Sediment transport in the Venice lagoon: sand transport in the inlets

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CORILA

Objectives and Methods

- **Classification, distribution and mass balance of the sediments in the Venice lagoon**
- **Use of models: hydrodynamic modeling (SHYFEM) and sediment dynamic (Sedtrans96)**
- **Application of the models to study the sand transport in the inlets:**
  - **phase 1: single point analysis with idealized forcings (tide and wind)**
  - **phase 2: transect analysis with idealized forcings (tide and wind)**
  - **phase 3: one year analysis with real forcings**

Sediment characteristics

DIMENSIONI	NOME DEI FRAMMENTI	NOME DEL SEDIMENTO		
		a) *generico*	b) *sciolto*	c) *litificato*
> 256 mm	Masso (*boulder*) Blocco (*block*)	rudite (psefite)	ammasso, detrito	"boulder bed" congl. molto grossolano.
256 - 64 mm	Ciottolo grossolano, pietra (*cobble*)		ghiaia grossolana detrito, pietrame	conglomerato grossolano. breccia grossolana
64 - 4 mm	Ciottolo, scheggia		ghiaia, pietrisco	conglomerato, breccia
4 - 2 mm	Granulo		ghiaietta	microconglomerato, brecciola
2 - 1/16 mm	Granulo, particella	arenite (psammite)	sabbia	arenaria
1/16 - 1/256 mm	Granulo, particella, lamella	lutite (pelite)	silt (fango)	siltite
< 1/256 mm	Particella, lamella, micella		argilla (fango)	argillite

shale

NON COESIVE (sands)

Grain size > 0.063 mm

Dynamic Processes: resuspension, transport, deposition

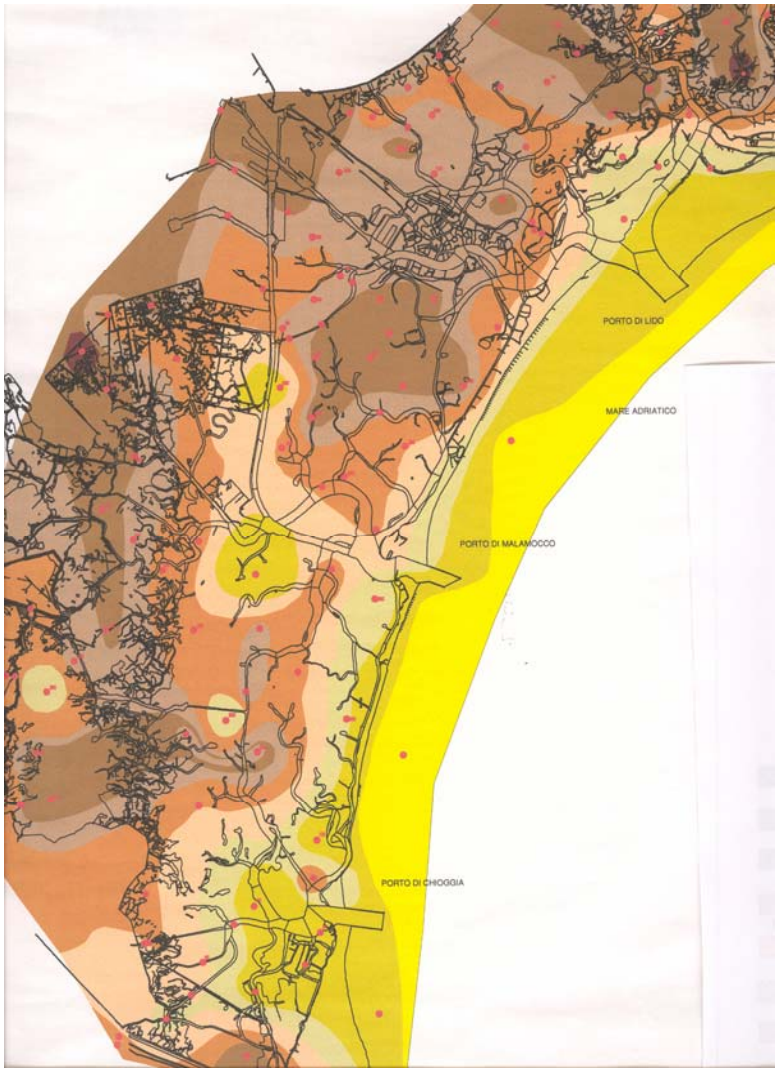
COESIVE (clay)

