Annex 6I

Model Results for Pipeline Installation by Trailing Suction Hopper Dredging (Sediment Dispersion & Dissolved Oxygen Depletion)

6I-1.1 INTRODUCTION

This additional water quality modelling exercise was conducted to illustrate the potential impacts of sediment dispersion, sediment deposition and dissolved oxygen (DO) depletion arising from the installation of Section 3 (Urmston Road Crossing) of Pipeline 1 by one trailing suction hopper dredger (TSHD).

6I-1.2 DREDGING PLANT: TRAILING SUCTION HOPPER DREDGER

Trailing Suction Hopper Dredgers (TSHD) may be used for dredging the submarine gas pipeline across Urmston Road Crossing.

The hopper dry density for a TSHD is typically 0.75 ton m^{-3}. TSHD could dredge at a faster rate than grab dredgers (typical dredging rate of 5,400 m^3 per trip per TSHD with a maximum dredging rate up to 7,200 m^3 per trip depending on the vessel size). For the modelling scenarios it has been assumed that the Contractor will utilise a small (< 5,000 m^3) to medium (5,000 – 10,000 m^3) TSHD.

A review of international data on losses from trailer dredgers has determined that a loss rate of 7 kg m^{-3} dredged would be appropriate irrespective of the size of the dredger, assuming no overflowing but that the Lean Mixture Overboard (LMOB) systems are in operation (1) (2) (3). LMOB is used at the beginning and end of the dredging cycle when the suction arm is being lowered and raised. At these times the majority of the material entering the hopper will be water with small amounts of fine sediments, which is discharged to the sea via the overflow system.

Overflowing refers to the discharge of fine sediment and water during bulk dredging and results in high losses of sediment to suspension. Overflowing is not usually permitted when dredging in marine mud and is usually only allowed during dredging of sand deposits, when overflowing is utilised to increase the density of the material in the hopper.

The value of 7 kg m^{-3} dredged for dredging using trailing suction hopper dredgers will be appropriate for this Study as LMOB will be used but

(1) ERM - Hong Kong, Ltd (1997) Op cit.

(2) Kirby, R and Land J M (1991). The impact of Dredging - A Comparison of Natural and Man-Made Disturbances to Cohesive Sedimentary Regimes. Proceedings CEDA-PIANC Conference (incorporating CEDA Dredging Days), November 1991, Amsterdam. Central Dredging Association, the Netherlands.

(3) Environment Canada (1994). Environmental Impacts of Dredging and Sediment Disposal. Les Consultants Jaques Beraube Inc for the Technology Development Section, Environmental Protection Branch, Environment Canada, Quebec and Ontario Branch.

overflowing will not be permitted. It has also been assumed that no more than one THSD dredger will be operating at any one time.

During dredging the drag head will sink below the level of the surrounding seabed and the seabed sediments will be extracted from the base of the trench formed by the passage of the draghead. The main source of sediment release is the bulldozing effect of the draghead when it is immersed in the mud. This mechanism means that sediment is lost to suspension very close to the level of the surrounding seabed and a height of 1 m will be adopted for the initial location of sediment release in the model.

It is assumed that the TSHD will be operated for 24 hours a day. The suggested size of trailer dredger is approximately 8,000 m^3, which commonly operate in Hong Kong. For each trip, the dredging volume will be 7,200 m^3, the most conservative case, lasting for approximately 45 minutes.

Disposal site at the East of Sha Chau is assumed to be available at the time of dredging works commissioned. Contractor should confirm the availability of the disposal site prior to any disposal events. Based on this assumption, the cycle time for a TSHD is calculated as presented in *Table 6A.4.* It is assumed that the trailer will dispose at the East of Sha Chau which would introduce the travelling time to and from the site to be 0.67 hour and a cycle time would be approximately 2.67 hours. This would equate to 9 trips per day, which means a daily dredging rate of 64,800 m^3 day^{-1}.

Table 6I.1 Cycle Time for a TSHD

Disposal Site	**Distance (km)**	**Sailing Speed ($km\ hr^{-1}$)**	**Off-site (Travel) Time (hr)**	**On-site Dredging Time (hr)**	**On-site Idle Time (hr)**	**Total Cycle Time (hr)**	**Working hours per day (hr)**	**Number of Cycles per day**
(a)	(b)	(c)	(d) = 2* (b)/(c)	(e)	(f) = 2 hr - (e)	(g) = (d) + (e) + (f)	(h)	(i) = (h)/(g)
East Sha Chau	9.5	28.34	0.67	0.75	1.25	2.67	24	9

6I-1.3 CONSTRUCTION SCENARIO

6I-1.3.1 *TSHD along Urmston Road Crossing (KP0.73 – KP2.52)*

An assumption of a 24 working hours per day with 7 working days per week has been adopted for trailing suction hopper dredging for pipeline section along the Urmston Road.

It is assumed that only one TSHD will be used, the dredging rates are 7,200 m^3 per trip and the loading time for each dredging trip is approximately 0.75 hour. The loss rate (in $kg\ s^{-1}$) (releasing at the bed layer about 10% of the water column) is calculated as follows:

Loss Rate ($kg\ s^{-1}$)

$= \textit{Dredging Rate Per Trip } (m^3 s^{-1}) * \textit{Loss Rate } (kg\ m^{-3})$

