Coasts and Coastal People Scenarios of Change and Responses

LOICZ II Inaugural Open Science Meeting

27-29 June 2005

Fine Sediment Retention in Estuaries: role of the different mechanisms in Amazon Estuary

(oral presentation, day 2 session 20)

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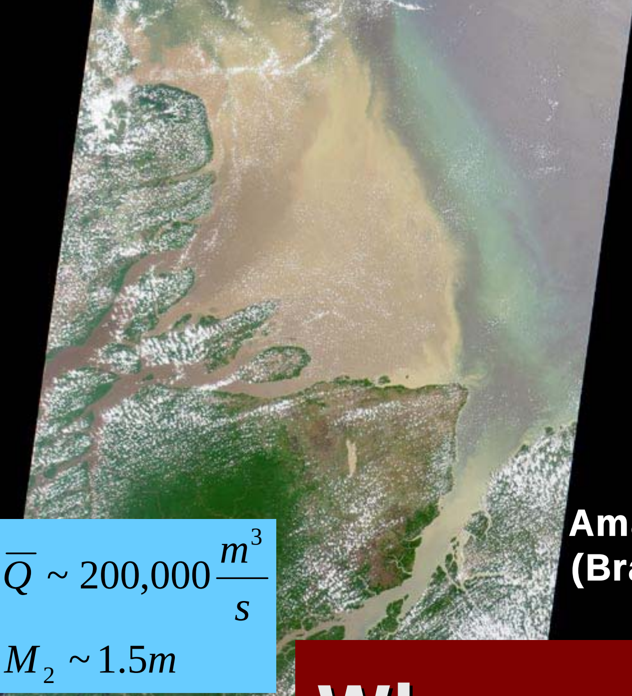
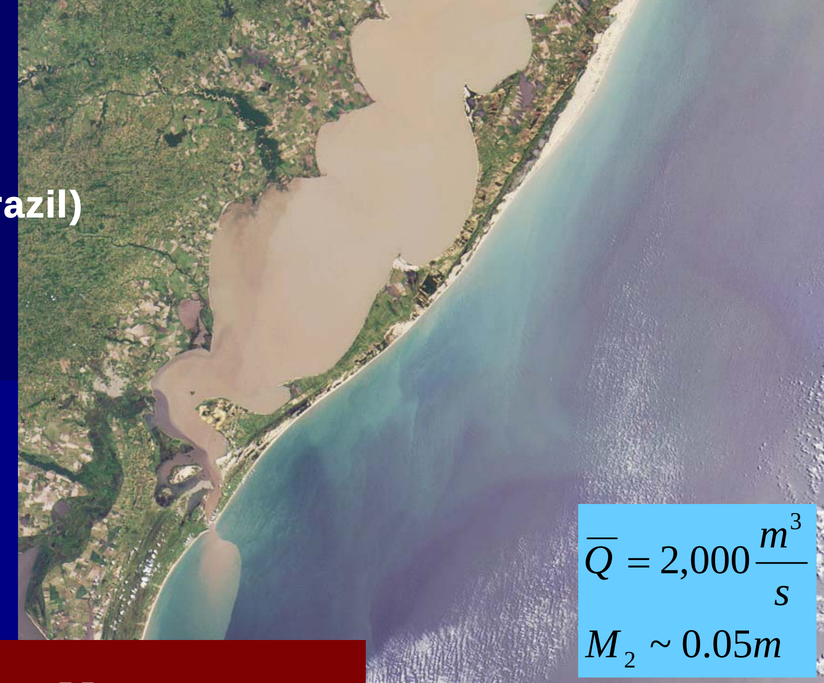
Where are the fine sediments trapped in larger quantities?



Amazon River (Brazil)

$\overline{Q} \sim 200{,}000 \dfrac{m^3}{s}$

$M_2 \sim 1.5m$



Dos Patos Lagoon (Brazil)

$\overline{Q} = 2{,}000 \dfrac{m^3}{s}$

$M_2 \sim 0.05m$

Paraiba do Sul River (Brazil)

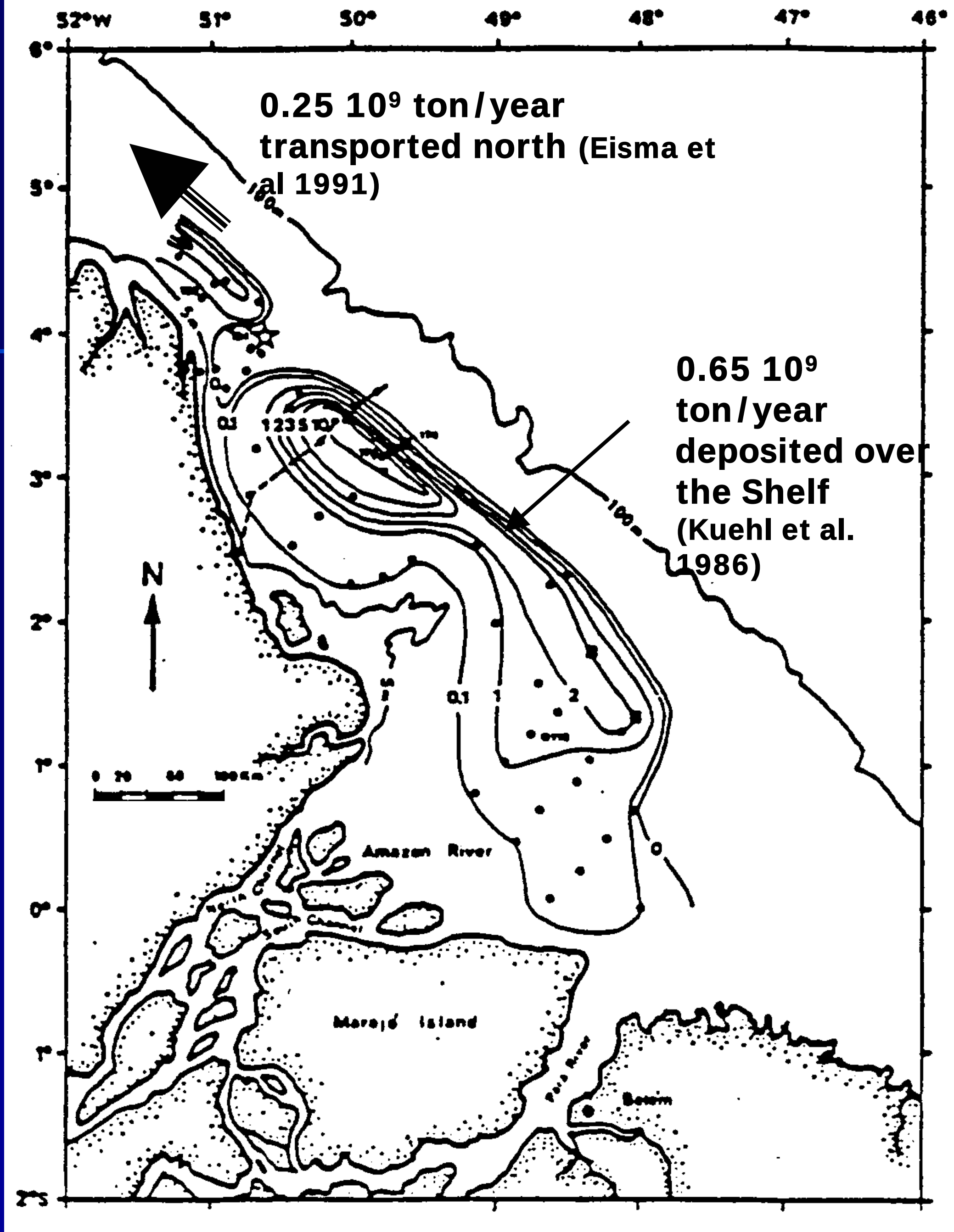
$\overline{Q} = 700 \dfrac{m^3}{s}$

$M_2 = 0.4m$

Plate River (Argentine-Uruguay)

$\overline{Q} = 20{,}000 \dfrac{m^3}{s}$

$M_2 \sim 0.1m$



A possible balance

(Meade, 1994)