Grain size < 0.063 mm

Dynamic Processes: erosion, transport, deposition

Characteristics: cohesion, floculation

Superficial grain size distribution in the Venice Lagoon



LA : Limo argill. o argilla limosa (%Sabbia<1%)

LADS: Limo argill. debolmente sabbioso (1<%Sabbia<5%)

LAS : Limo argillo-sabbioso (5<%Sabbia<15%)

LAcS: Limo argill. con sabbia (15<%Sabbia<45%)

LAeS: Limo argill. e sabbia (45<%Sabbia<55%)

ScLA: Sabbia con limo argill. (15<%Limo e argilla<45%)

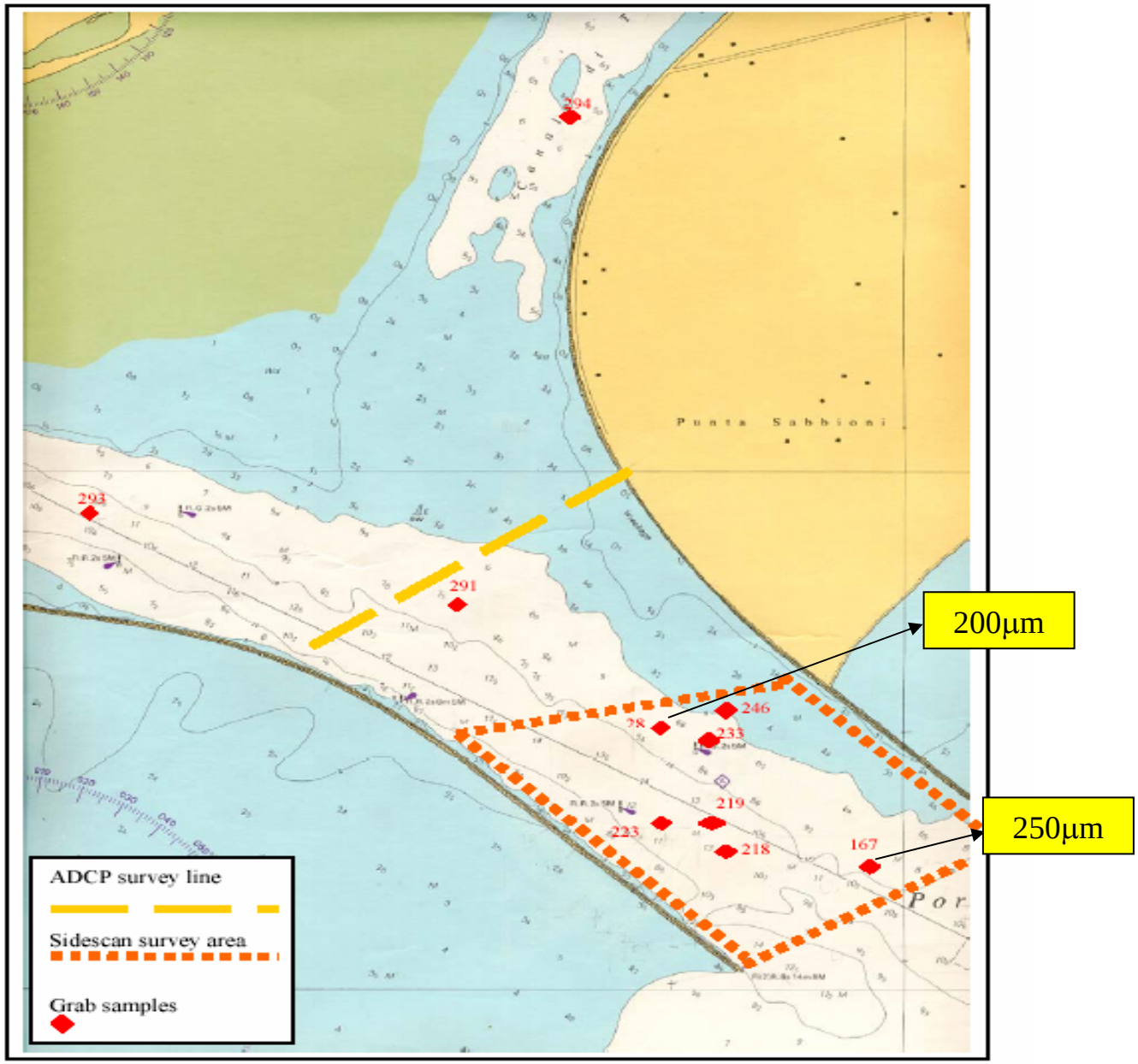
SLA : Sabbia limoso-argill. (5<%Limo e argilla<15%)

