



2-4<sup>th</sup> April 2012

# Biogeochemistry of Indian estuaries: Influence of Human Interferences

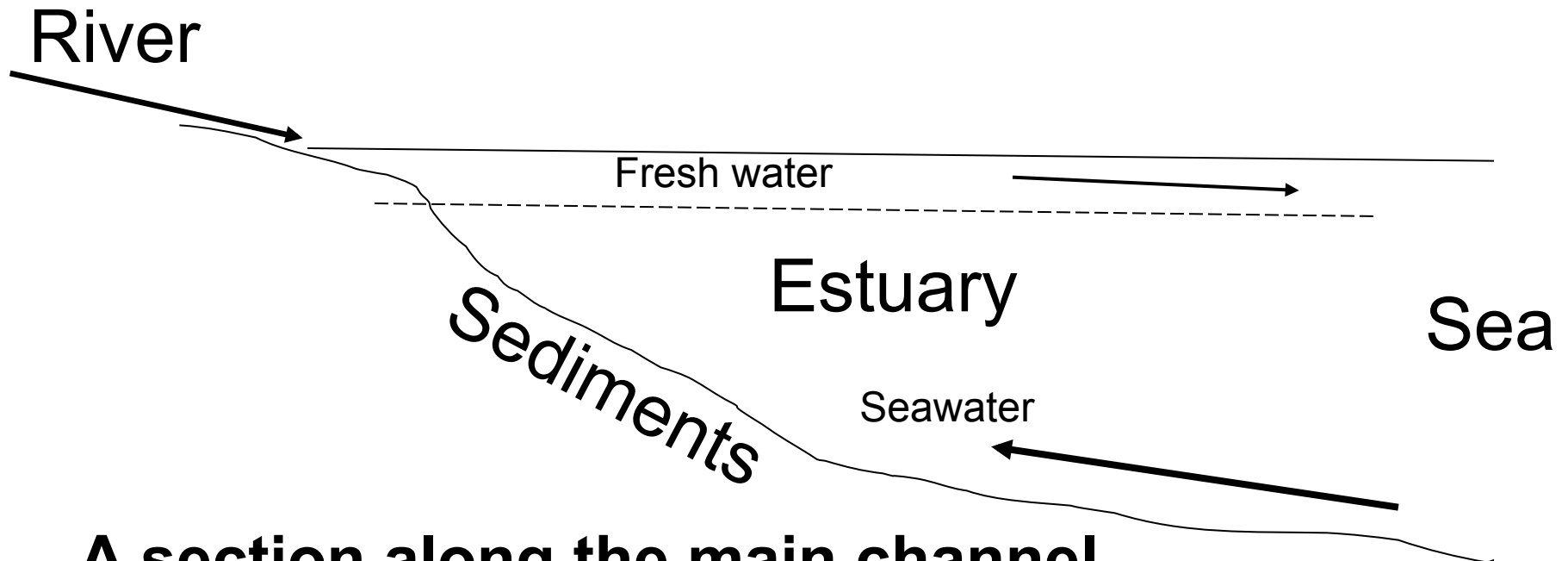
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National Institute of Oceanography  
India

GEOSS, Miraikan, Japan



# ***An estuary is...***

“a transition zone between river and sea in which fresh water gets mixed with seawater and tidal influence is strongly felt ”

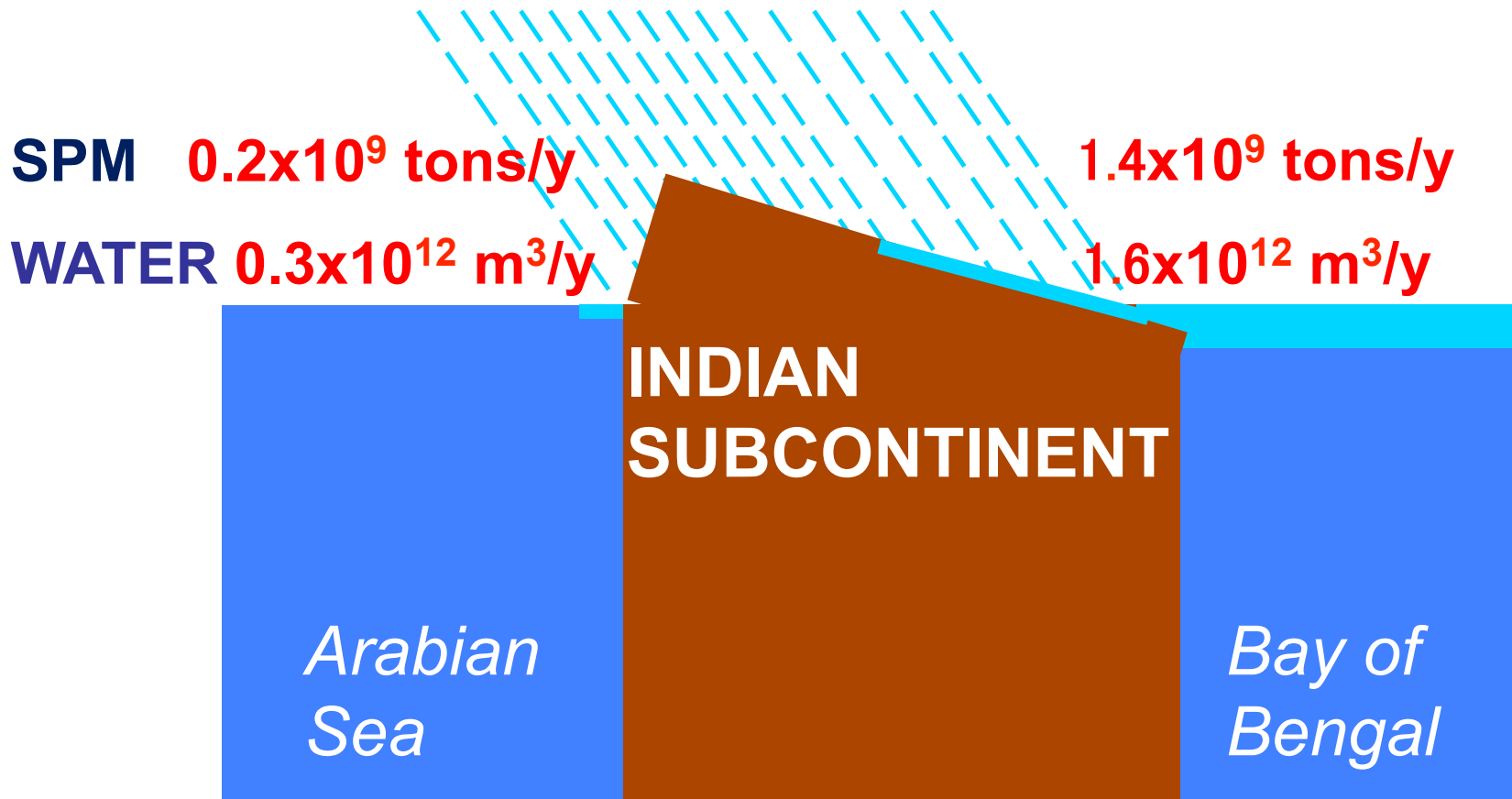


**A section along the main channel**

## **Estuaries significance...**

- important in hydrological cycles
- sediment supplies to ocean
- habitats for a large variety of life
- highly productive among aquatic systems
- food resources of socioeconomic relevance
- influence ocean dynamics in the neighbourhood