1.20 10^9 ton/year

(passing Obidos, Meade 1982)

- 0.65 10^9 ton/year

(deposited over the Shelf)

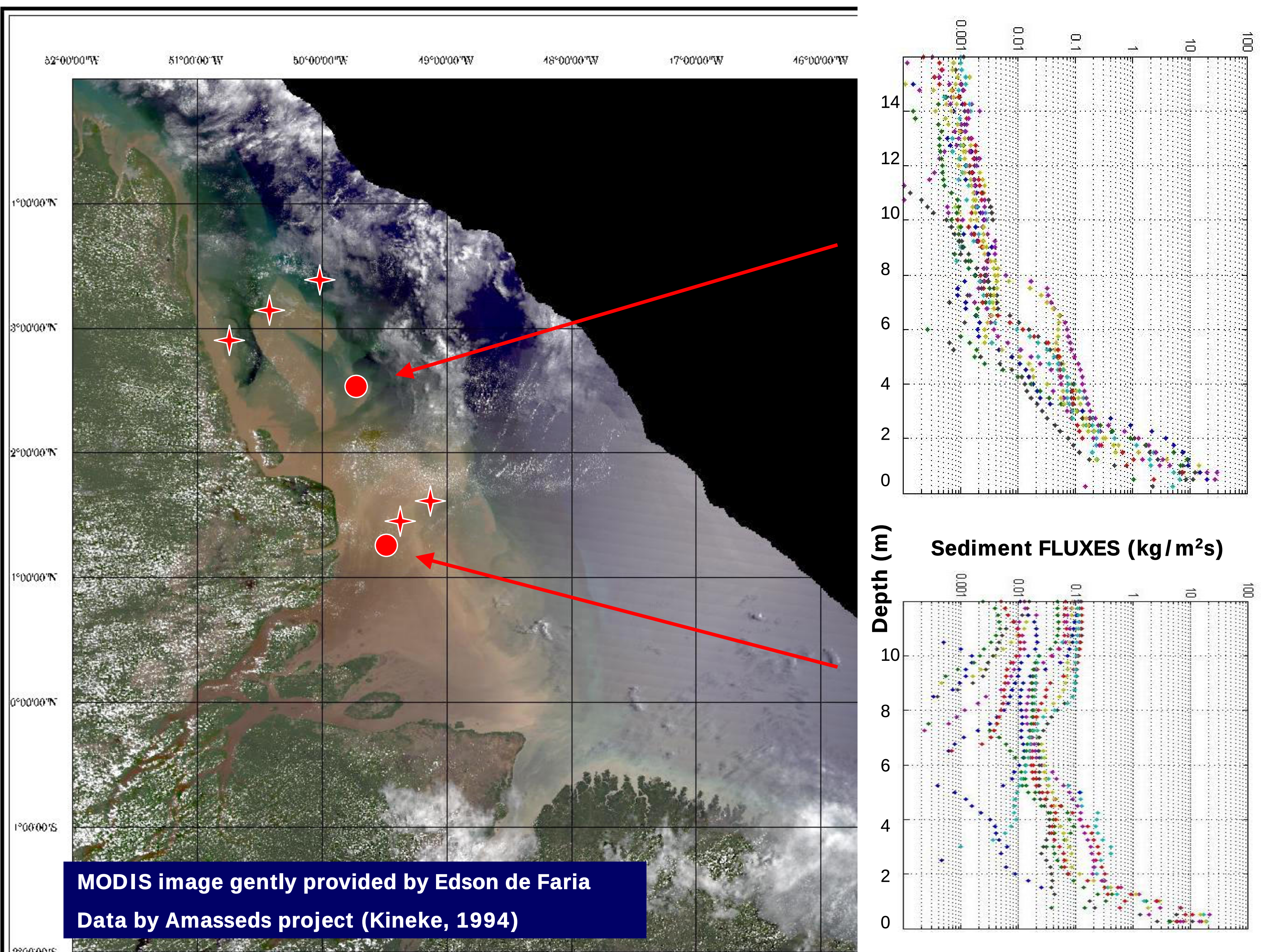
- 0.25 10^9 ton/year

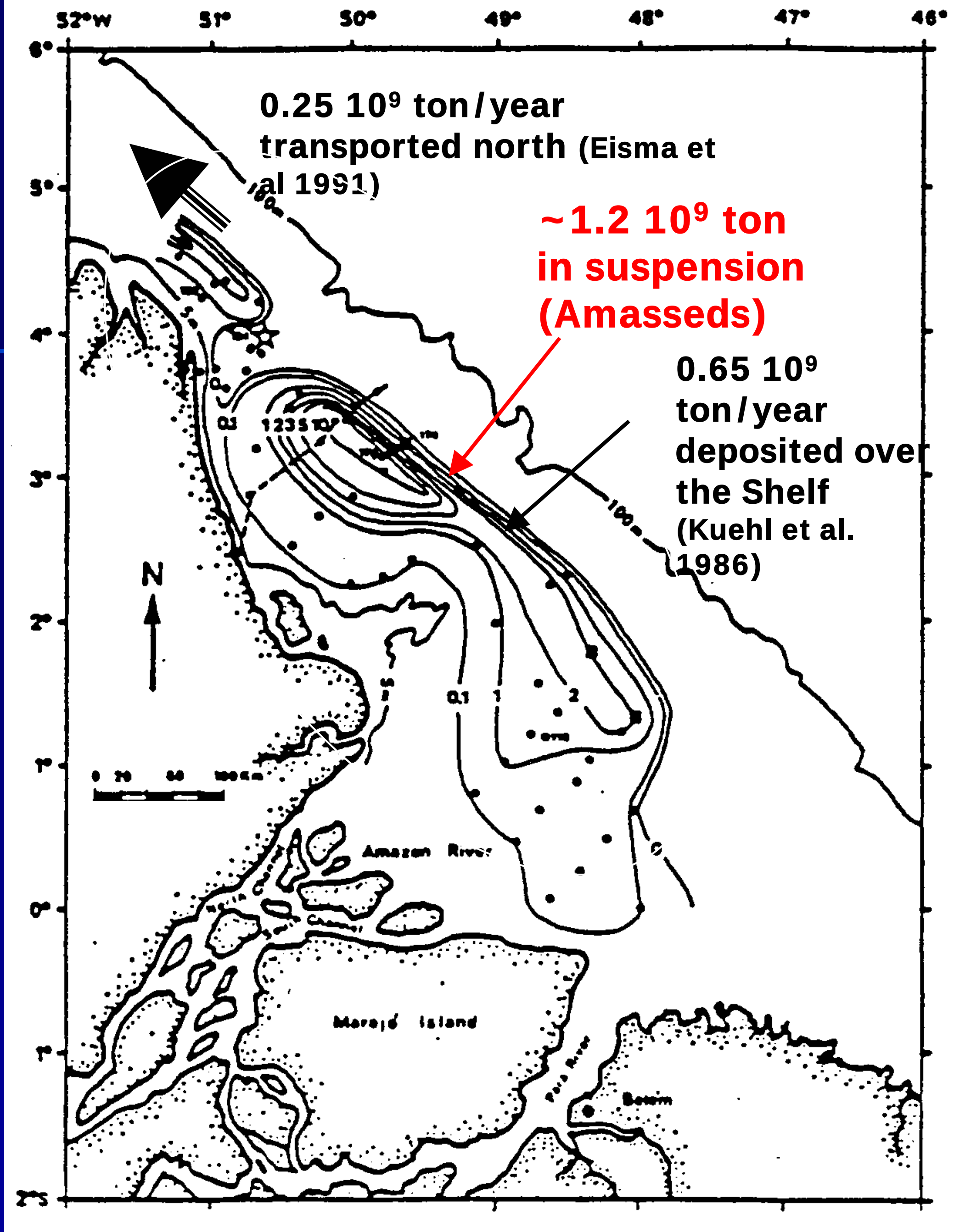
(moving north)

Where are the remaining

= 0.30 10^9 ton/year ?