SDLA: Sabbia debol. limosa ed argill. (1<%Limo e argilla<5%)

N

Ubicazione dei prelievi di sedimento

Grain size distribution in the Lido inlet

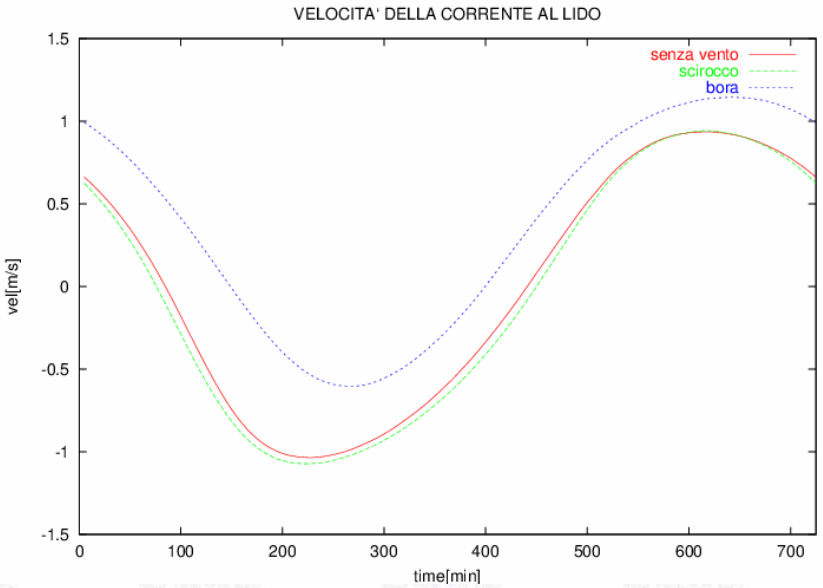


The sediment model: SEDTRANS96

Hydrodynamic parameters	Sedimentological parameters
Current velocity (m/s)	Density (Kg/m^3)
Current direction (°N)	Grain diameter (m)
Distance from bed (m)	Ripple height (m)
Wave height (m)	Ripple length (m)
Wave period (s)	Critical shear stress (N/m^2)
Wave direction (°N)	

- Numerical model for the computation of sediment transport
- Applicable for both cohesive and non-cohesive sediments
- Coupled to the hydrodynamic model
- In this study only sand transport is considered