# Influence of different river discharges on oceans in our neighbourhood



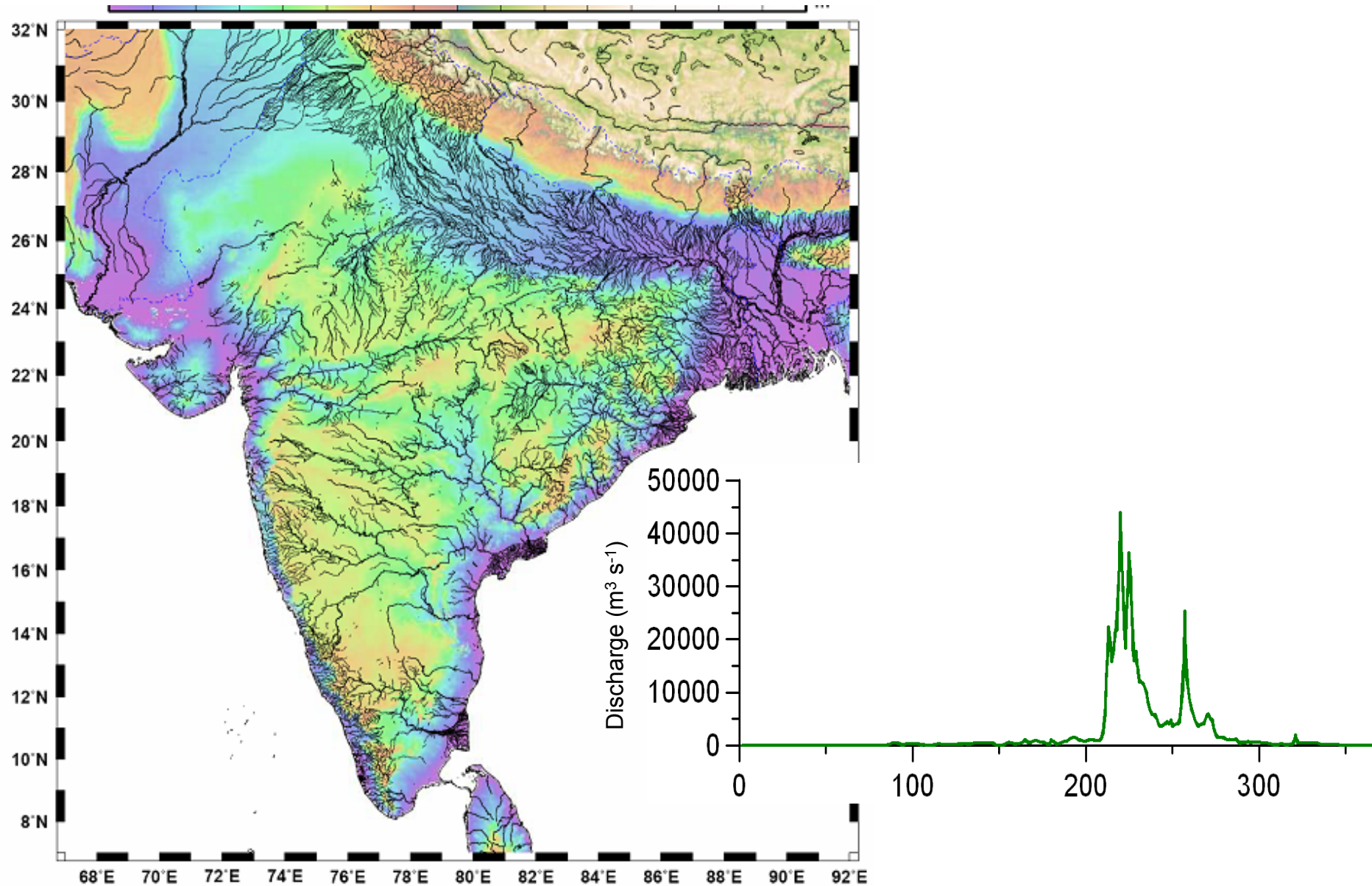
**River and estuarine systems  
facilitated human settlements on  
their banks through the civilizations**

***However, human interference with  
these systems is a cause for worry!***

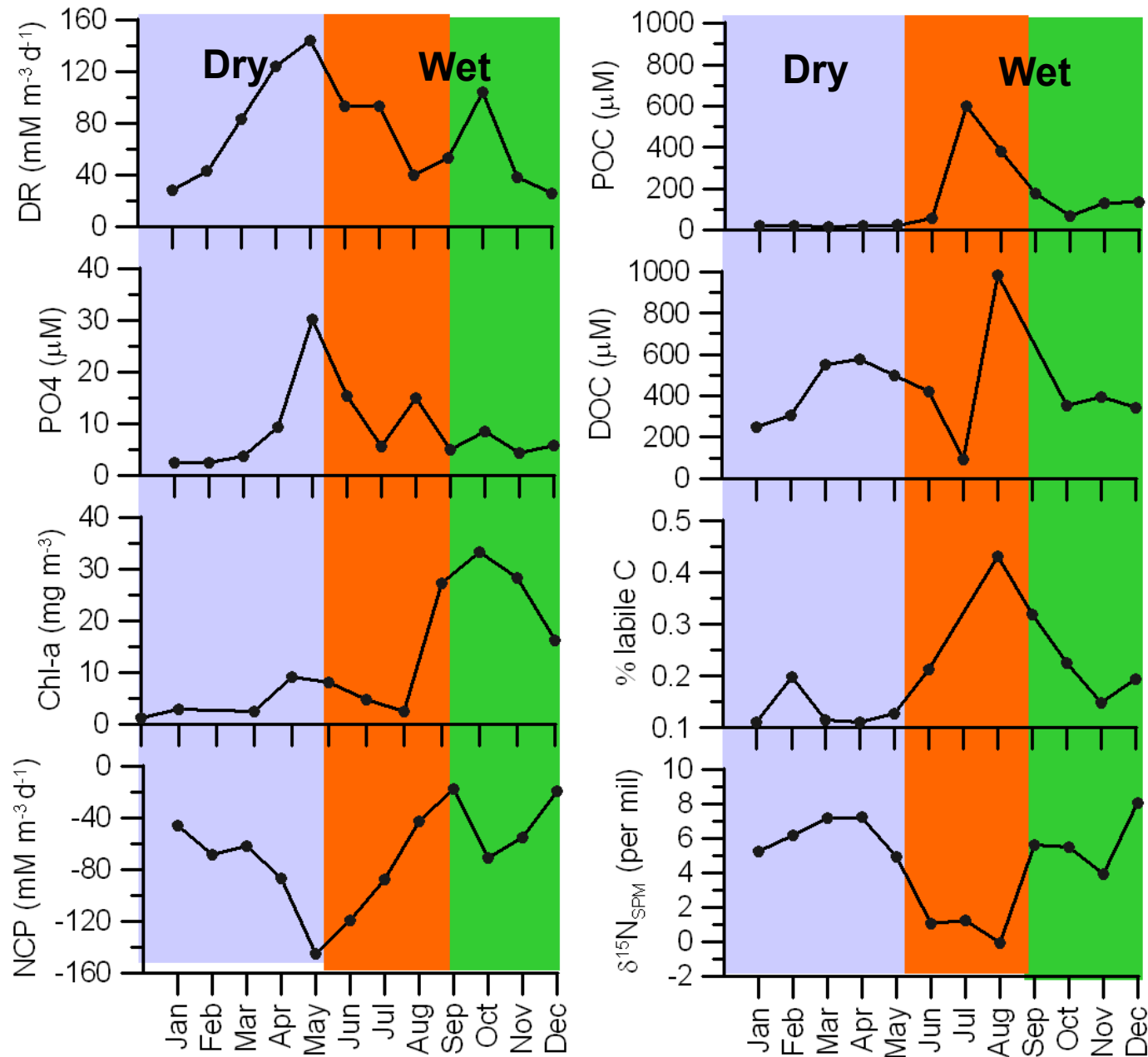
# ENVIRONMENTAL ISSUES IN ESTUARIES

- Changes in sediment load and water caused by clearing forests for agriculture and development
- Construction of dams
- Waste disposal
- Commercial fishing
- Dredging
- Shipping
- Habitat destruction