Sedimentation rate determined using ^{210}Pb (KUEHL et al., 1986)


52°00'00"W
51°00'00"W
50°00'00"W
49°00'00"W
48°00'00"W
47°00'00"W
46°00'00"W
Sediment FLUXES (kg/m²s)
Depth (m)
0.001
0.01
0.1
1
10
100
0
2
4
6
8
10
12
14
MODIS image gently provided by Edson de Faria
Data by Amasseds project (Kineke, 1994)

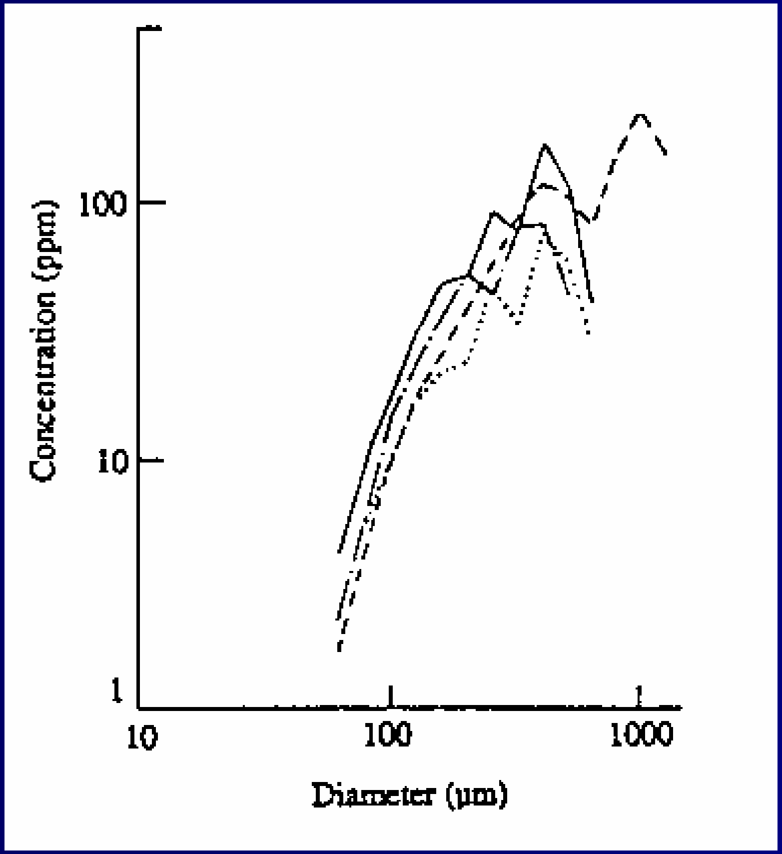


- Residence time of about one year, we cannot ‘see’ the river stages over the Shelf
- Retention of sediments occurs mostly where the turbidity maximum is
- We need some mechanism to keep this sediments in suspension: trapping mechanisms

Which mechanisms ?

- Sediment flocculation
- Recirculation zones
- Tidal asymmetry
- Salinity driven circulation
- Wind wave drift

(1) Sediment Flocculation



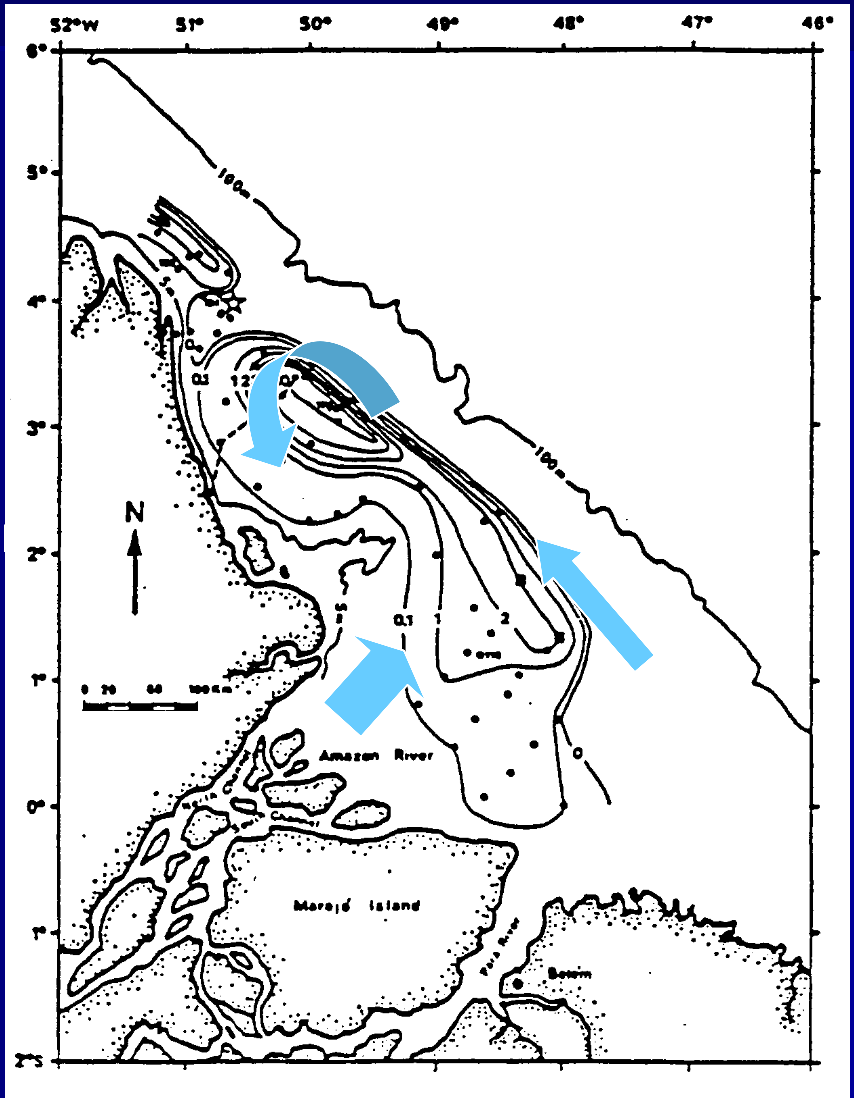
Amazon data:

Floc sizes measured at 35m depth, over the Shelf (KRANCK and MILLIGAN 1992)