$= 7{,}200\ m^3\ trip^{-1} / 0.75\ hr / 3600\ s\ hr^{-1} * 7\ kg\ m^{-3}$

$= \mathbf{18.67\ kg\ s^{-1}}$

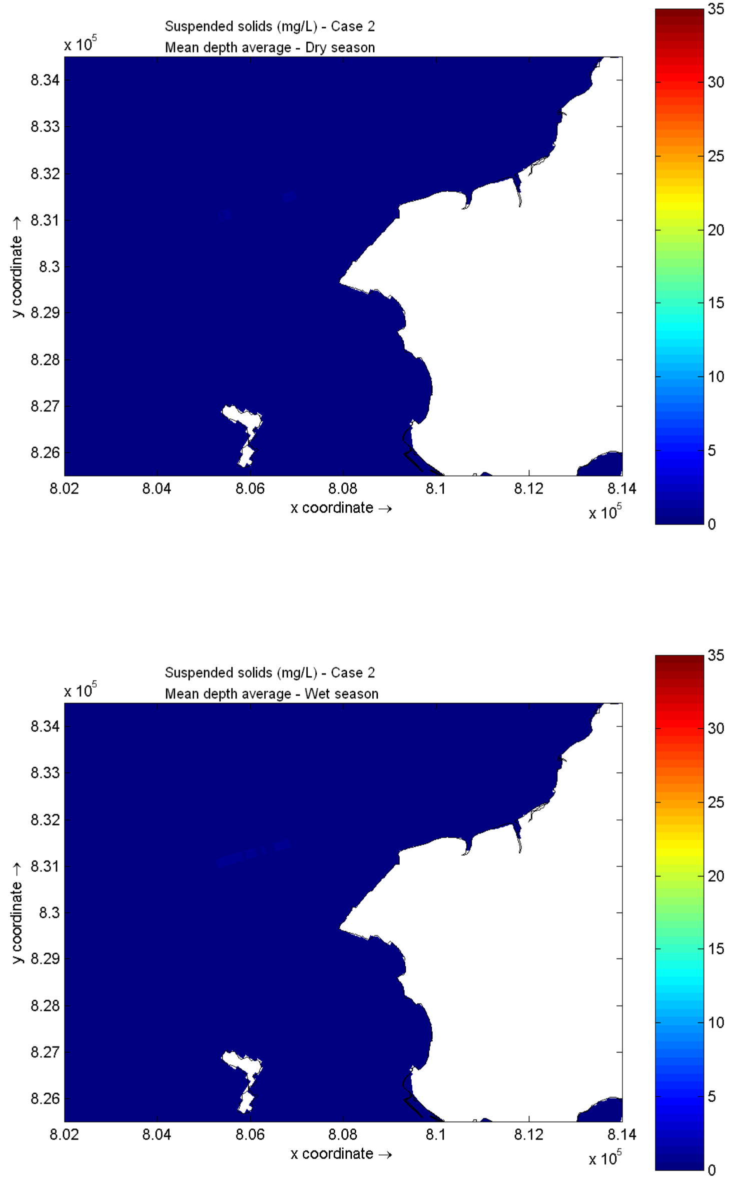
It is considered that if trailing suction hopper dredging is to be adopted for installation of the Urmston Road Crossing pipeline section, TSHD activities would commence upon completion of the grab dredging activities, but prior to the jetting activities, to be conducted as part of First Phase Construction. Therefore this additional modelling scenario examines the potential water quality impacts associated with dredging by TSHD only.

The construction details by TSHD are as follows:

- Total Dredged Volume: 226,000 m^3
- Moving Speed: 33 m hr^{-1}
- Dredging Rate per Plant: 64,800 m^3 day^{-1}
- Maximum Daily Working Hours: 24 hours

6I-1.4 MODELLING OUTPUT

Contour plots of SS elevation, sediment deposition and DO depletion are attached herein.



TSHD Scenario – Depth-averaged
Suspended Solids (mg/L) – Mean over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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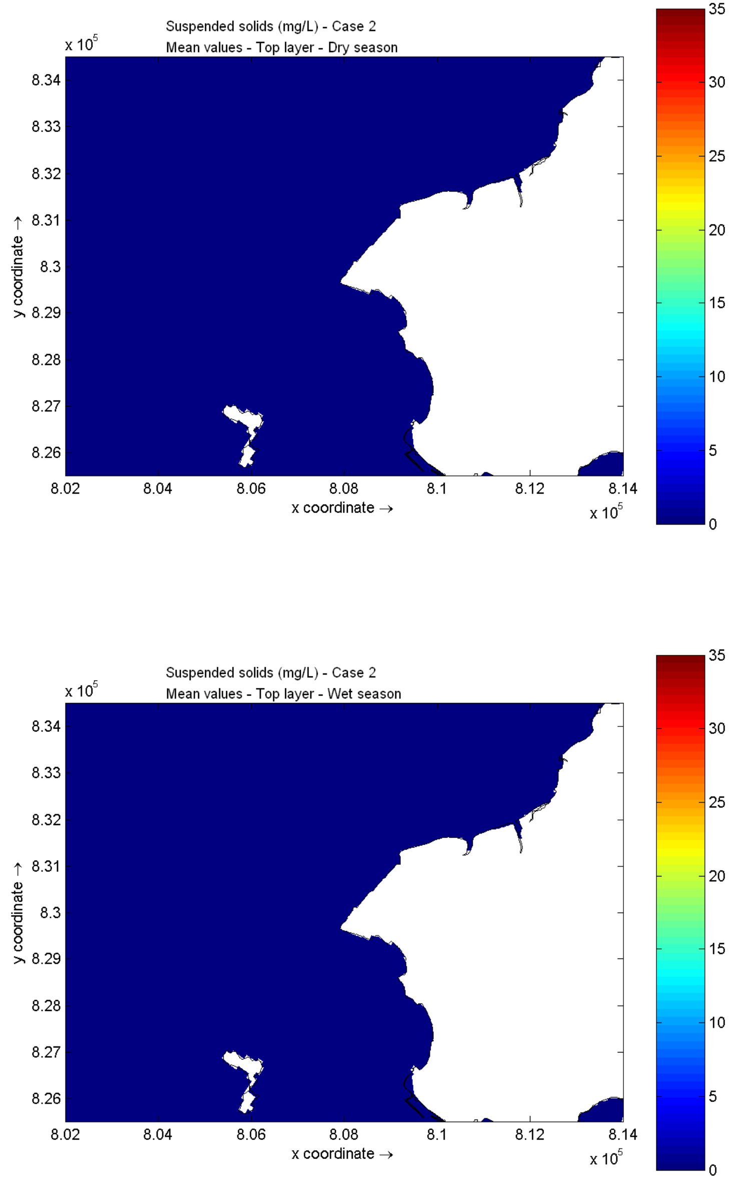

TSHD Scenario – Top layer
Suspended Solids (mg/L) – Mean over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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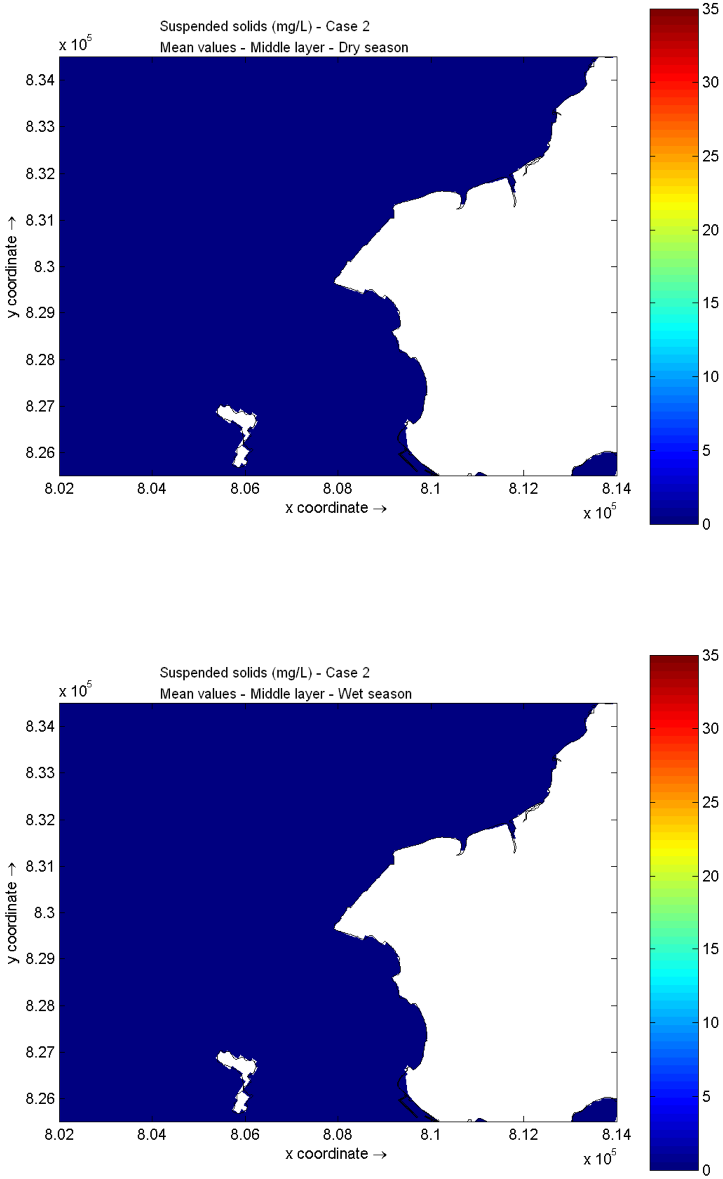