# Indian monsoonal river systems



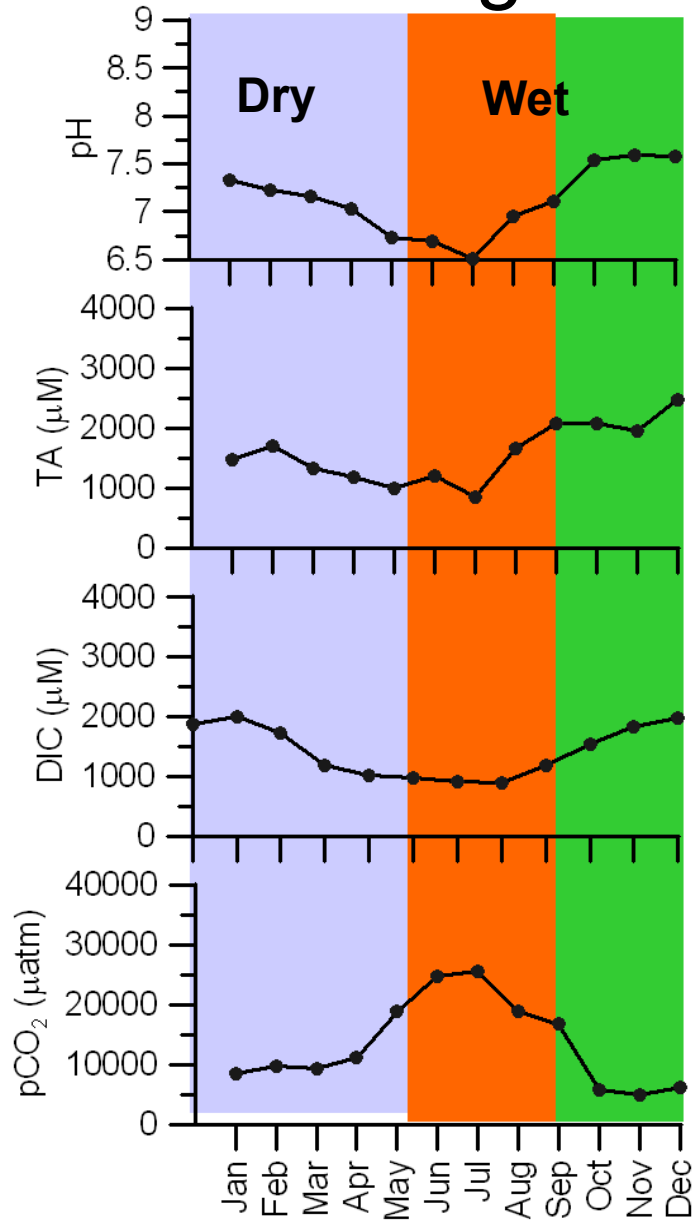
# Modification of organic matter in the Dam reservoir



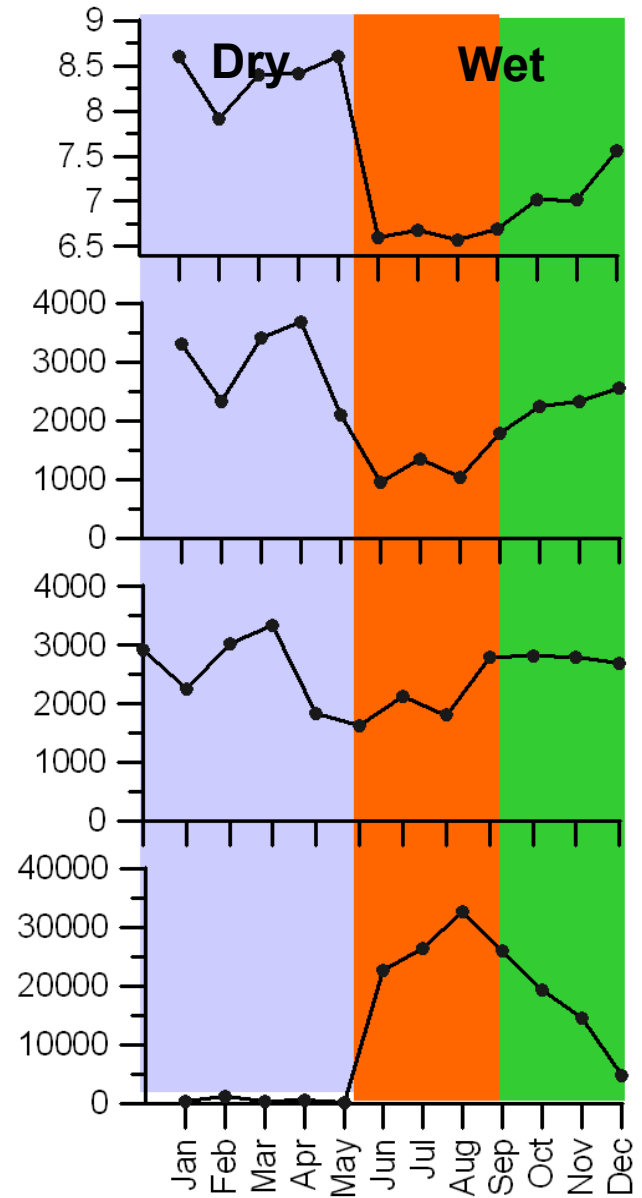


# Influence on inorganic carbon system

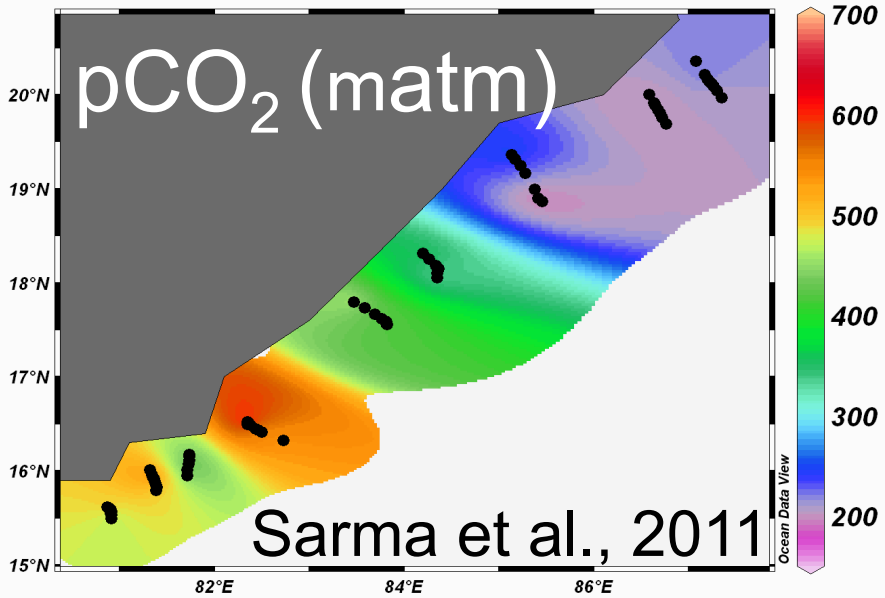
**DAM**



**ESTUARY**

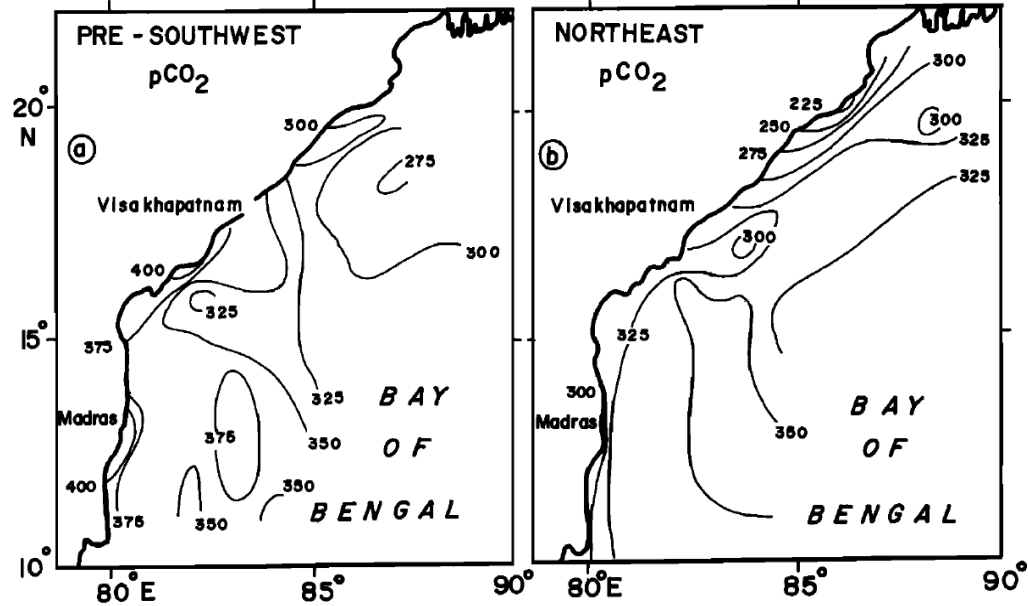
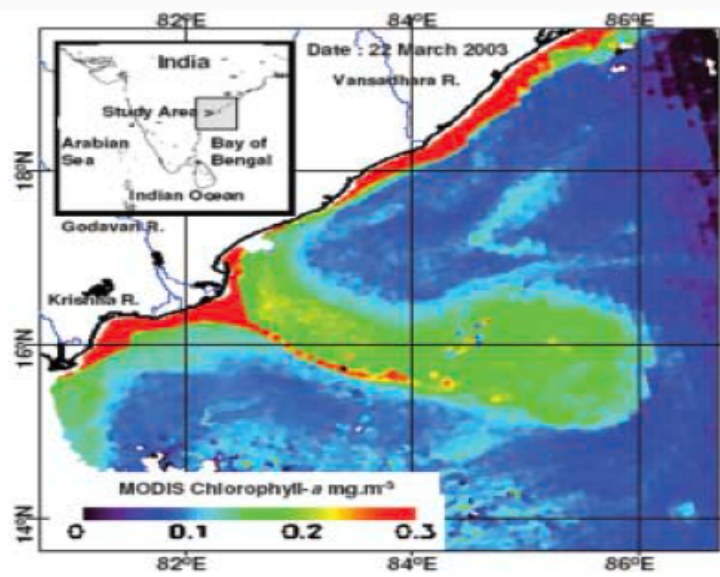