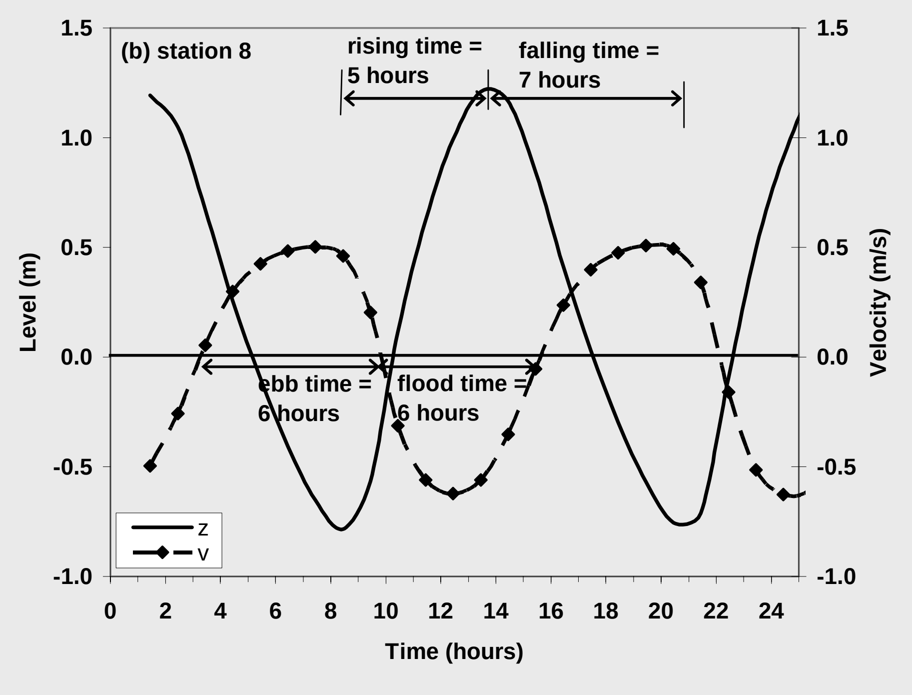
single particles d_{50} = 4µm

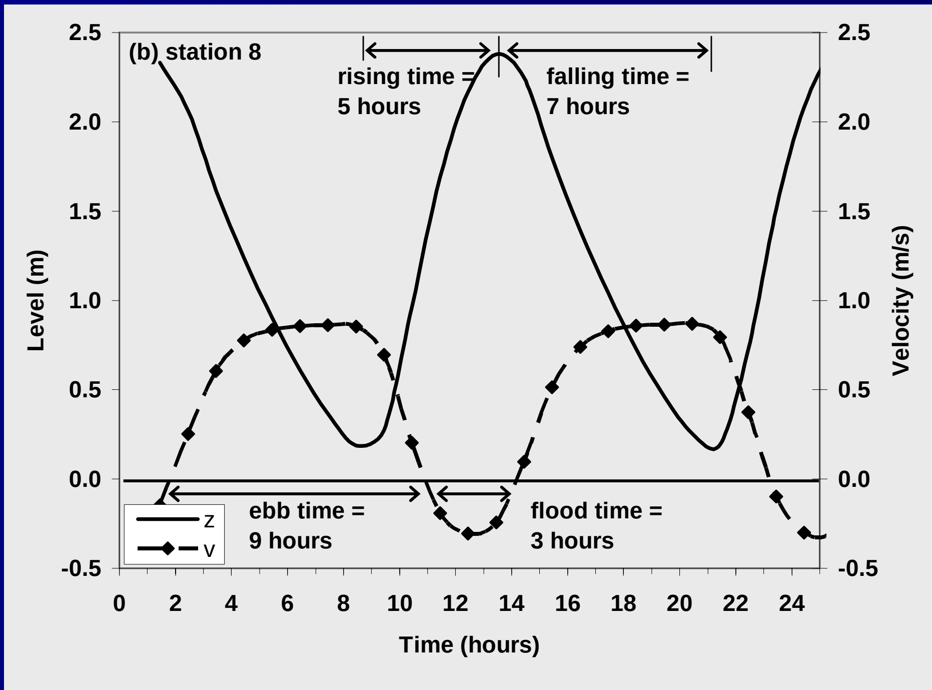
FOCCULATION IS STRONGLY LINKED TO FLOW SHEAR !

(2) Morphology induced recirculation



(3) Vertical (water level) and horizontal (mean velocity) asymmetry

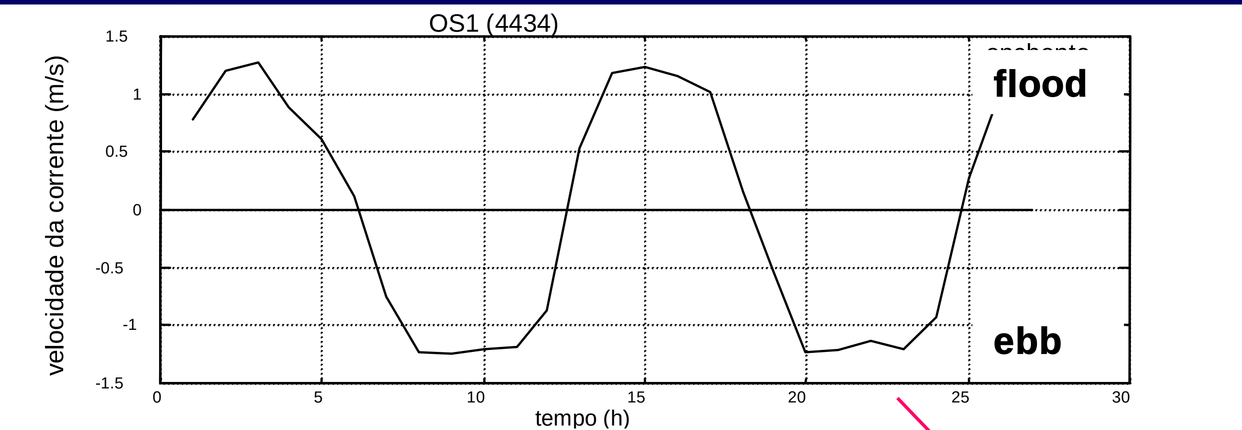




Q=0

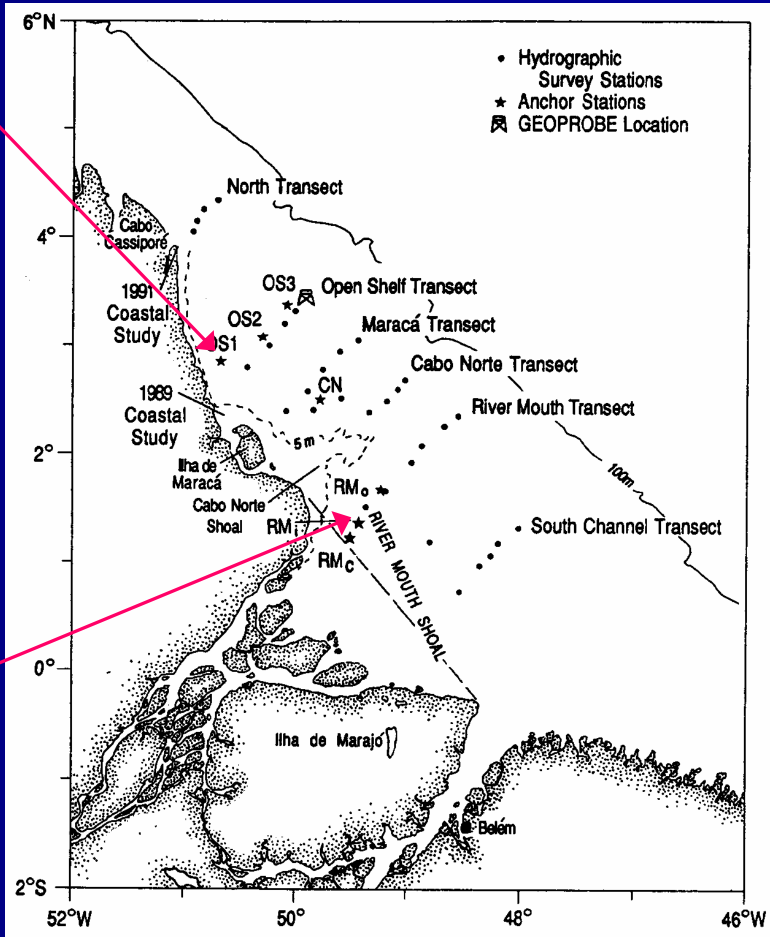
Q=180,000 m3/s

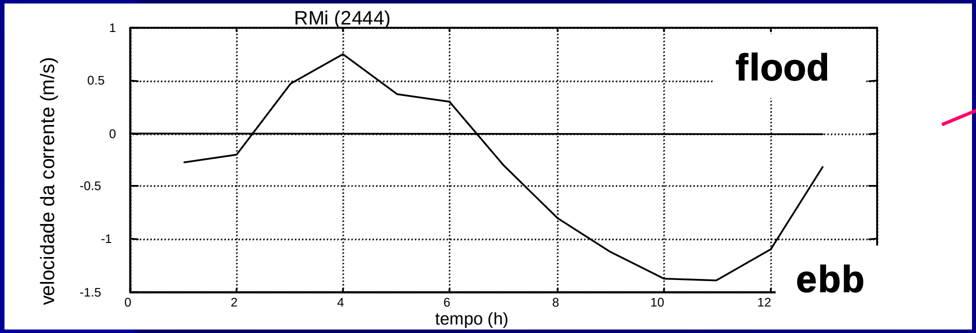
(numerical simulations – water level and mean velocities)