TSHD Scenario – Middle layer
Suspended Solids (mg/L) – Mean over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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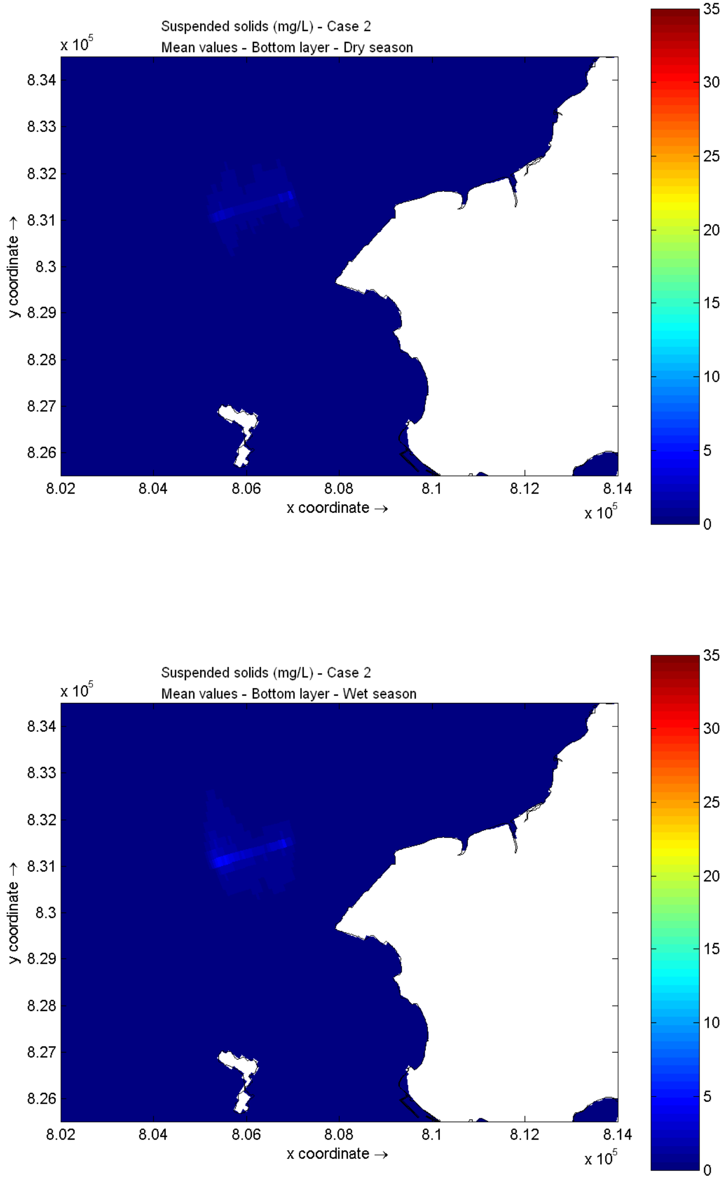

TSHD Scenario – Bottom layer
Suspended Solids (mg/L) – Mean over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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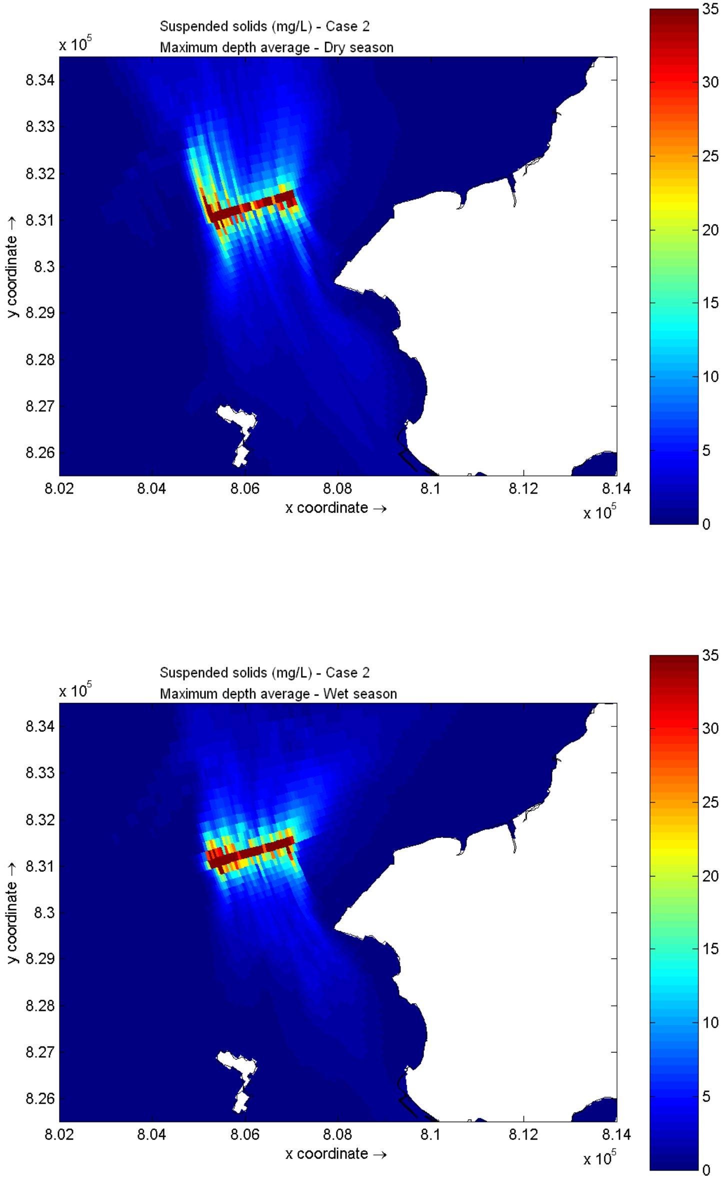