# Enhanced coastal CO2 fluxes...

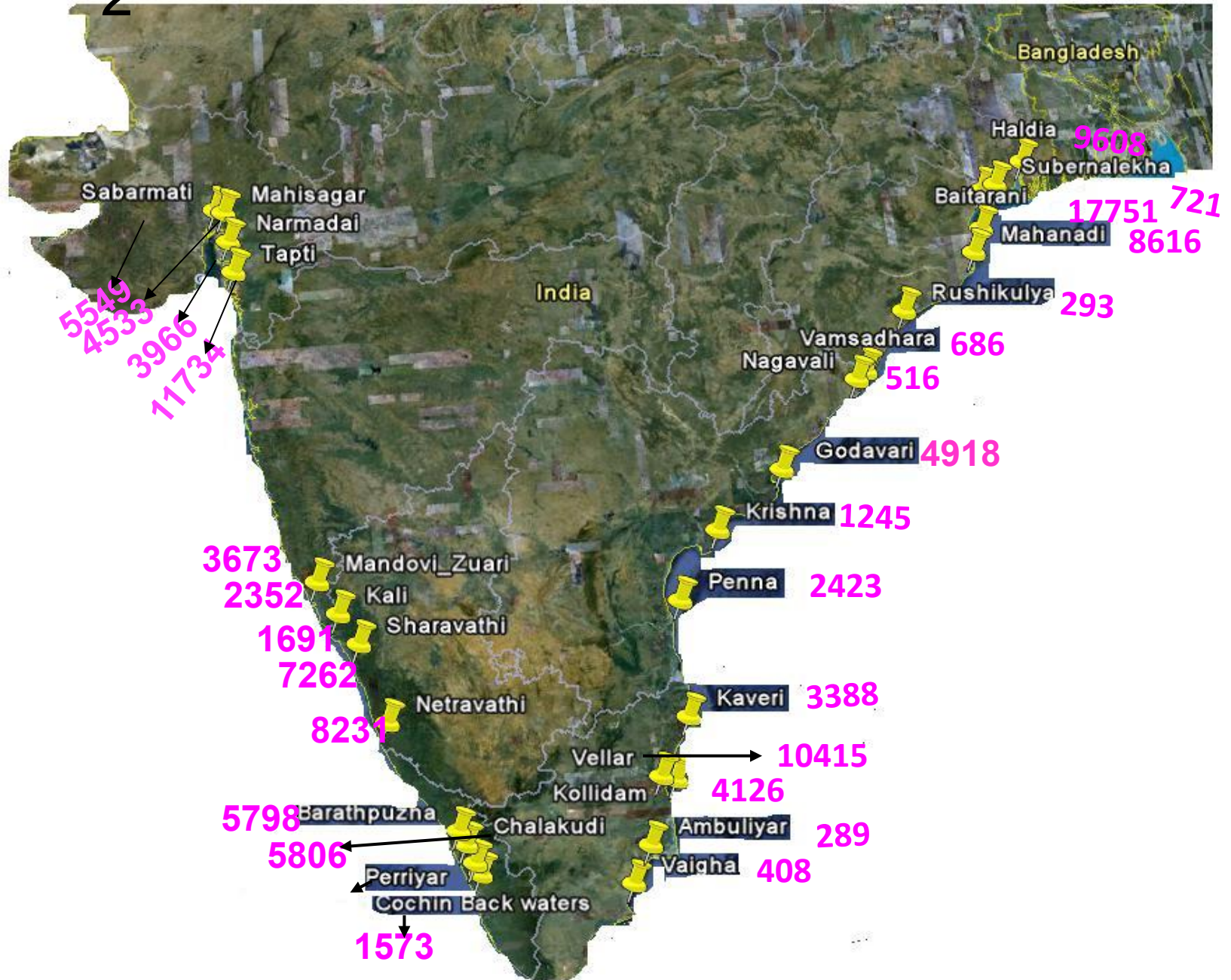


**Fluxes in mmolC m<sup>-2</sup> d<sup>-1</sup>**

Winter monsoon - -0.66  
 Intermonsoon - +0.06  
 Summer monsoon +7.8



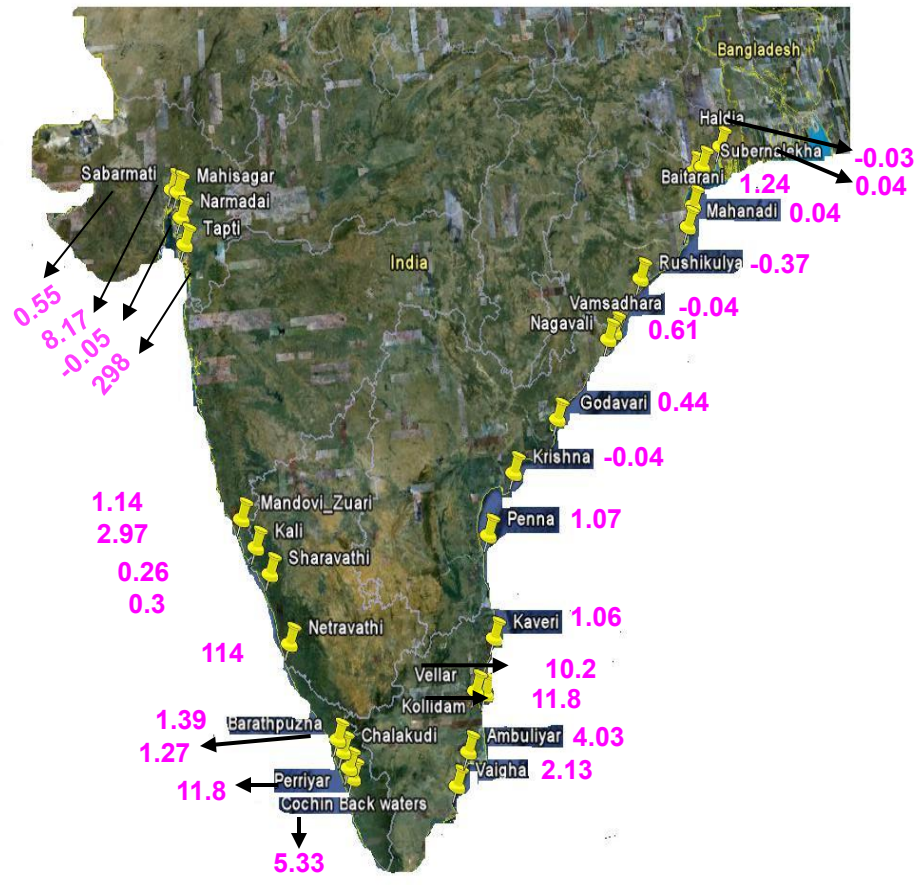
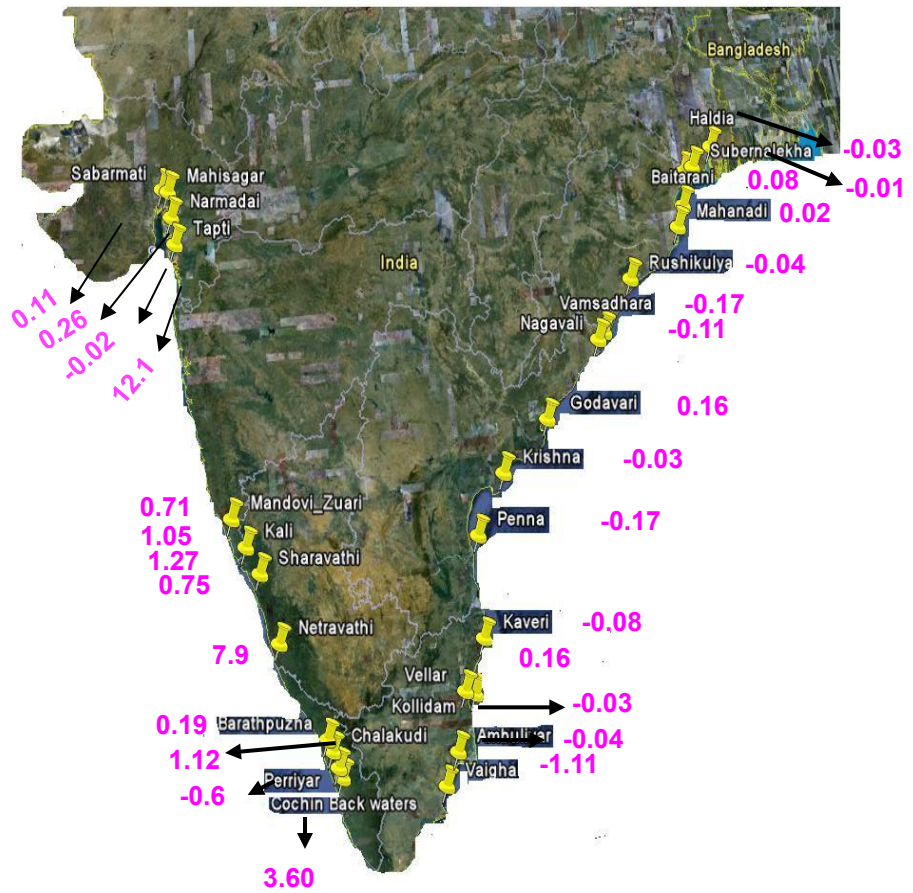
# pCO<sub>2</sub> in the Indian estuaries