(3) Horizontal tidal asymmetry

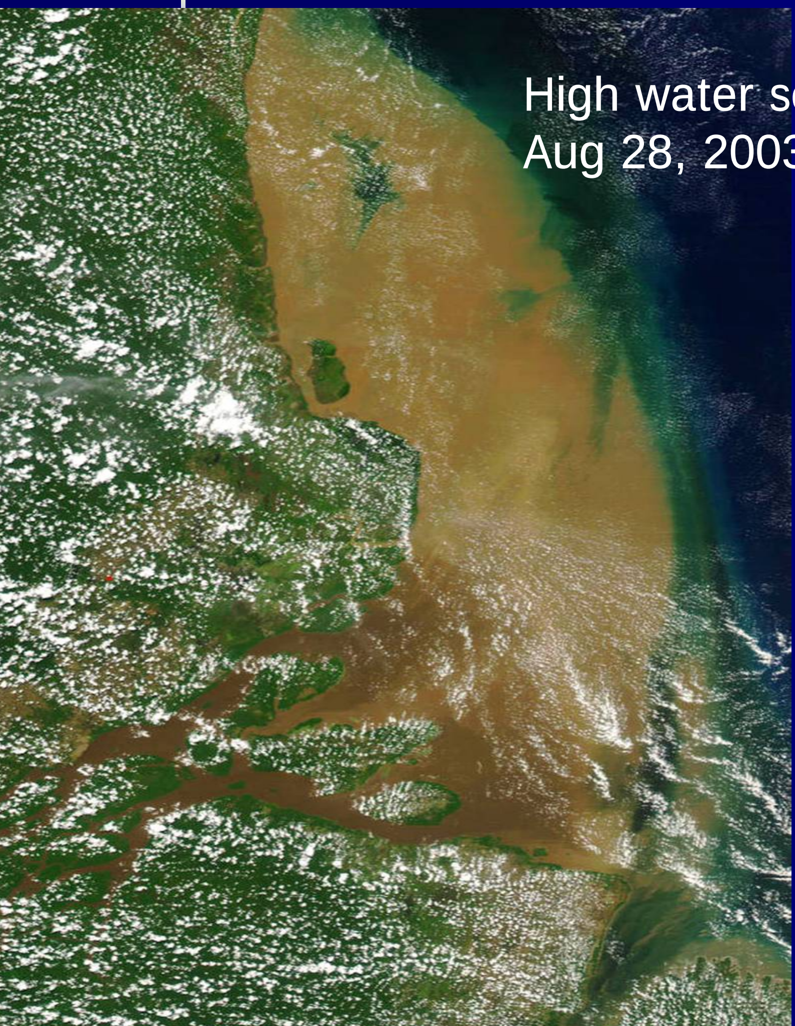
(data - mean velocities)

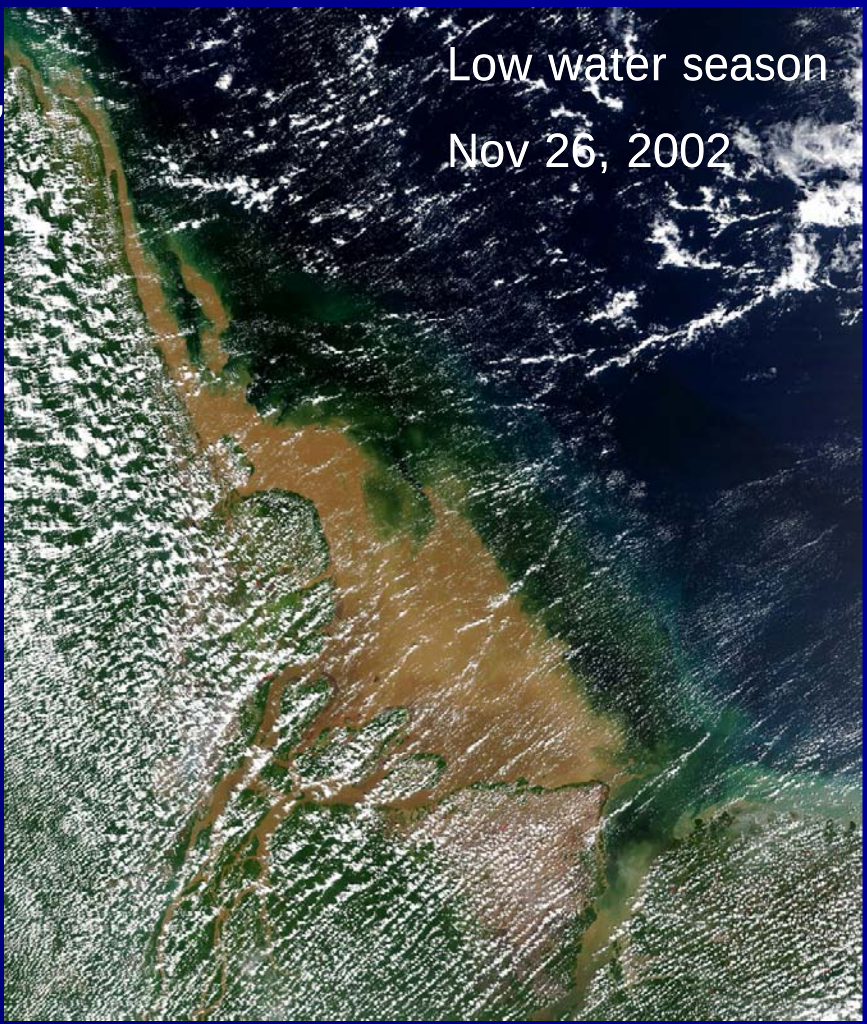




(4) Density driven circulation

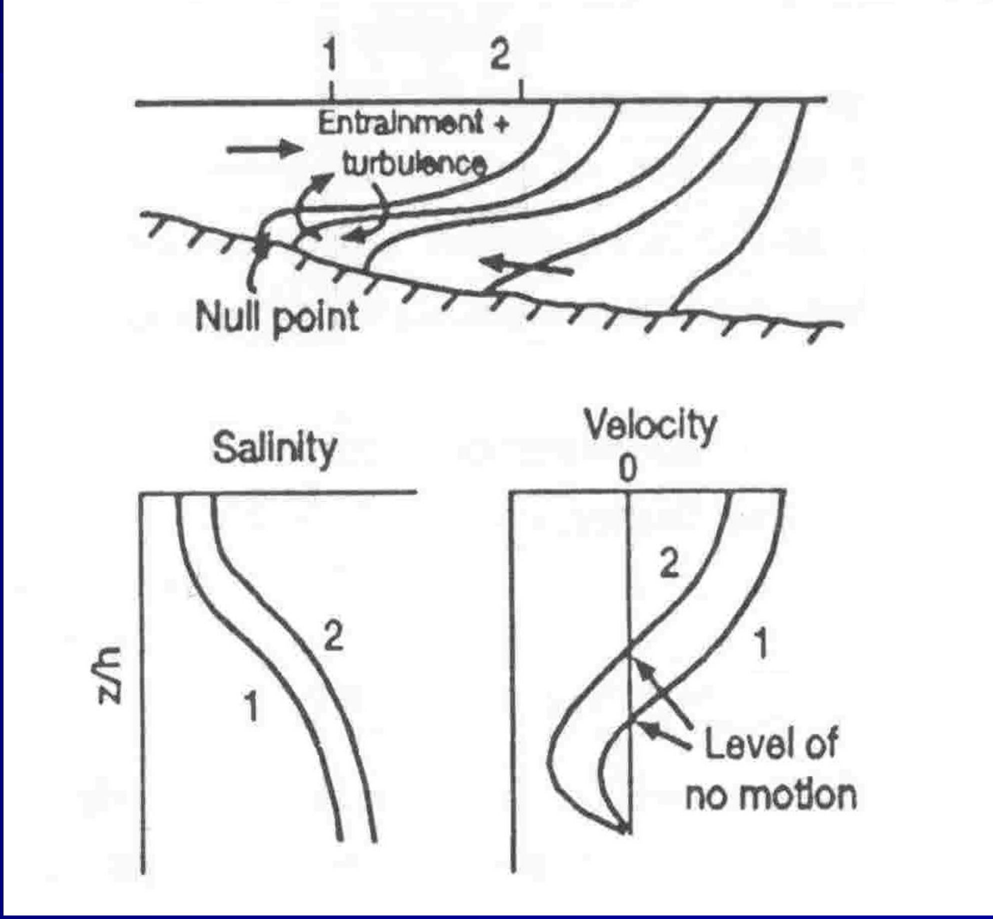
- Where salinity front is ?
- How gravitational circulation provides mechanisms for sediment trapping?