Phase 1 LIDO inlet

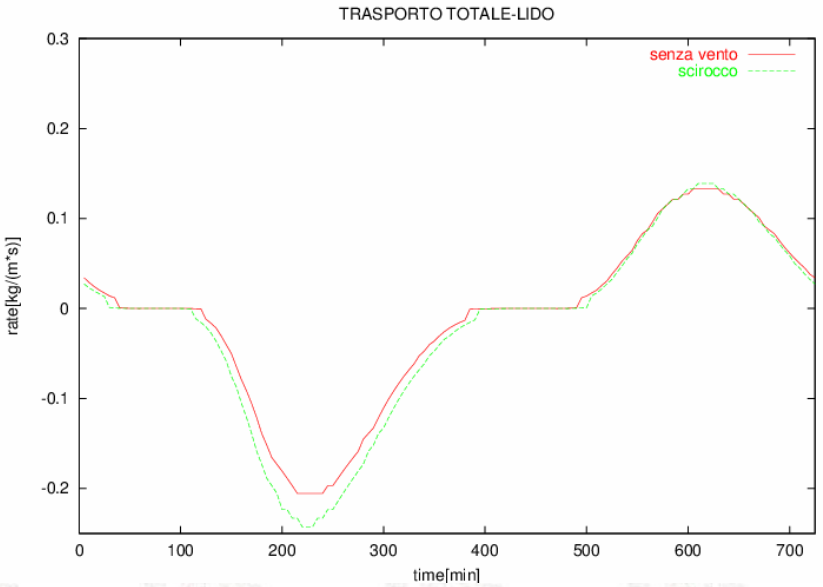


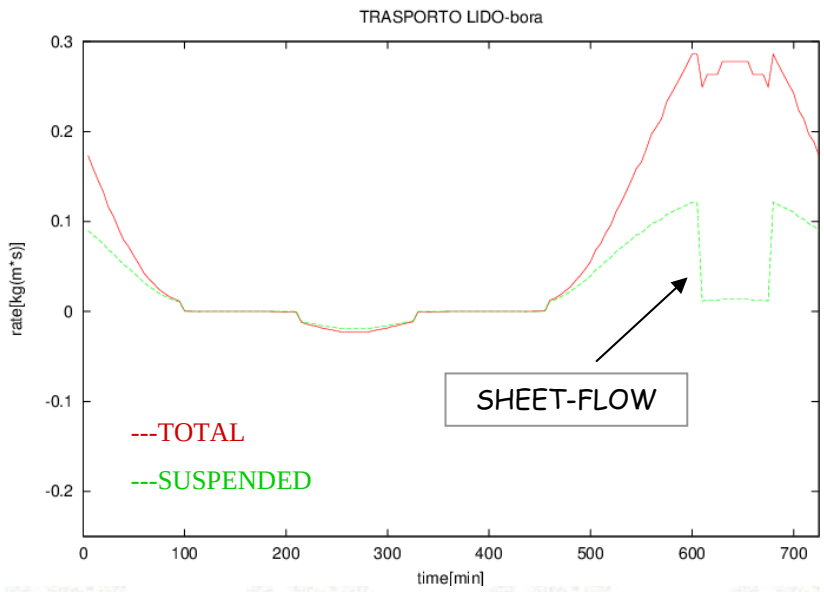
Current velocity

- similar values of no wind and Scirocco
- Bora winds create stronger currents in inflow