# Fluxes of CH<sub>4</sub> and N<sub>2</sub>O from the Indian Estuaries

N<sub>2</sub>O-Flux( $\mu\text{mole m}^{-2} \text{ Day}^{-1}$ )

CH<sub>4</sub>-Flux( $\mu\text{mole m}^{-2} \text{ Day}^{-1}$ )





# Fluxes of trace gases

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Region	CO <sub>2</sub>	N <sub>2</sub> O	CH <sub>4</sub>	DMS
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## Estuaries (10<sup>7</sup> g y<sup>-1</sup>)

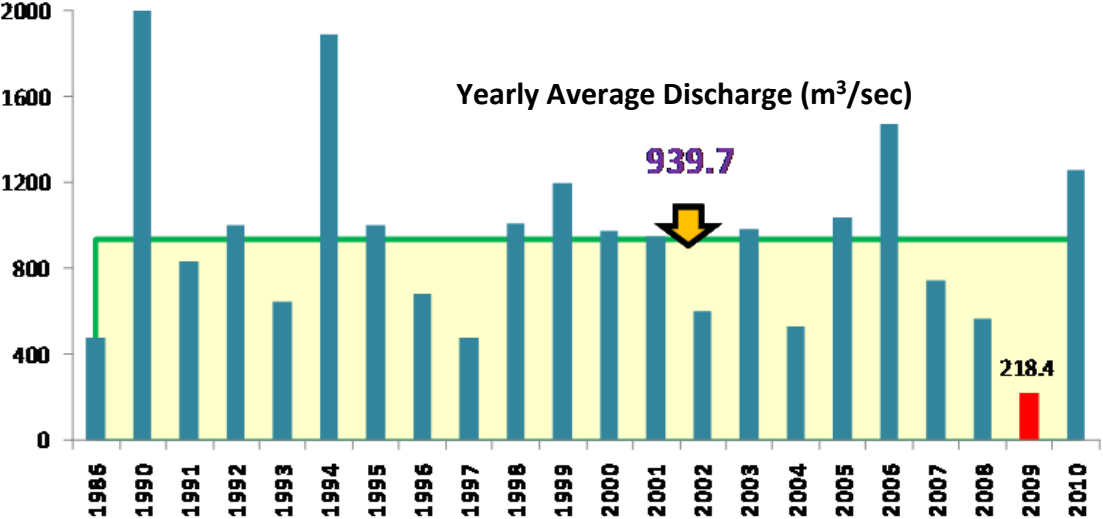
East coast	1300	0.82	0.20	1.80
West coast	2300	1.04	8.43	0.80
TOTAL	3600	1.86	8.63	2.60

## Coastal region (10<sup>12</sup> g y<sup>-1</sup>)

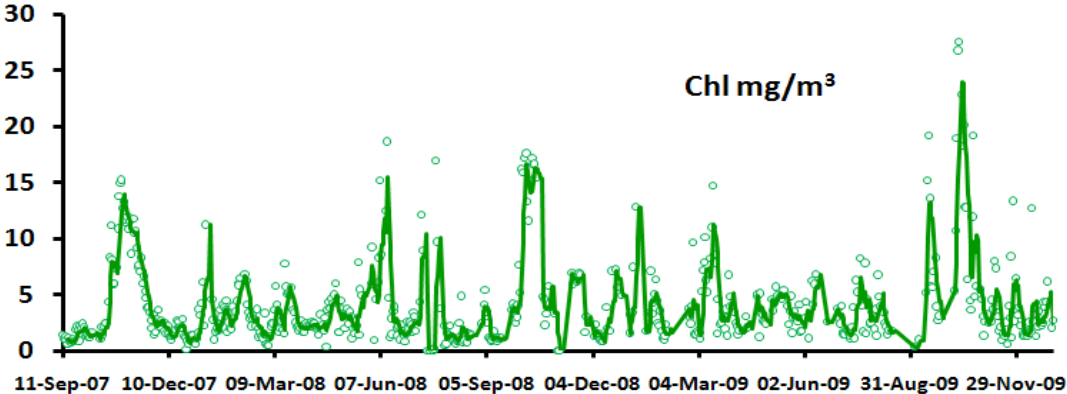
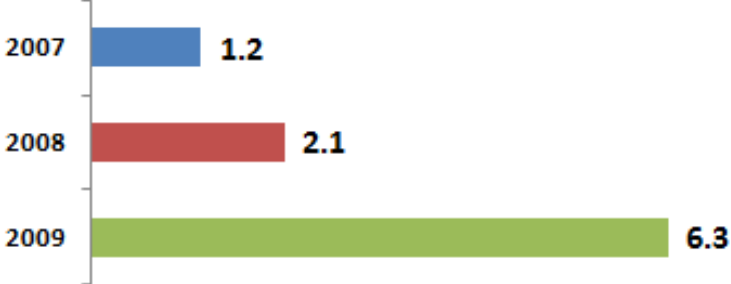
Bay of Bengal	1.30	-0.03	0.08	0.04
Arabian Sea	5.03	0.33	0.09	0.006
TOTAL	6.33	0.30	0.17	0.046

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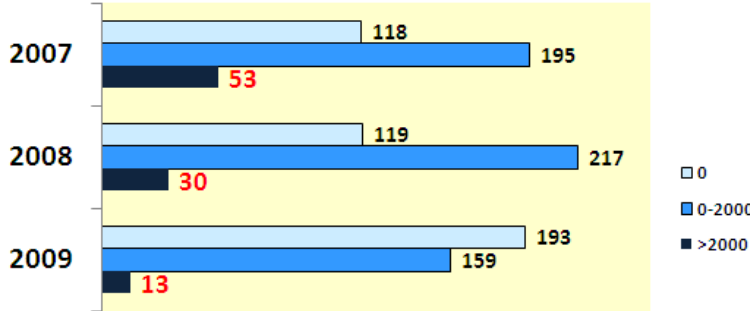
# Discharge versus phytoplankton blooms



Mean flushing time (No. of days) [Aug-Sep]



Categorical frequency distribution of discharge



# Discharge versus phytoplankton

Magnitude and pattern of discharge has significant impact on phytoplankton bloom. Modification of this pattern may lead to change so far healthy Indian estuaries into eutrophicated.

# Impact of Fertilizer usage on Phytoplankton diversity in the Indian estuaries



# Estuarine systems under threat ...

Fertilizer washings – *biological productivity*  
*eutrophication & oxygen deficiency*



Riverine Nr export to the coastal zone (Tg N yr<sup>-1</sup>) in the past (1860 Left bar), present (1990 Center bar) and future (2050 Right bar). Dry and inland watershed regions that do not transmit to coastal areas are shown in gray.