(4) Density driven circulation

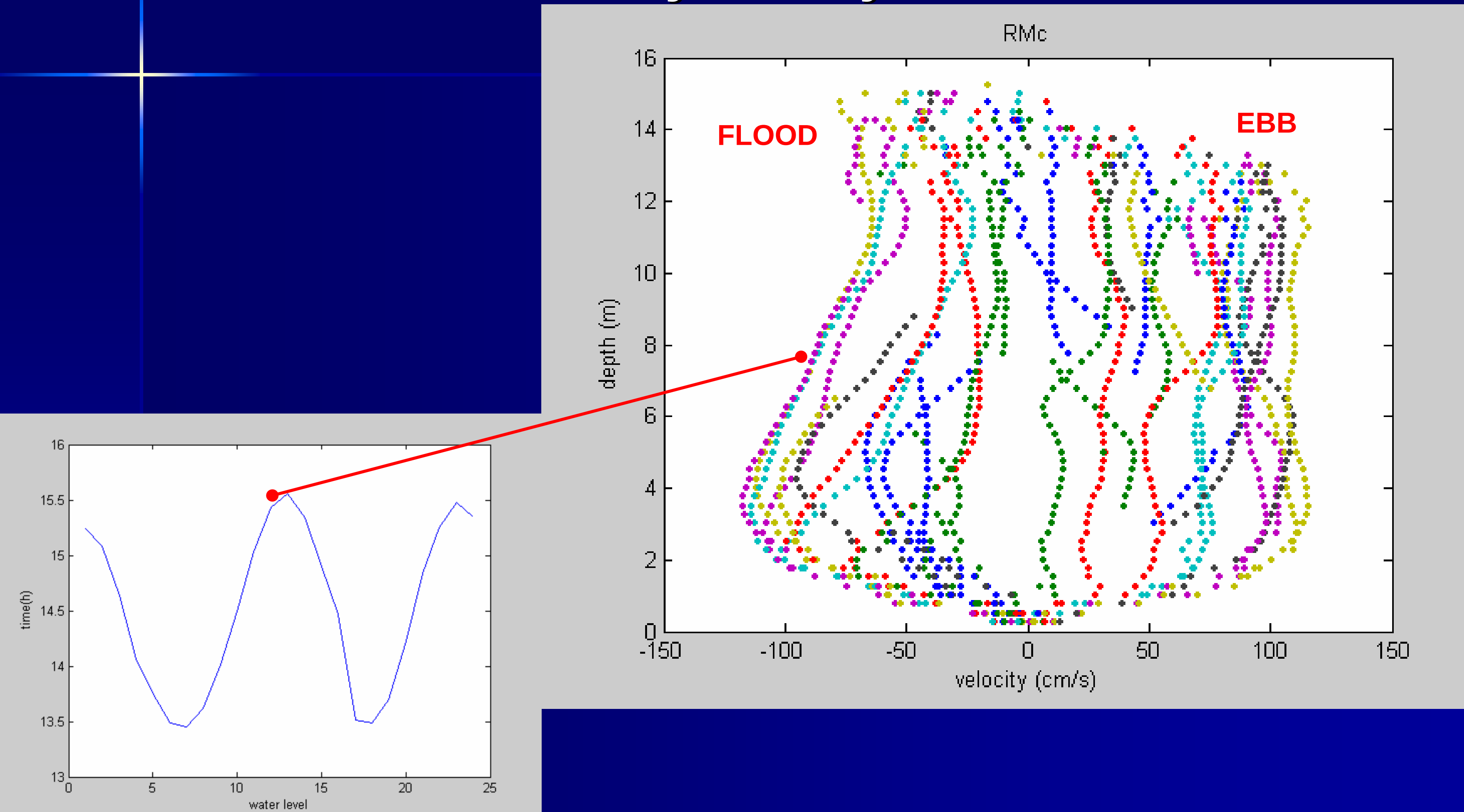
- **Residual gravitational circulation (advection)**