TSHD Scenario – Depth-averaged
Suspended Solids (mg/L) – Maximum over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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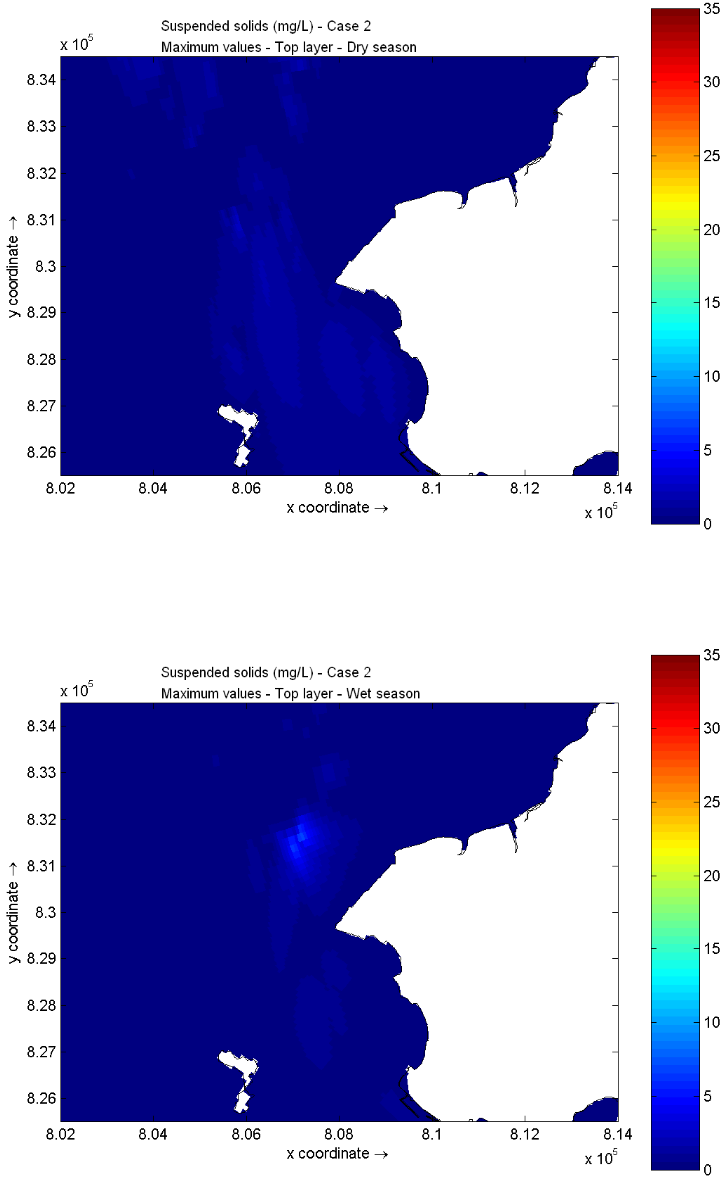

TSHD Scenario – Top layer
Suspended Solids (mg/L) – Maximum over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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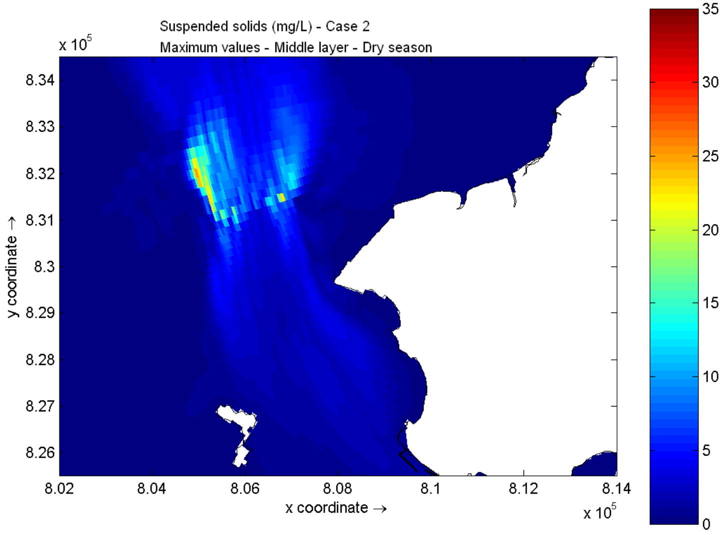

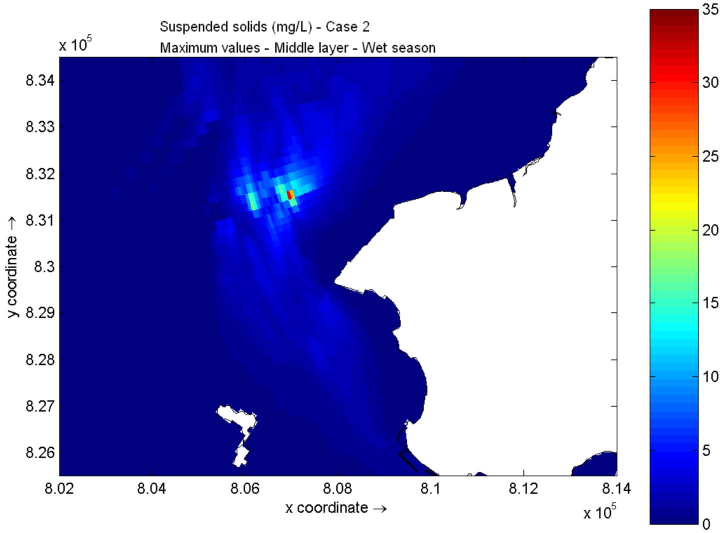

TSHD Scenario – Middle layer
Suspended Solids (mg/L) – Maximum over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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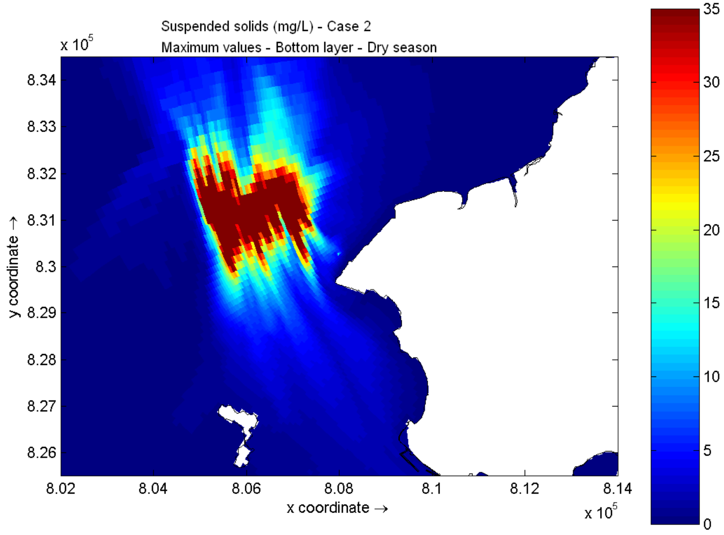