# Variable nutrients composition

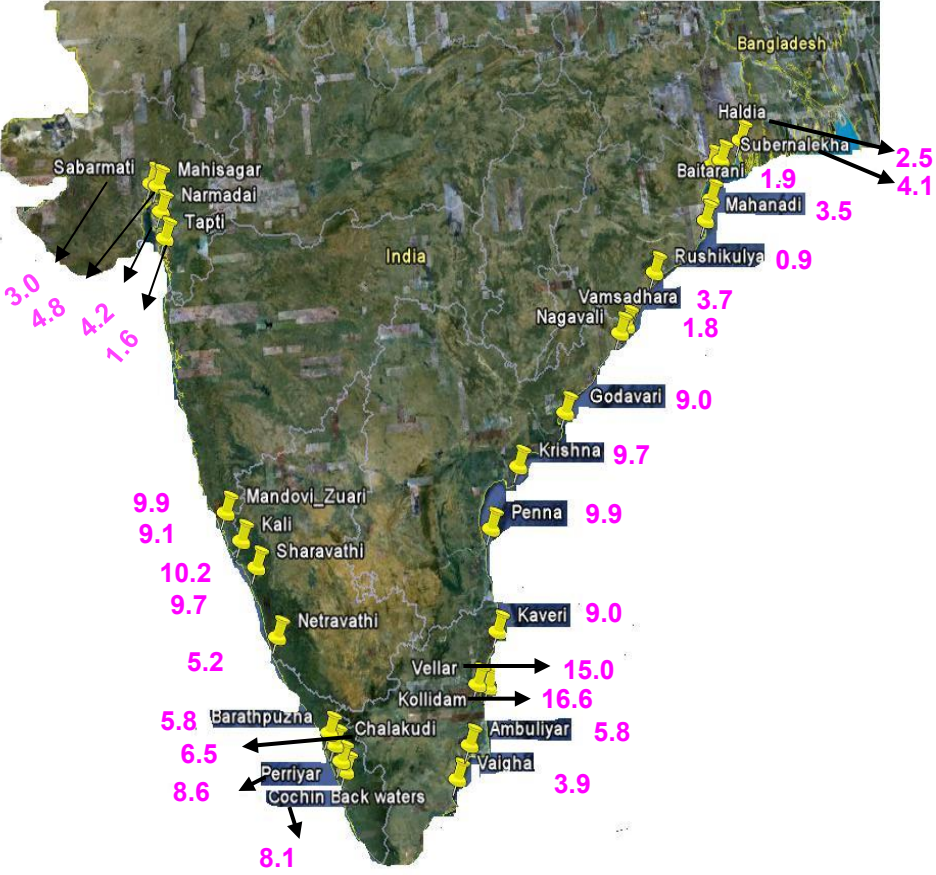
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<b>Parameter</b>	<b>N. India</b>	<b>S. India</b>
Nitrate	26.2±8	4.3±1
Ammonium	3.8±1	2.1±1
Silicate	32.8±8	157±48
DIN:DIP	8.3±2	1.9±2
Chl-a	2.1±1	4.3±1

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# Nitrogen isotopic ratios in the Indian estuaries

$\delta^{15}\text{N}_{\text{PN}}$  (per mil)



Mean

2.9

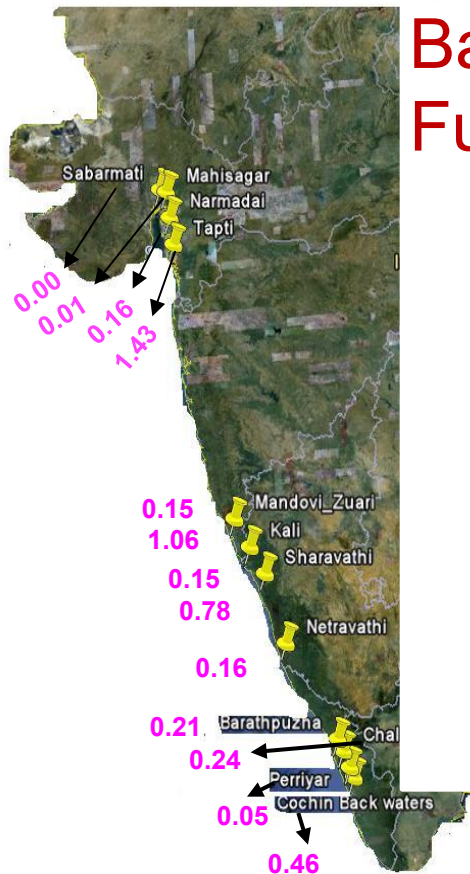
8.8



# Variability in pigments composition in Indian estuaries

Fucoxanthin (mg/L)

b-Carotinoid (mg/L)