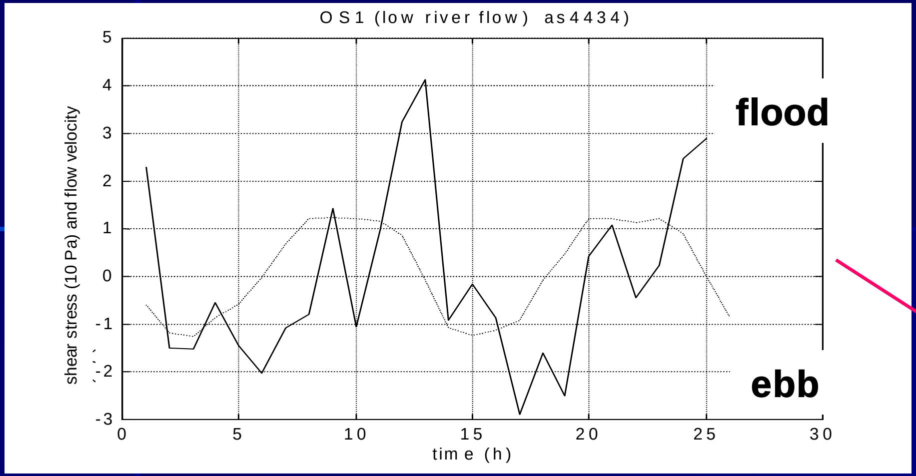
Tidally averaged velocity and salinity

(4) Density driven circulation

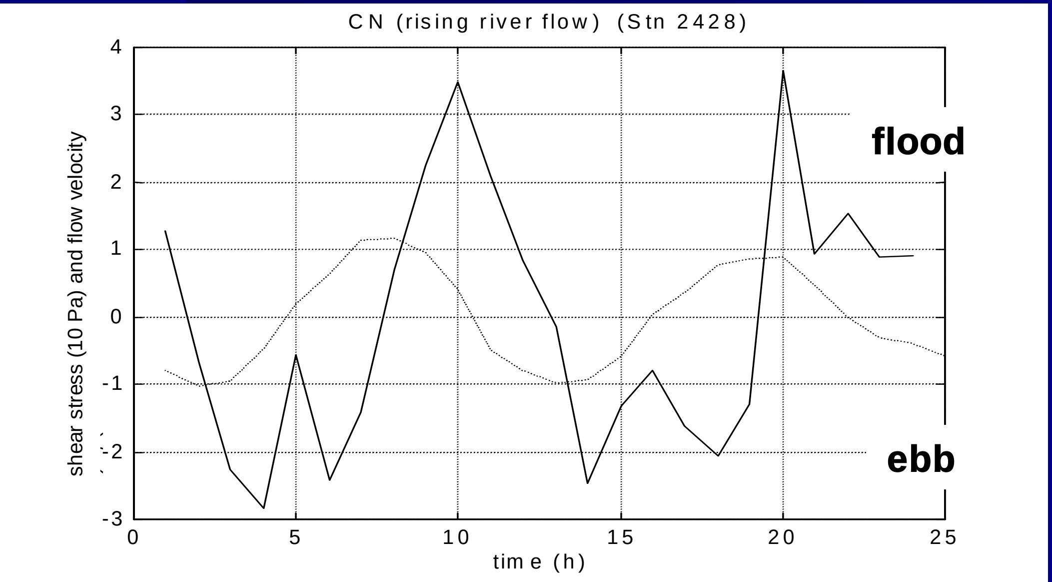
- **Bottom shear stress asymmetry**

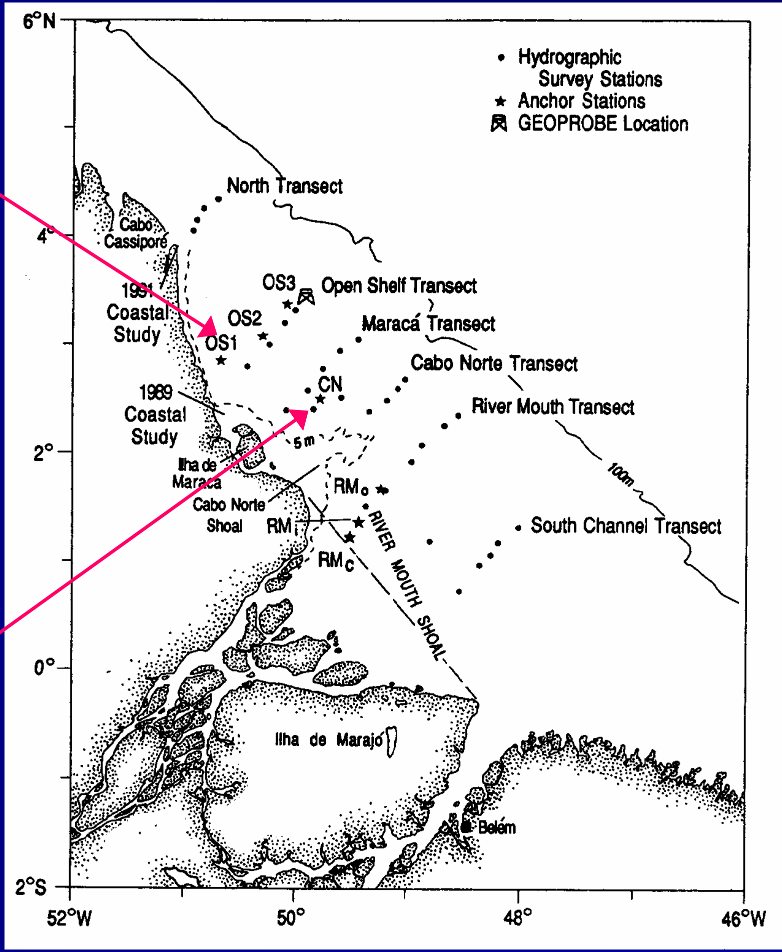


(4) Density driven circulation



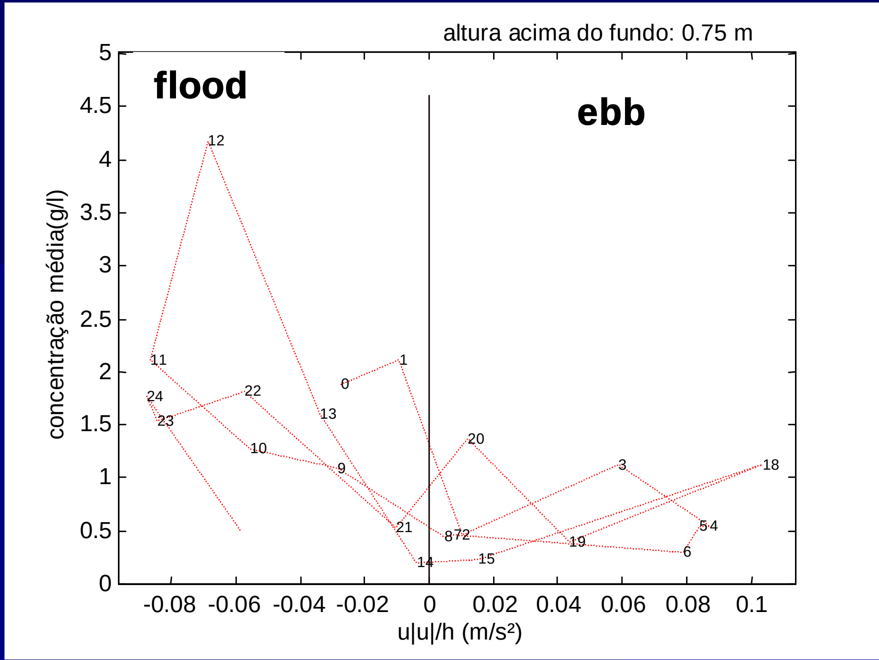
Shear stress asymmetry (related to salt stratification structure)

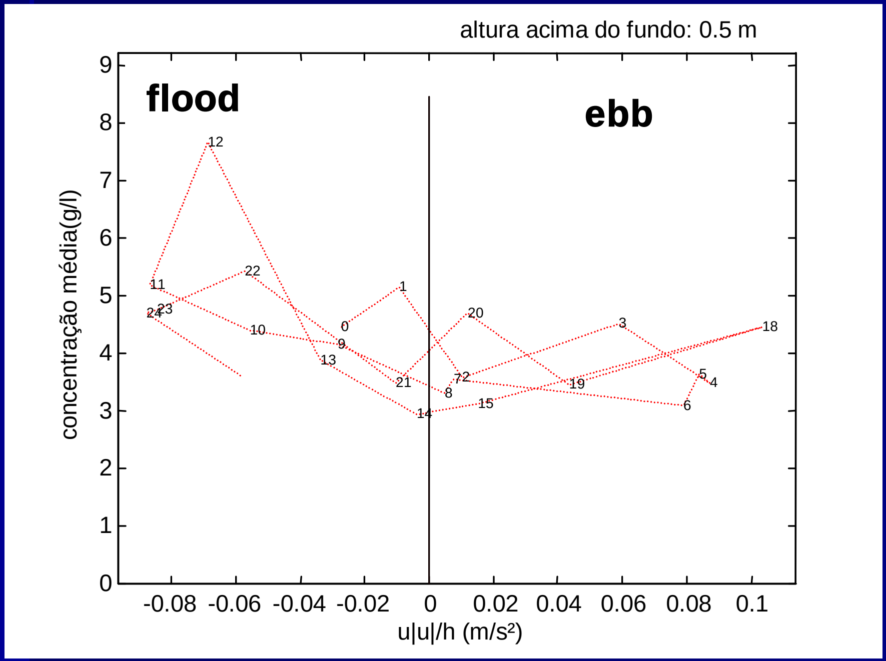


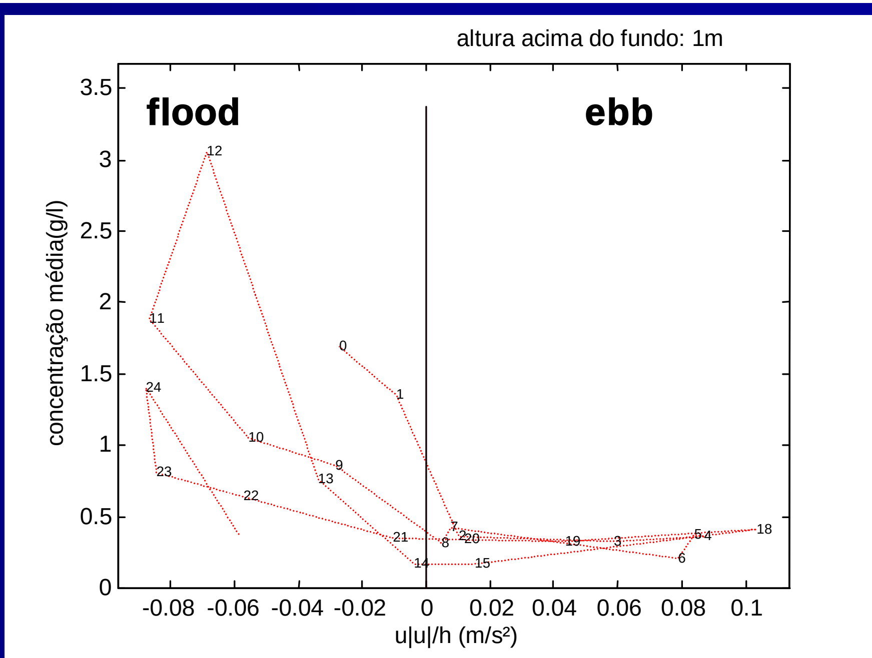


(4) Density driven circulation

- **Mixing asymmetry (related to transport capacity)**







Changes in SSC with u|u|/h, at 0.5, 0.75 and 1m from bed (Station RMc, 4413).

Concluding remarks (1)

How the system would respond to changes in the basin in term of sediment retention?