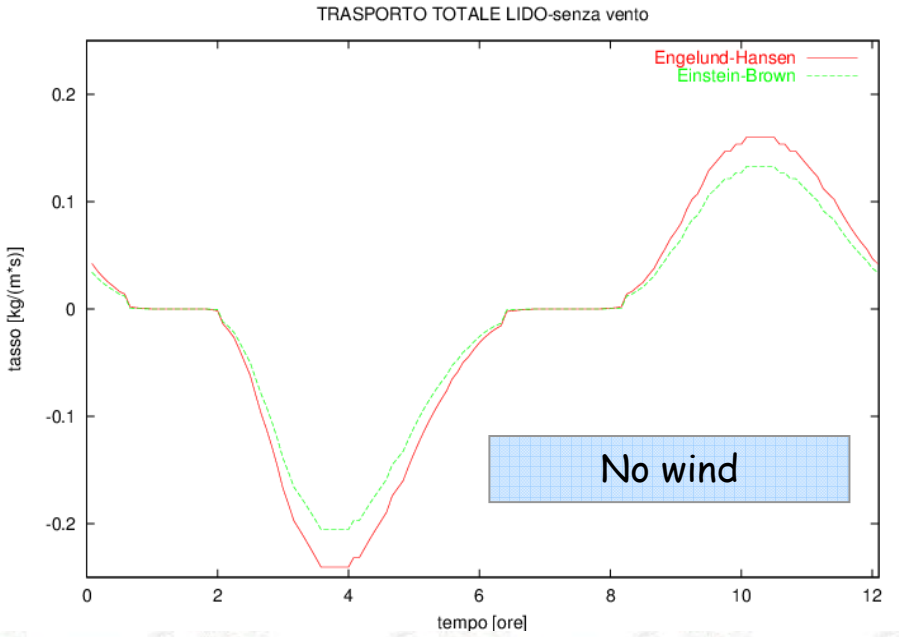
Sediment transport

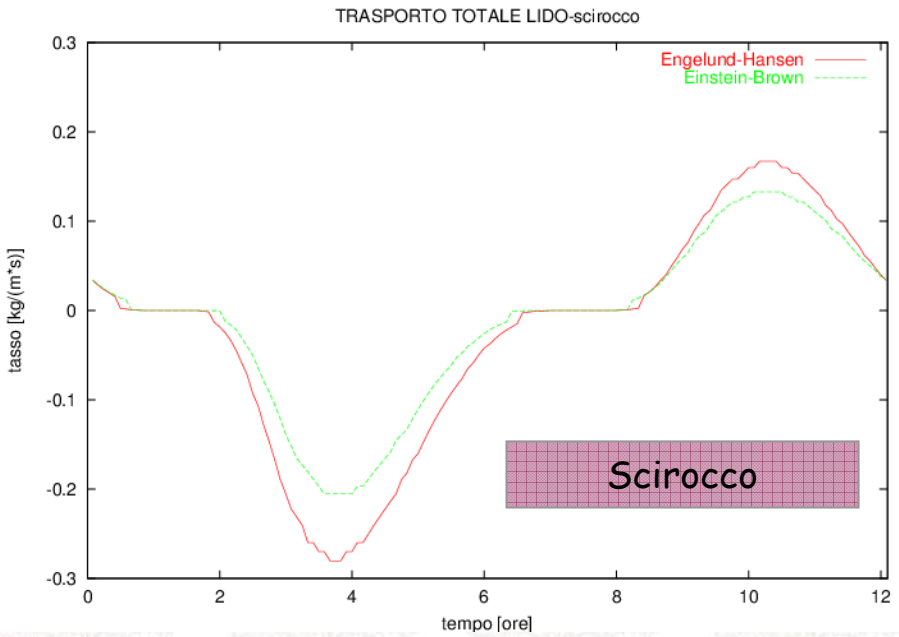
- higher outgoing transport with Scirocco
- with Bora only ingoing sand transport
- during Bora winds sediment transport takes also place in sheet flow