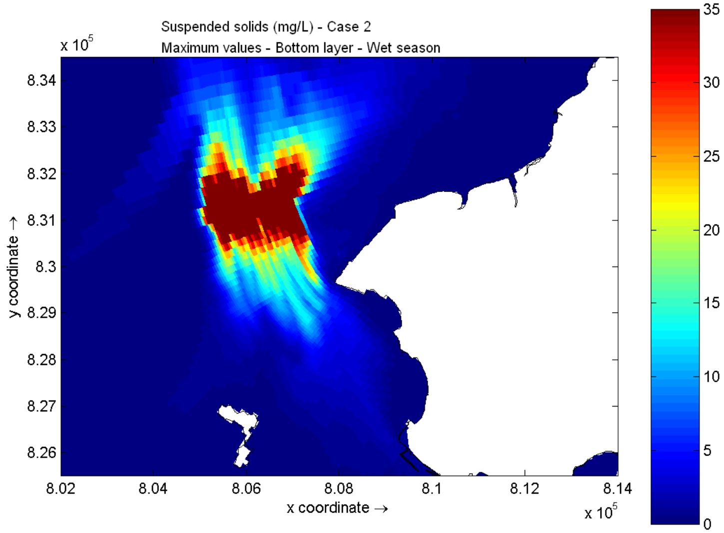

TSHD Scenario – Bottom layer
Suspended Solids (mg/L) – Maximum over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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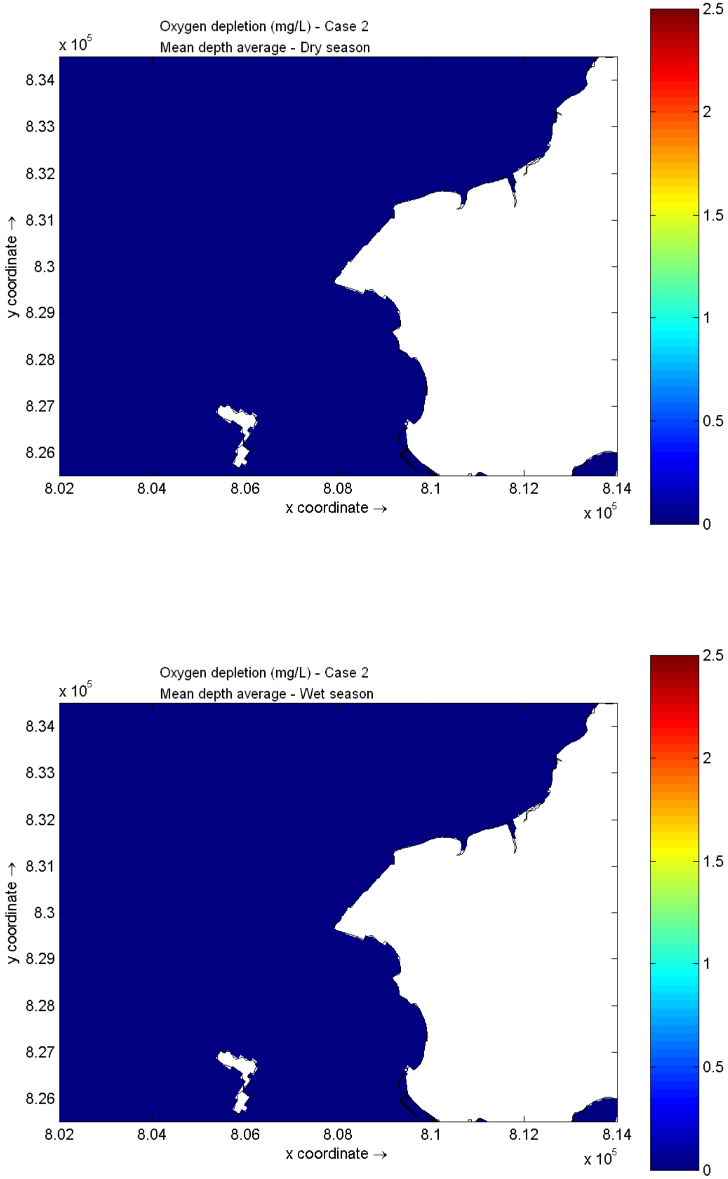

TSHD Scenario – Depth-averaged
Dissolved Oxygen Depletion (mg/L) – Mean over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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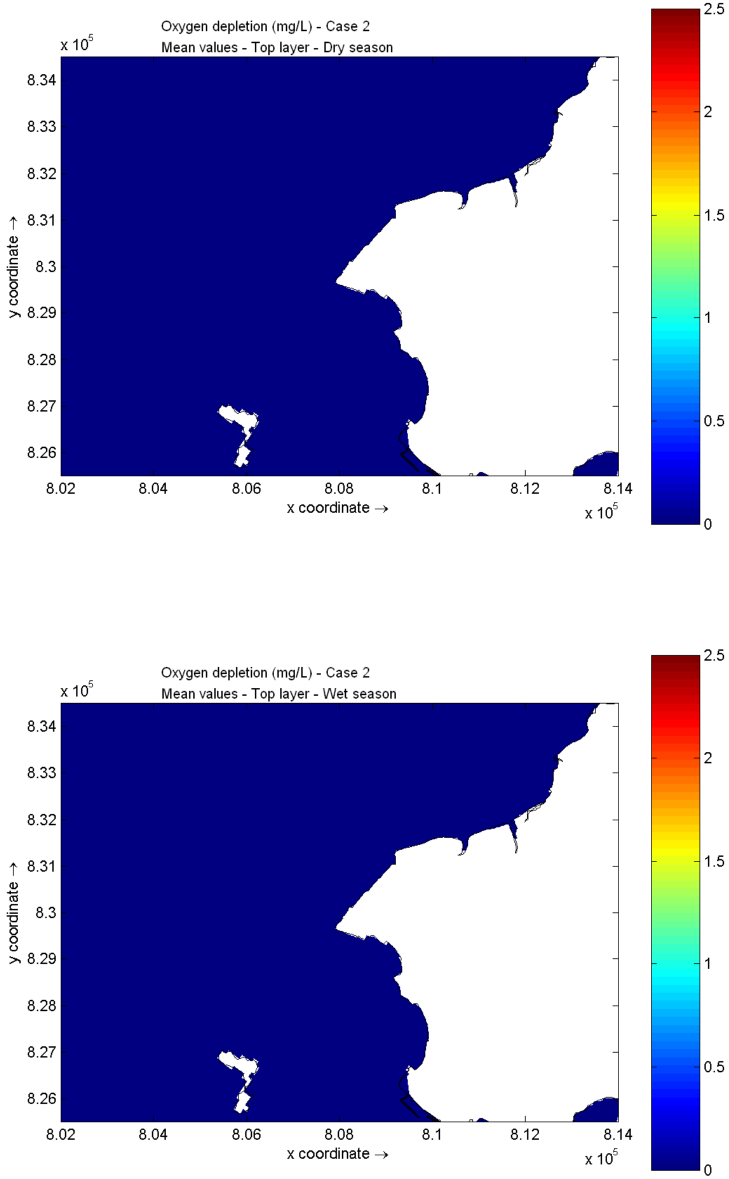