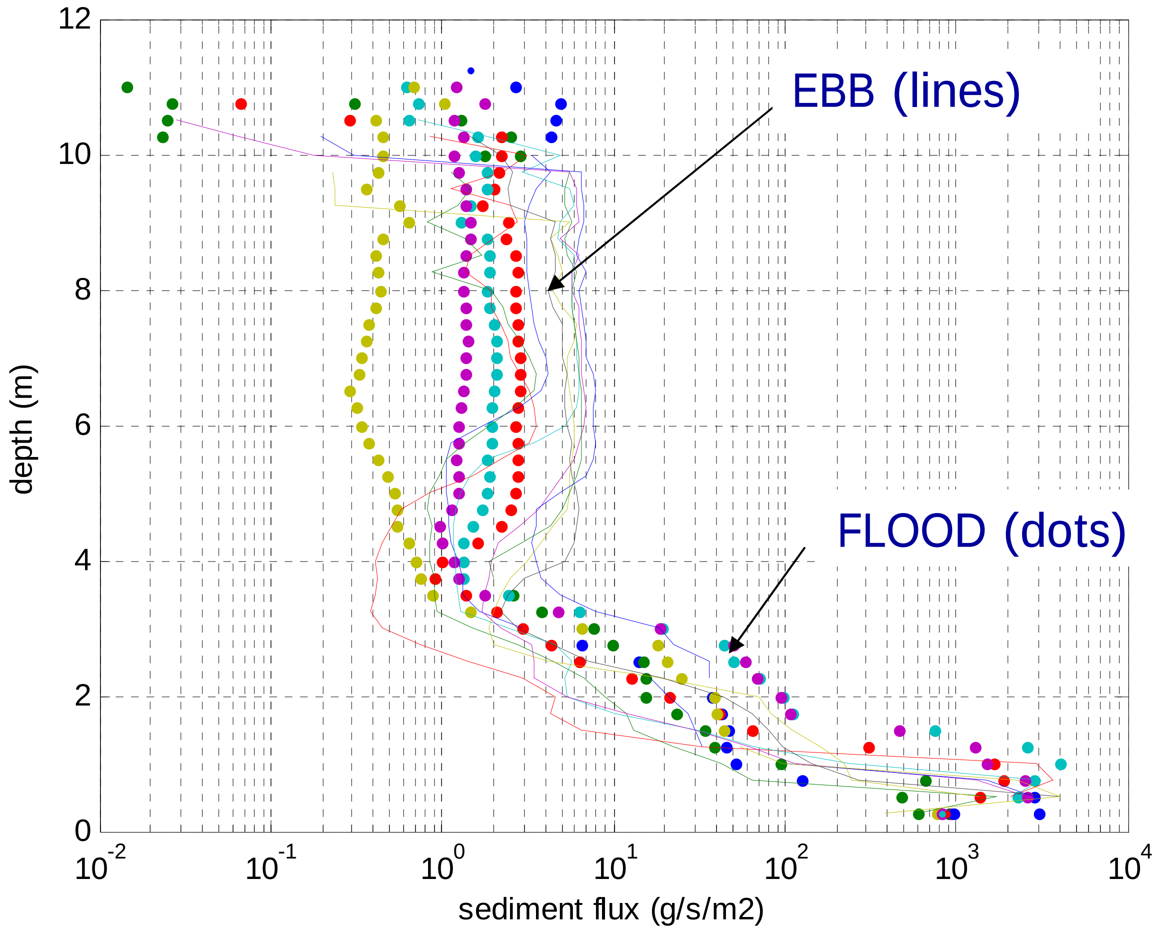
a) Tidal asymmetry (mean velocity) is not relevant for Amazon and may be for river-influenced estuaries in general.

b) Residual advection and asymmetries in shear stress and mixing due to gravitational circulation play an important roll for trapping sediment over the Amazon Shelf.

c) Recirculation due to morphology and flocculation must still be properly addressed for this case.

Concluding remarks (2)

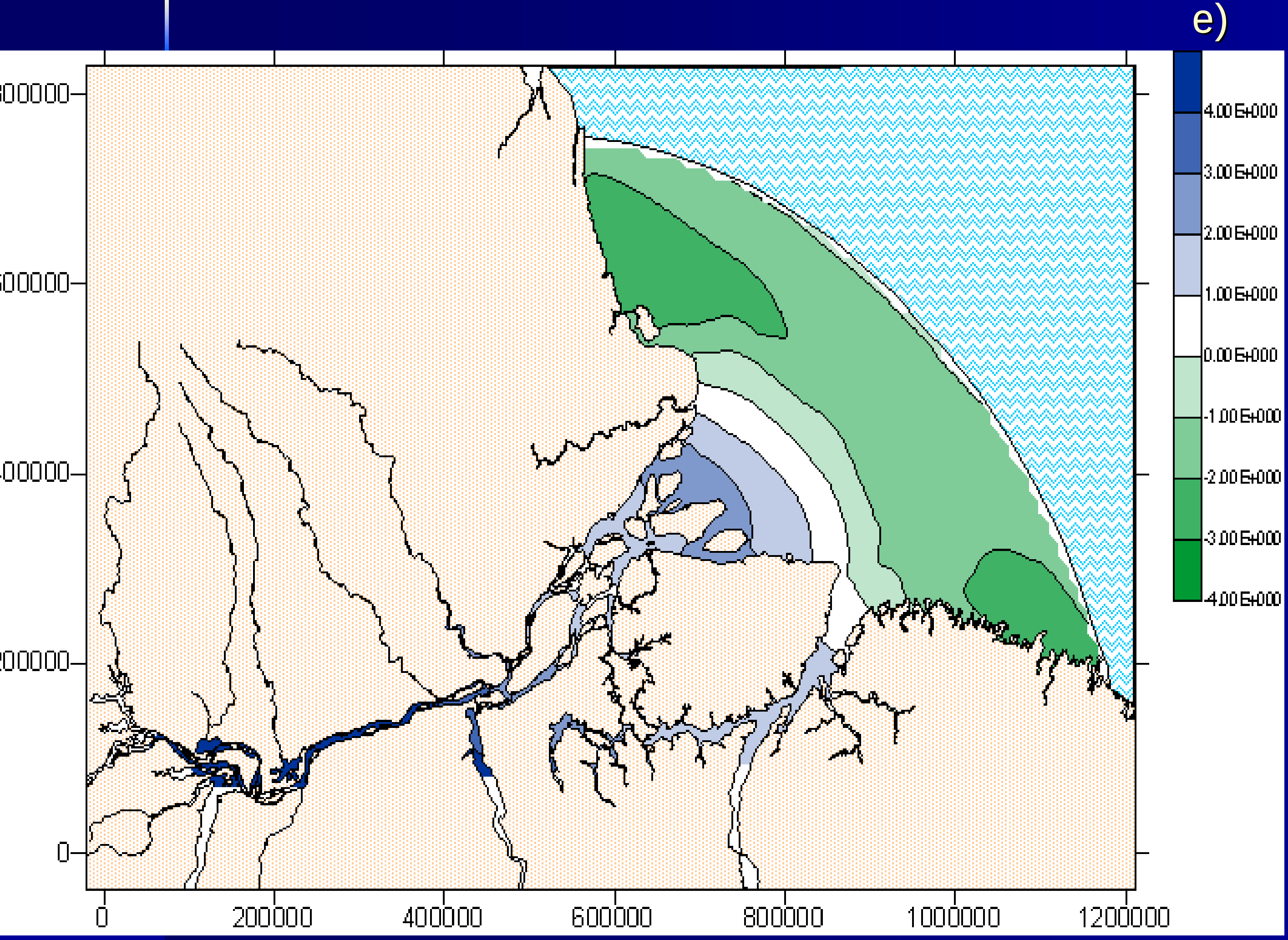
How to assess sediment retention ?



d) Estuaries and coastal areas are highly complex (superposition of time and space scales), as a consequence, for establishing fluxes may be is necessary to look at residual values (i.e. deposition rates), more than ‘instantaneous’ ones.

Concluding remarks (3)

Would basin's changes (discharge of water and sediment) change the 'ocean' boundary conditions?



Be aware of feed-back mechanisms (coupling between sediments and hydrodynamics)

Acknowledgments:

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