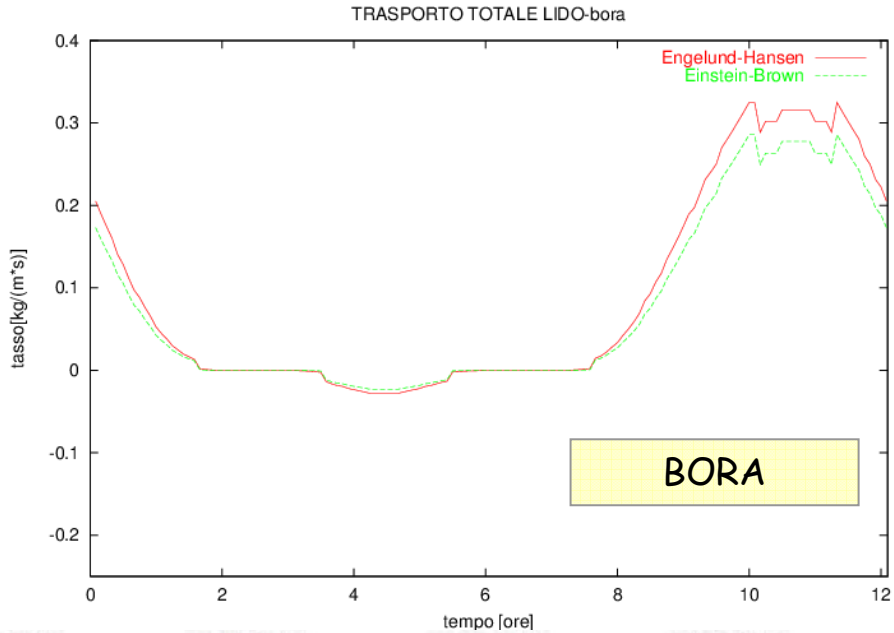


Phase 1 Two algorithms confronted: Engelund-Hansen and Einstein-Brown