TSHD Scenario – Top layer
Dissolved Oxygen Depletion (mg/L) – Mean over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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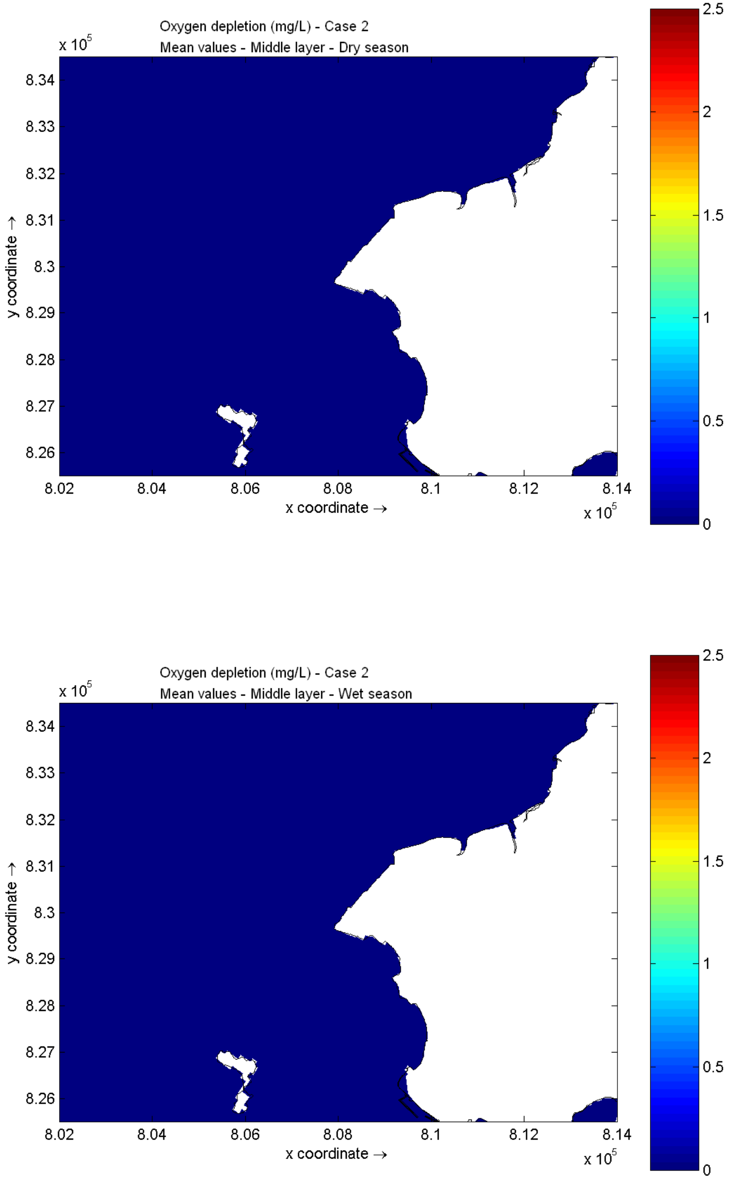

TSHD Scenario – Middle layer

Dissolved Oxygen Depletion (mg/L) – Mean over a complete spring neap cycle

Upper plot: Dry Season ; Lower plot: Wet Season

Environmental Resources Management

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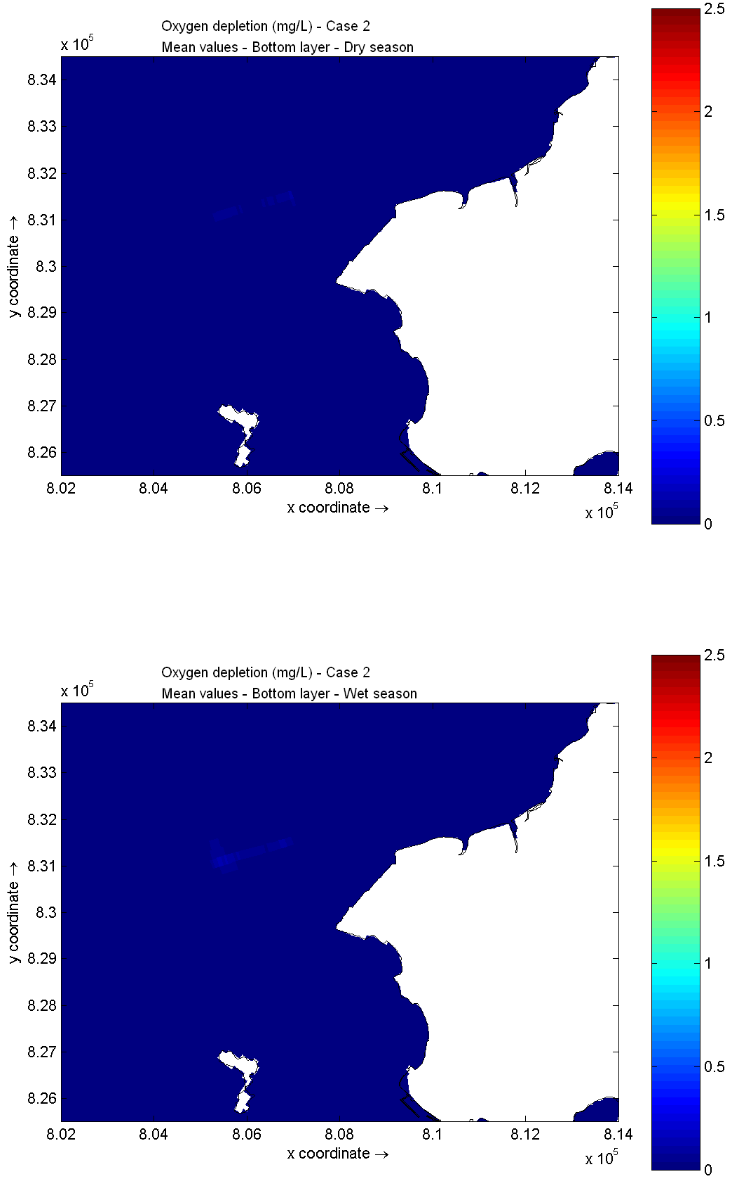