Bacillariophy.  
Fucoxanthin

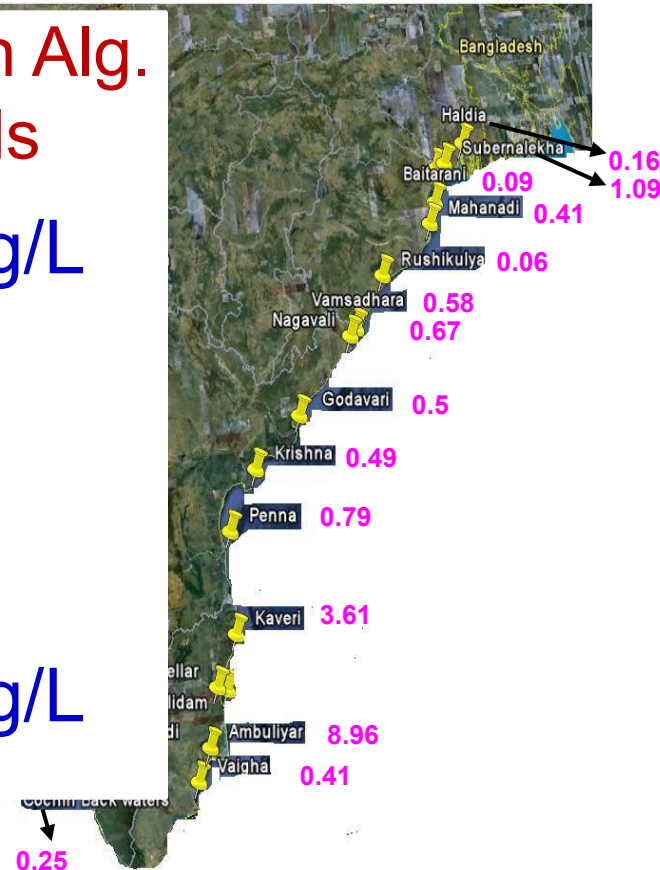
0.75

Blue-green Alg.  
b-carotinoids

0.48 mg/L

0.28

0.00

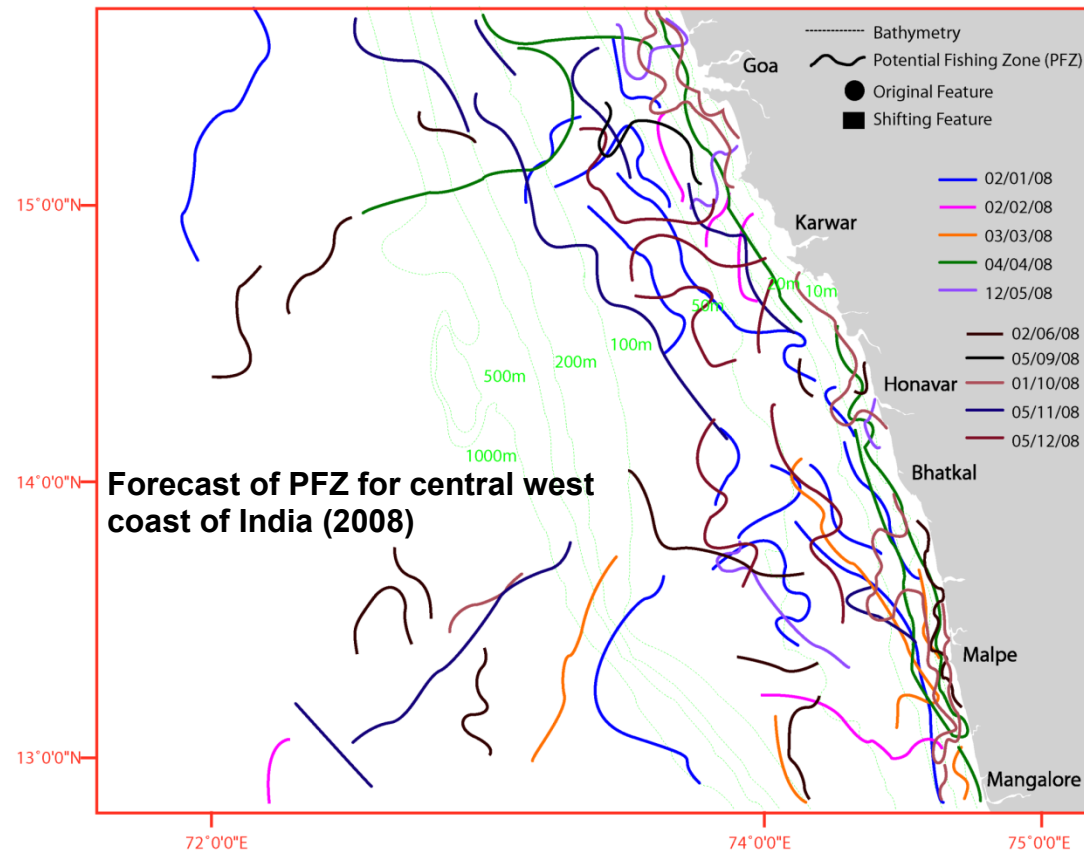
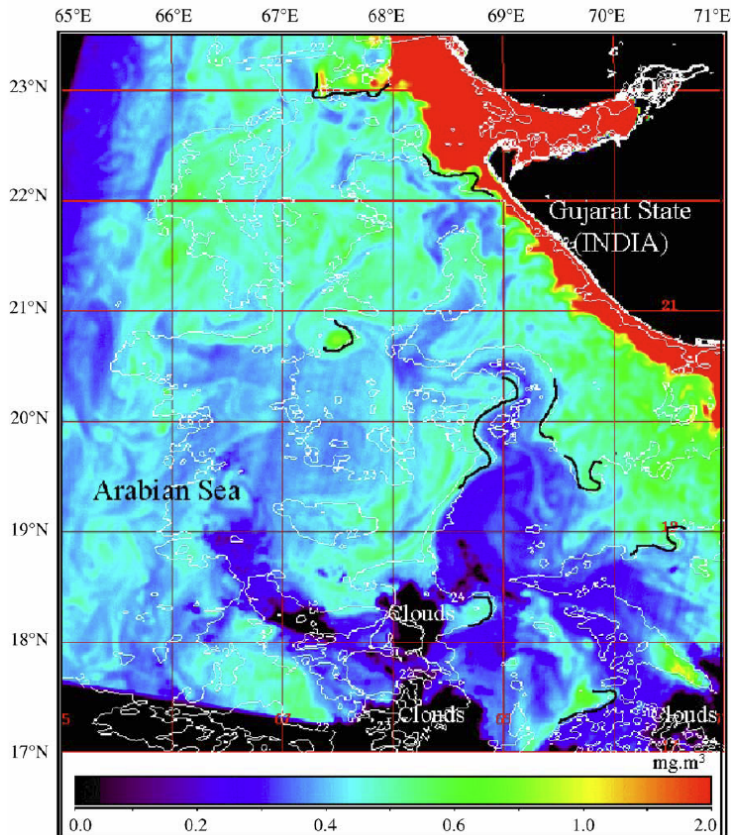


# **XII Five Year Plan (2012-2017)**

**Ocean Science for Forecasting  
Indian Marine Living Resource  
Potential (OCEAN FINDER)**



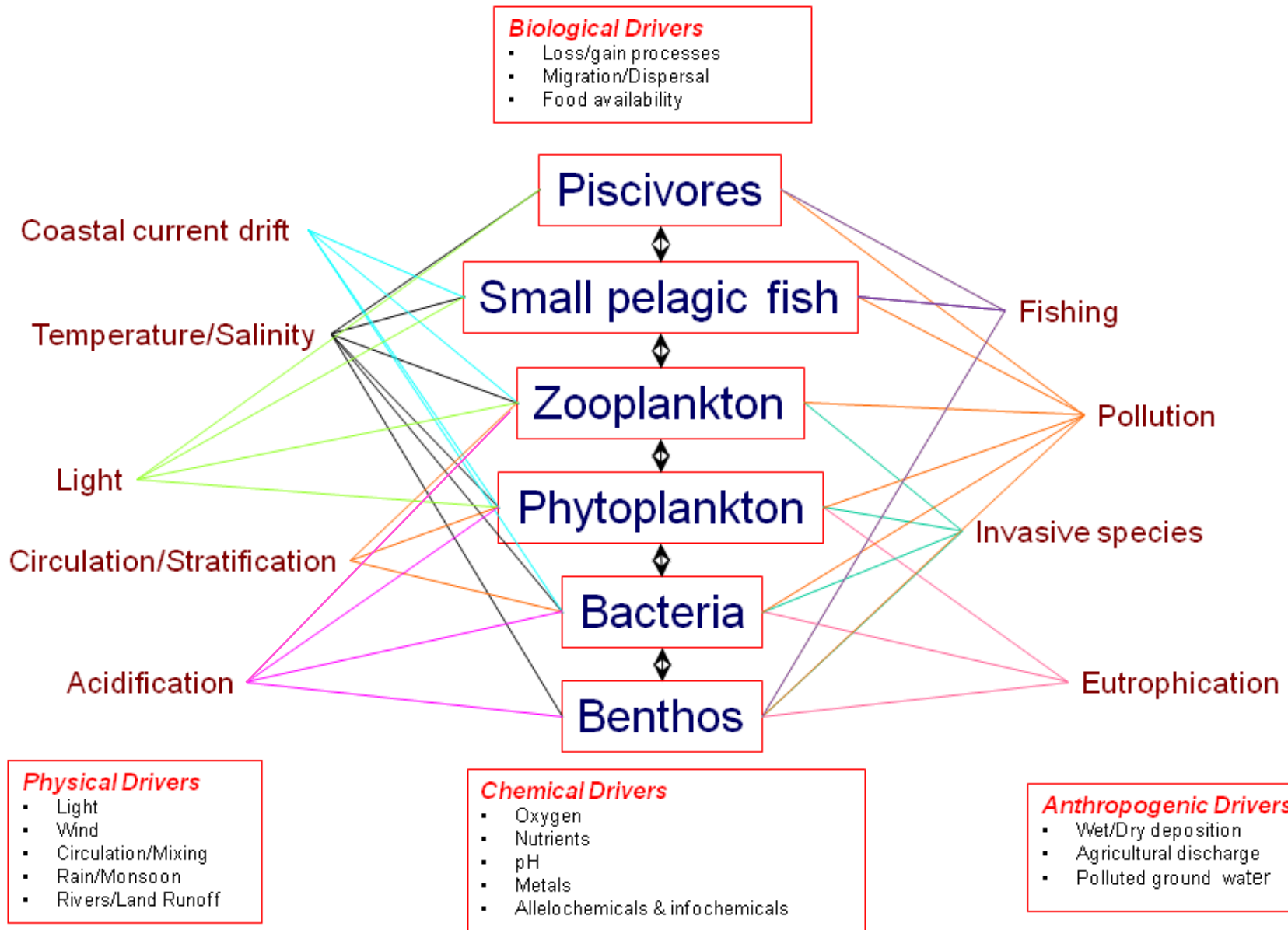
# Forecasting Potential Fishery Zones (PFZ) : connection between sea surface temperature, chlorophyll & fish catch



What is the basis for this connection?

