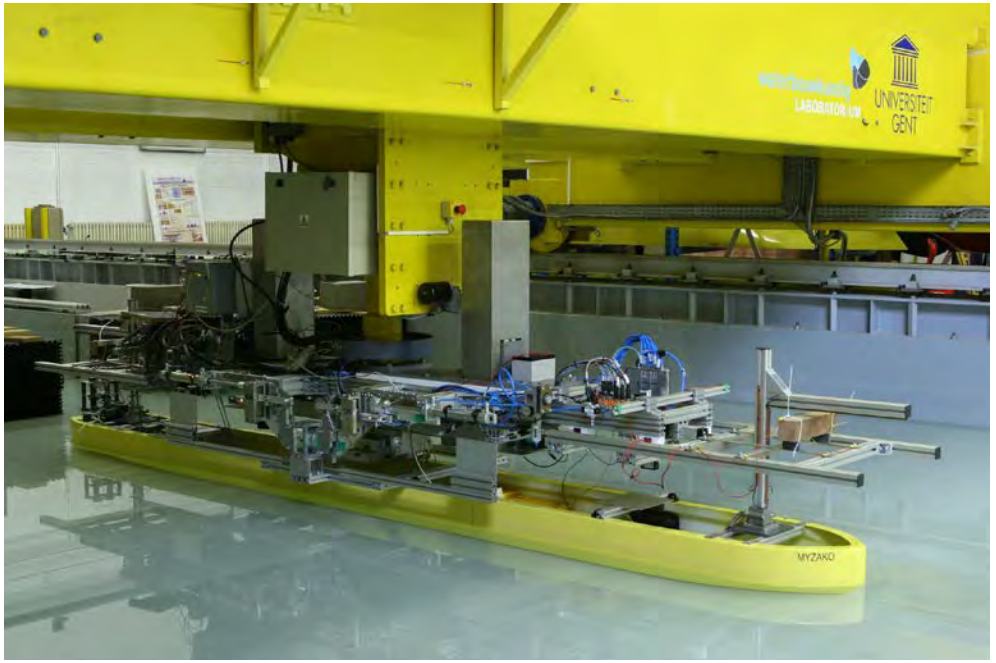
Multitude of scenario's

with different mud conditions and UKC

➔ Pilot feedback + objective parameters

➔ Nautical criterion





Area	Design ship	
	Length overall [m]	Draft [m]
Outer Channel	350	14.5
Inner Channel	250	14.5
ICTT	350	14.5
Mattancherry	183	9.1
Ernakulam	250	12.5

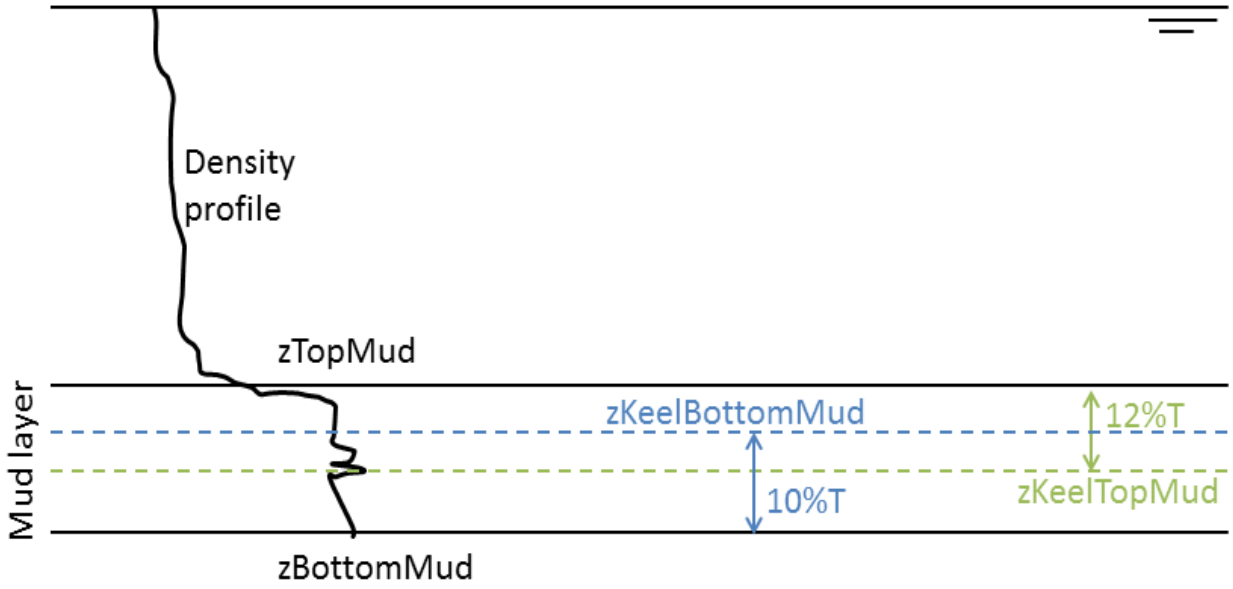
Ship number	Type	Loa [m]	Lpp [m]	T [m]	B [m]
S1	**Container**	335	322	**14.5**	42.8
S2	**Tanker**	250	237	**12.5**	38.6
S3	**General cargo**	250	240	**12.5**	32.2
S4	**General cargo**	183	175	**9.1**	24.0