TSHD Scenario – Bottom layer

Dissolved Oxygen Depletion (mg/L) – Mean over a complete spring neap cycle

Upper plot: Dry Season ; Lower plot: Wet Season

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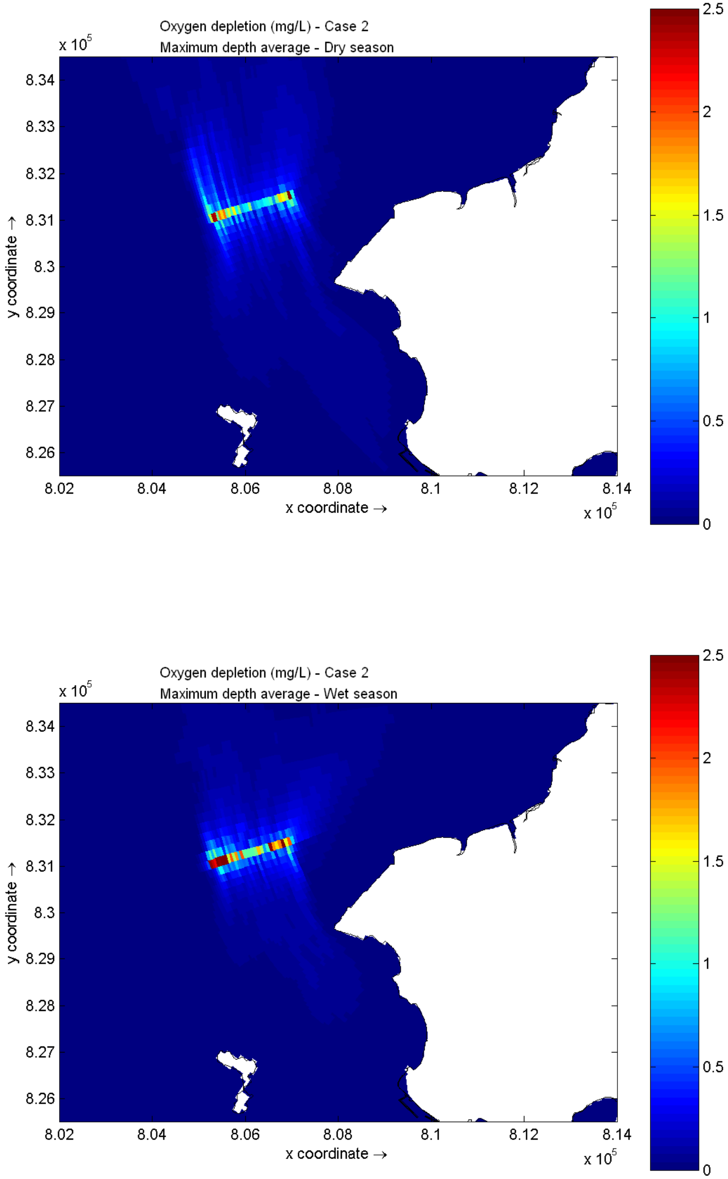

TSHD Scenario – Depth-averaged
Dissolved Oxygen Depletion (mg/L) – Maximum over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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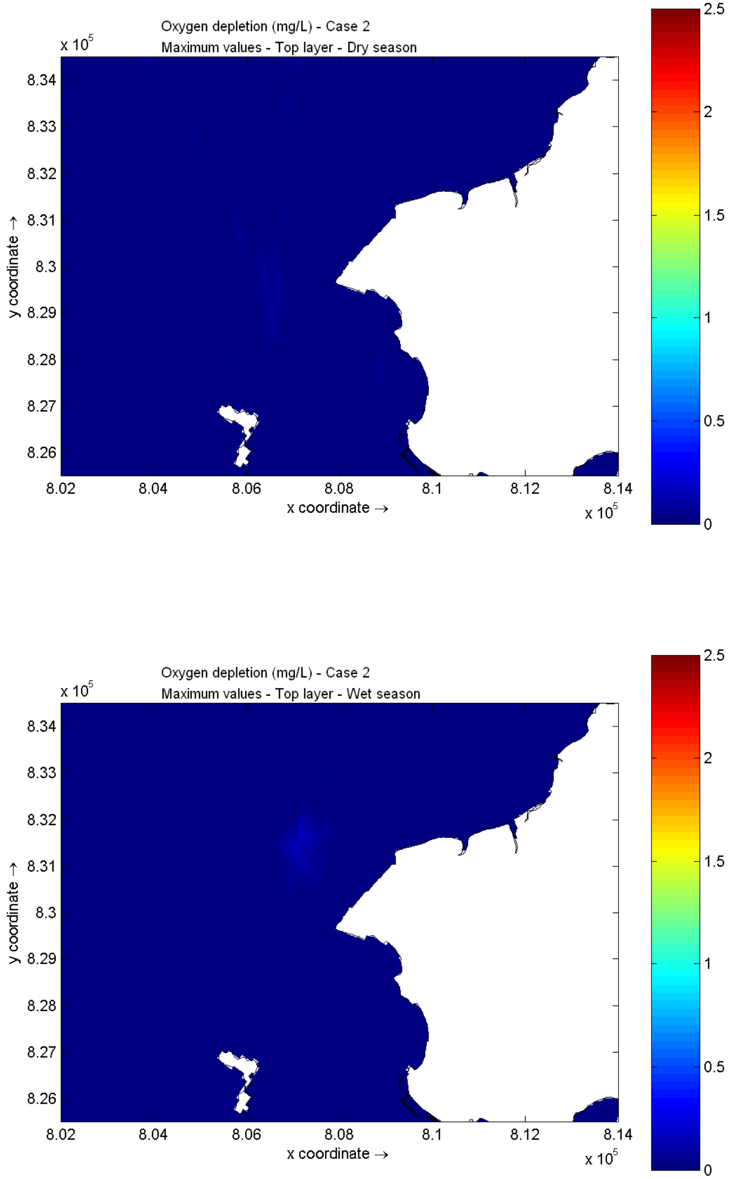

TSHD Scenario – Top layer
Dissolved Oxygen Depletion (mg/L) – Maximum over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