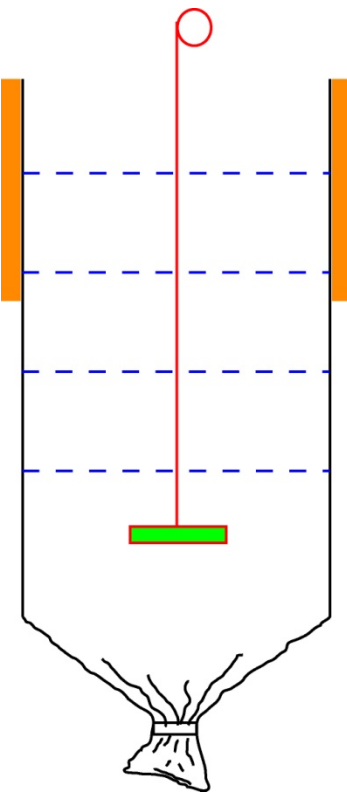
From INCOIS

# Schematic of an ecosystem model

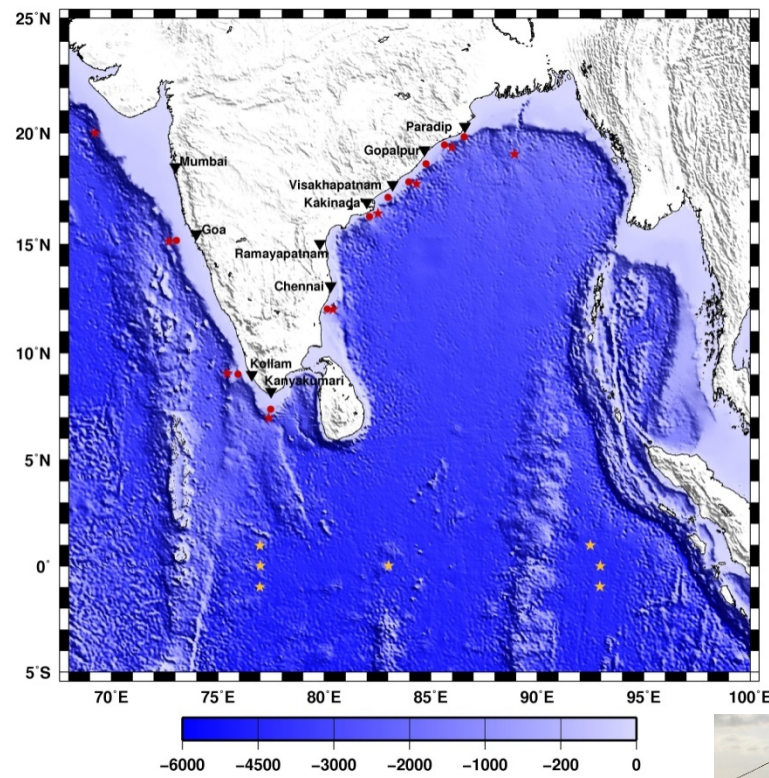




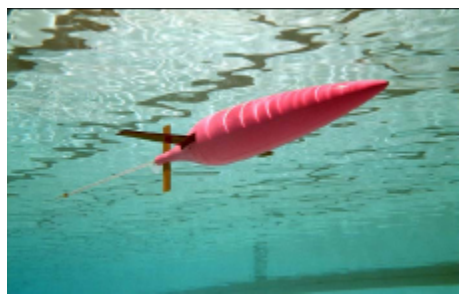
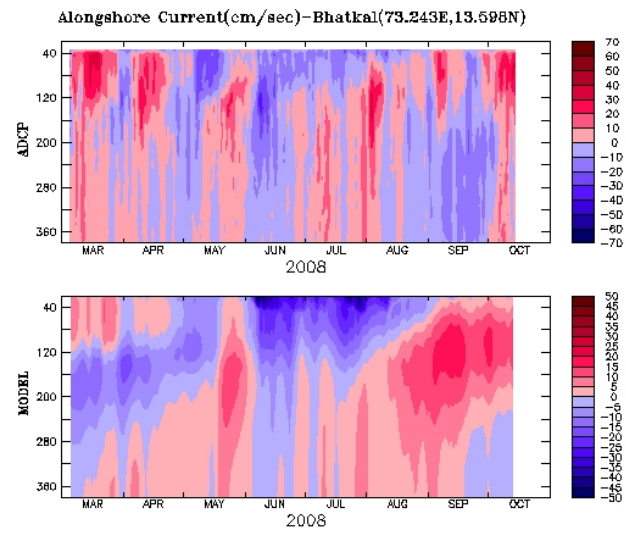
# Mesocosm (Expedition to Experiment)



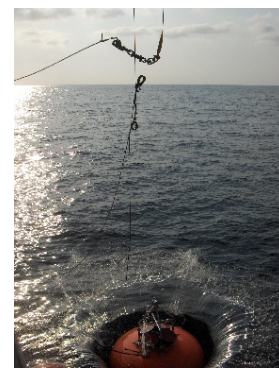
# Observations



# Modelling



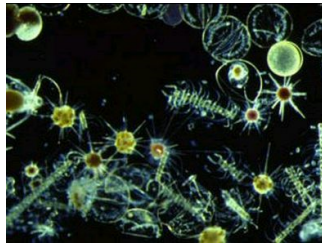
Glider



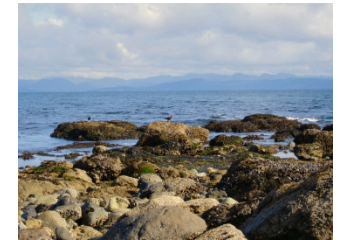
Acoustic Doppler Current Profiler

# Forecasting living resources

## Organism



## Habitat

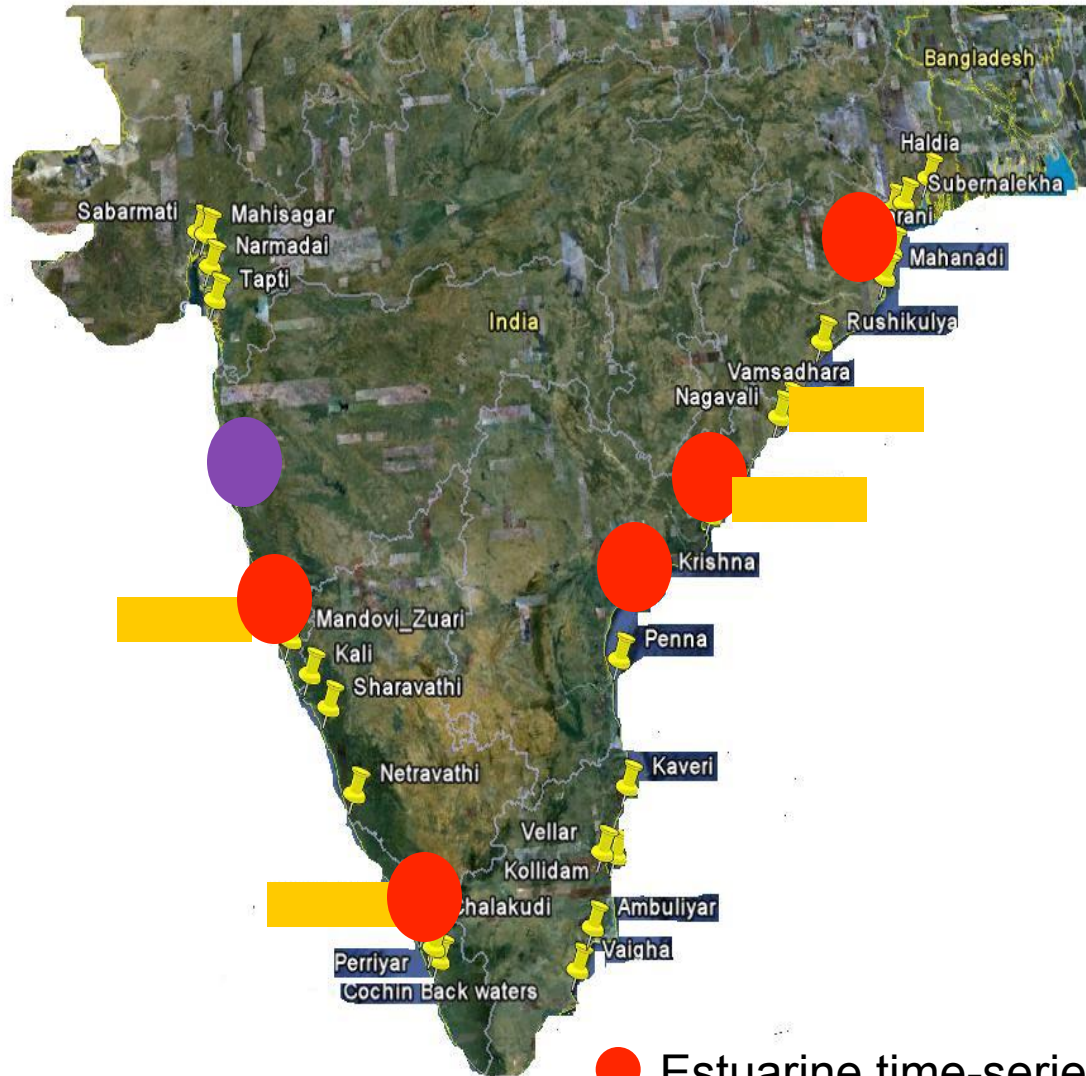


## Benthic/Pelagic

- ✓ Expedition to experiment
- ✓ Spatial & temporal observations (to supplement information for ecosystem analyses & forecasting)



# Time-series locations



## Coastal time-series

ADCP moorings

Sediment traps

Profiling buoys

Gliders

Ship-based observations

Mesocosm experiments

● Estuarine time-series

■ Coastal time-series

**Thanks!**