Nautical simulations

Flanders Hydraulics Research

UKC (safety standards):

- Minimum 10% of draft above hard bottom
- Maximum 12% of draft under top mud



Criterion for mud penetration dominant if mud layer thicker than 22% of ship draft

For a draft of 14.5m this corresponds to a mud layer thickness of 3.2m

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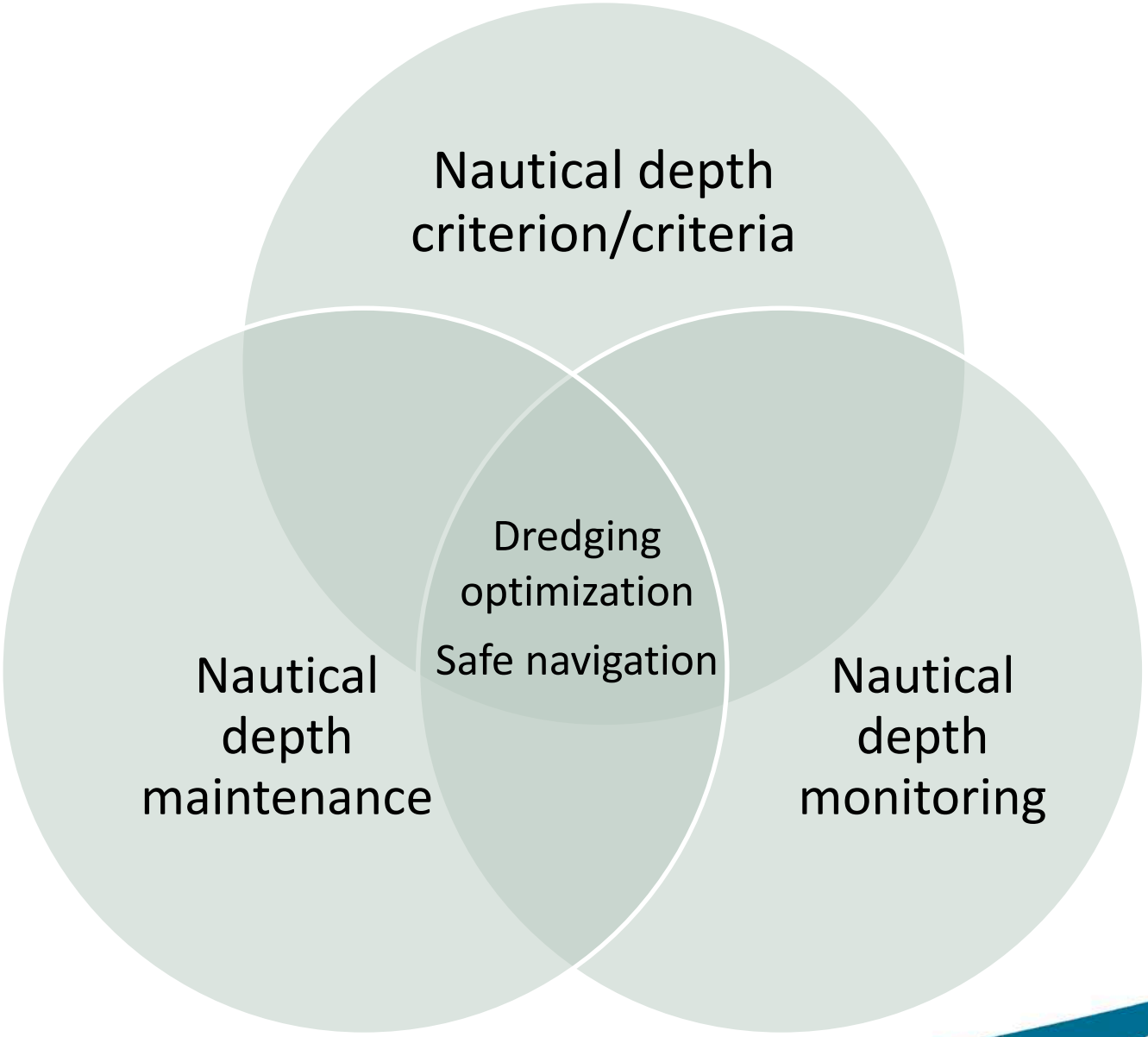
Nautical simulations

36 scenario’s

Following mud conditions will be implemented and simulated:

- Outer Channel, Inner Channel and ICTT with S1 (Container: Loa 335 m, T 14.5 m)
  - Mud layer thickness 3.22 m
    - UKC to top mud (UKC solid bottom) -12.2 (10), -7.2 (15), 4.1 (26.3)
    - Mud types (density, viscosity) C (1.13; 0.06), H (1.19; 0.19), G (1.23; 0.33)
    - Mud code TL, TM, TN, RN, RO, RP, RC, RB, RA
  - Mud layer thickness 1.61 m
    - UKC to top mud (UKC solid bottom) -1.1 (10)
    - Mud types (density, viscosity) C (1.13; 0.06), H (1.19; 0.19), G (1.23; 0.33)
    - Mud code TI, RK, PZ
  - Total: 12 conditions
- Mattancherry Channel with S4 (General Cargo: Loa 183 m, T 9.1 m)
  - Mud layer thickness: 2.02 m
    - UKC to top mud (UKC solid bottom) -12.2 (10), -7.2 (15), 4.1 (26.3)
    - Mud types (density, viscosity) C (1.13; 0.06), H (1.19; 0.19), G (1.23; 0.33)
    - Mud code TL, TM, TN, RN, RO, RP, RC, RB, RA
  - Mud layer thickness: 1.01 m
    - UKC to top mud (UKC solid bottom) -1.1 (10)
    - Mud types (density, viscosity) C (1.13; 0.06), H (1.19; 0.19), G (1.23; 0.33)
    - Mud code TI, RK, PZ
  - Total: 12 conditions
- Ernakulam Channel with S3 (General Cargo: Loa 250 m, T 12.5 m)
  - Mud layer thickness: 2.78 m
    - UKC to top mud (UKC solid bottom) -7.2 (15), 4.1 (26.3), 9.8 (32)
    - Mud types (density, viscosity) C (1.13; 0.06), H (1.19; 0.19)
    - Mud code TK, TL, TM, RN, RM, RO
  - Total: 6 conditions
- Ernakulam Channel with S2 (Tanker: Loa 250 m, T 12.5 m)
  - Mud layer thickness: 2.42 m
    - UKC to top mud (UKC solid bottom) -9.4 (10), -4.4 (15)
    - Mud types (density, viscosity) G (1.23; 0.33)
    - Mud code SD, SC
  - Mud layer thickness: 1.21 m
    - UKC to top mud (UKC solid bottom) 0 (10), 5.3 (15)
    - Mud types (density, viscosity) H (1.19; 0.19), G (1.23; 0.33)
    - Mud code SI, SL, QV, QW
  - Total: 6 conditions


Nautical depth criterion/criteria
Dredging optimization
Safe navigation
Nautical depth maintenance
Nautical depth monitoring

Though Fr Edwin informed the court that it was a conspiracy by other priests and the family of the girl, he was denied bail. Police had registered a case against Fr Edwin under Protection of Children from Sexual Offences (Pocso) Act, 2012.

Johnson, who suspected her of having illicit relations, is said to have killed his wife and later attempted suicide.

Police said the incident took place in the wee hours on Wednesday. However, neighbours came to know

CPT to conduct study for selective dredging

M.K.Sunilkumar
@timesgroup.com

Kochi: Fed up with draining out close to Rs 170 crore on dredging navigation channels every year, the Cochin Port Trust (CPT) has finally decided to conduct nautical depth studies to carry out selective dredging which may help the authorities cut down the cost by at least 20%. The CPT has started installing current flow meters as part of *nautical flow studies, which is expected to be completed within 12 months.*

The current meter will give details like depth of the channel, sediment deposit in each area, nature of silt and waves. This will help the CPT to identify areas that required massive dredging. The move may reduce the port's annual loss, which is around Rs 100 crore, by half.

Given the fact that the CPT had to shell out around Rs 650 crore on dredging the navigation channel in the past four years, the cost cutting will help the port authorities to reduce the loss. According to sources, the loss during the 2014-15 fiscal is around Rs 107 crore. "We have installed current flow meters at nine points along the navigation channel. We expect that the study will help us cut short the dredging cost by at least 20%," said Paul N Joseph, deputy conservator, CPT.

"According to the CPT's agreement with Dubai Port World, which operates Vallarpadam International Container Transshipment Terminal, the port should conduct periodical dredging to facilitate the movement of 14-metre draft ship. As per the agreement, an additional 10% depth of the draft should also be carried out. Thus, the total depth should be 15.4m," said Nandakumar C D, trustee of CPT and general secretary Cochin Port employees organization.

The additional dredging of 16 metre is being carried out considering safety matters. "The navigation channel in Kochi has a silt bottom (unlike other ports like Mumbai. Once the study results are out, we may be able to cut short the depth of dredging to 14m. As the channel has a silt bottom, chances are very less for ships to ground even if the depth is less than draft of the ship. So, we can explore the possibilities reducing the depth further," he said.

Draft or draught of a ship is the vertical distance between the waterline and bottom of the hull or keel. The study is being conducted by a Hyderabad-based firm with technical support from international agencies in the field, CPT officials said.

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