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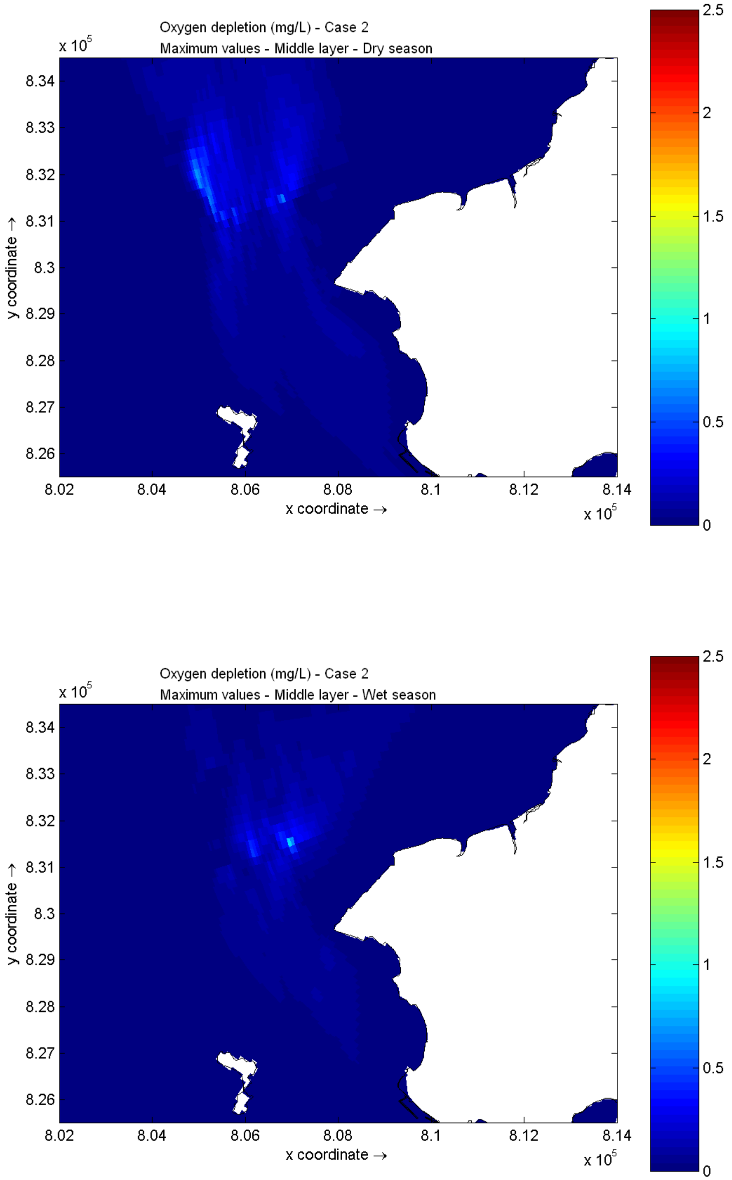
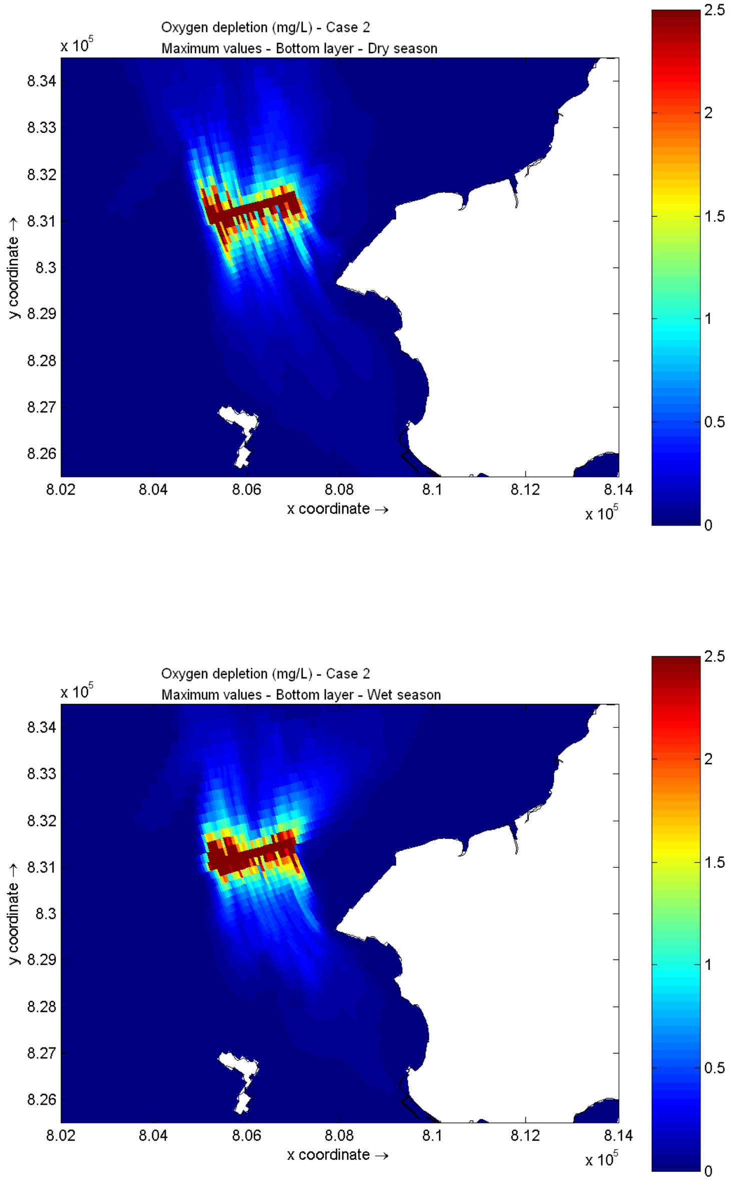


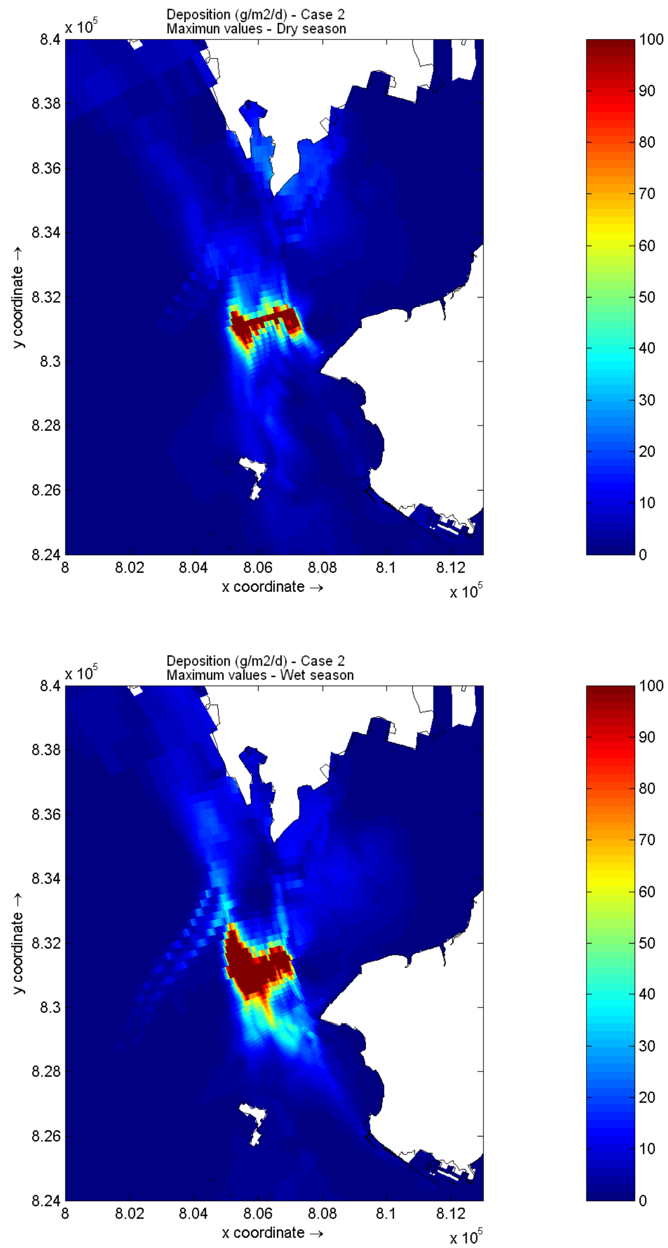
TSHD Scenario – Middle layer
Dissolved Oxygen Depletion (mg/L) – Maximum over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

Environmental Resources Management



TSHD Scenario – Bottom layer
Dissolved Oxygen Depletion (mg/L) – Maximum over a complete spring neap cycle
Upper plot: Dry Season ; Lower plot: Wet Season

Environmental Resources Management



TSHD Scenario – Maximum daily deposition at any time during the simulation over a complete spring neap cycle

Upper plot: Dry Season ; Lower plot: Wet Season

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