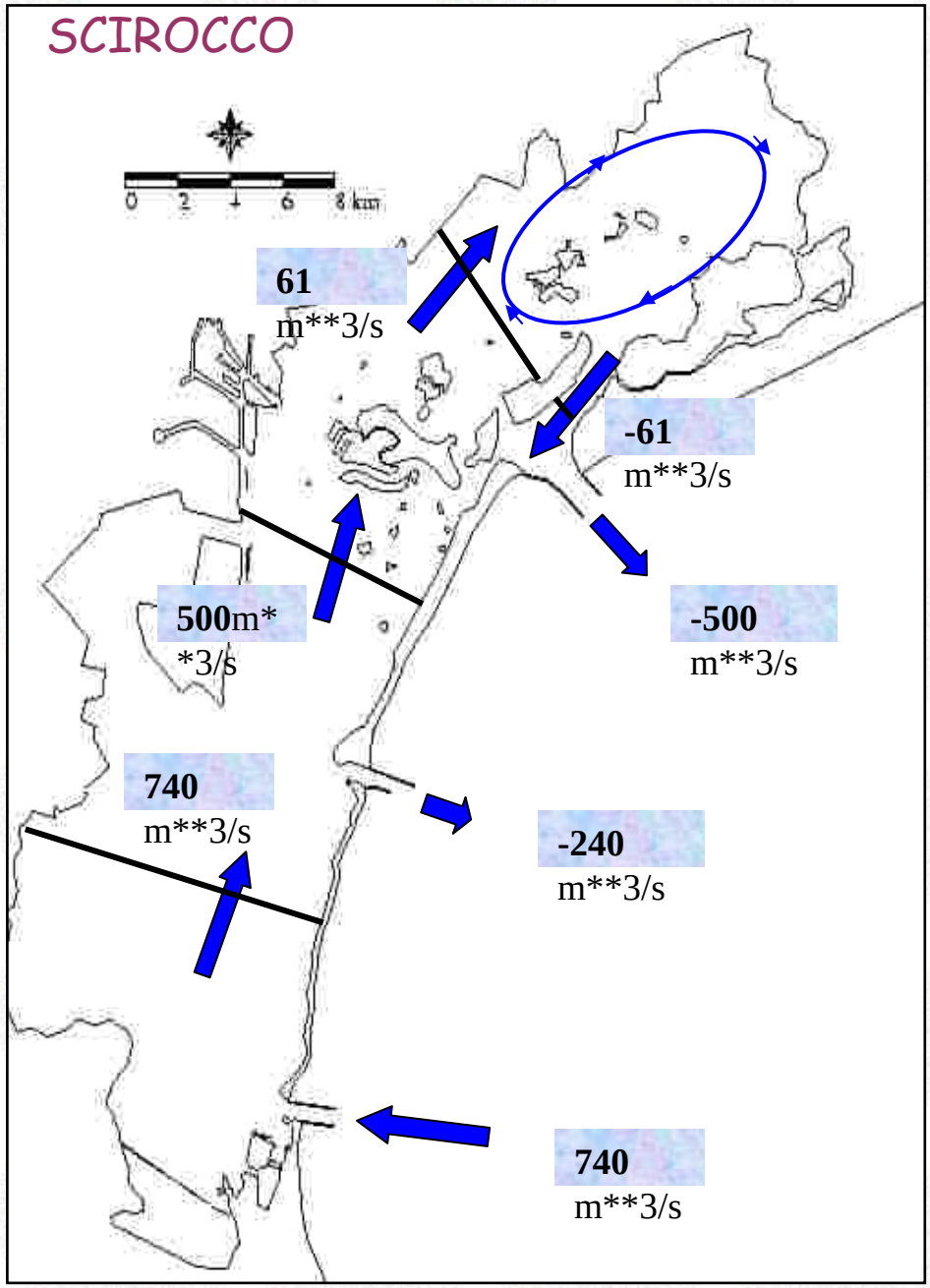


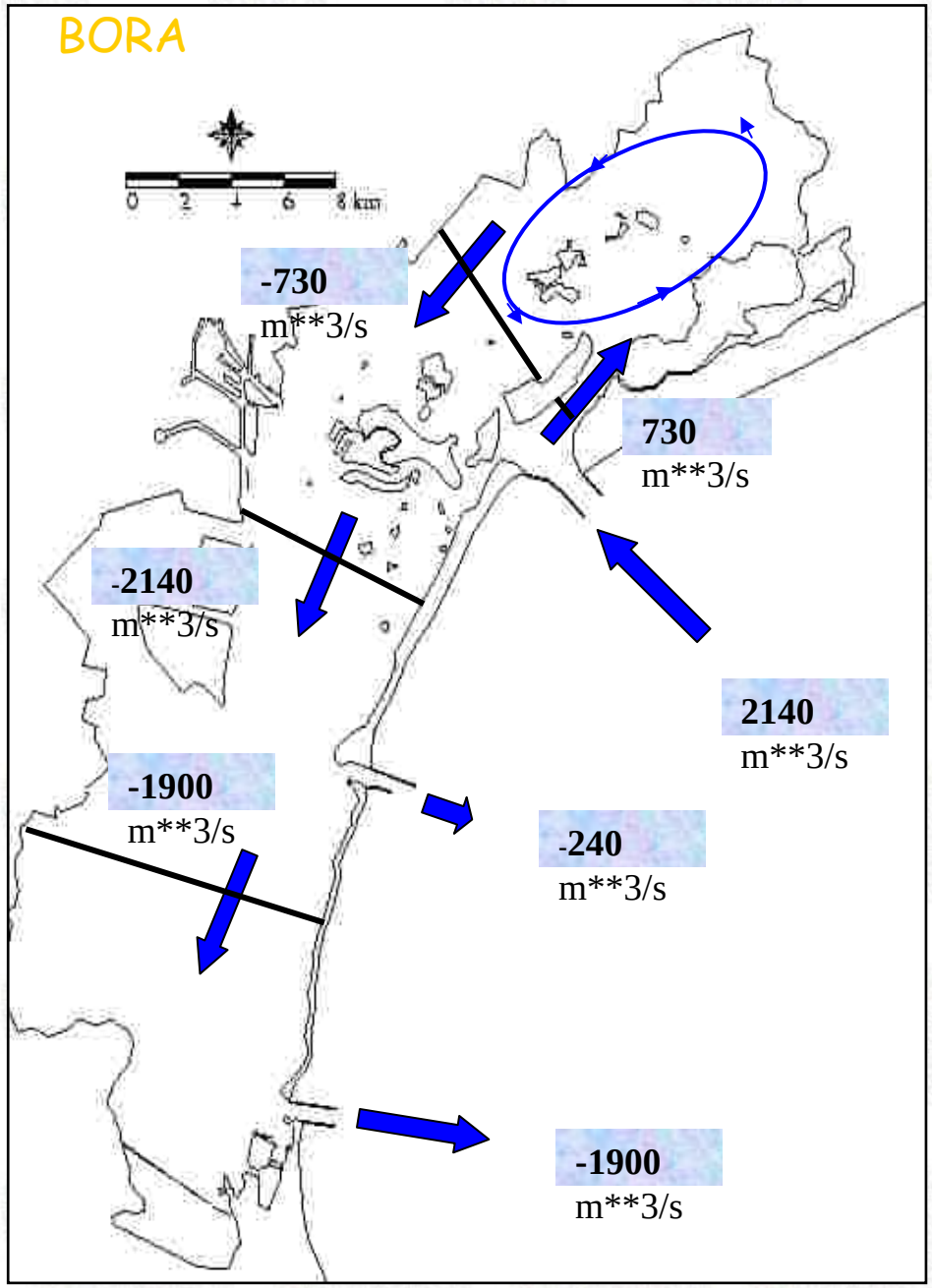


Lido inlet



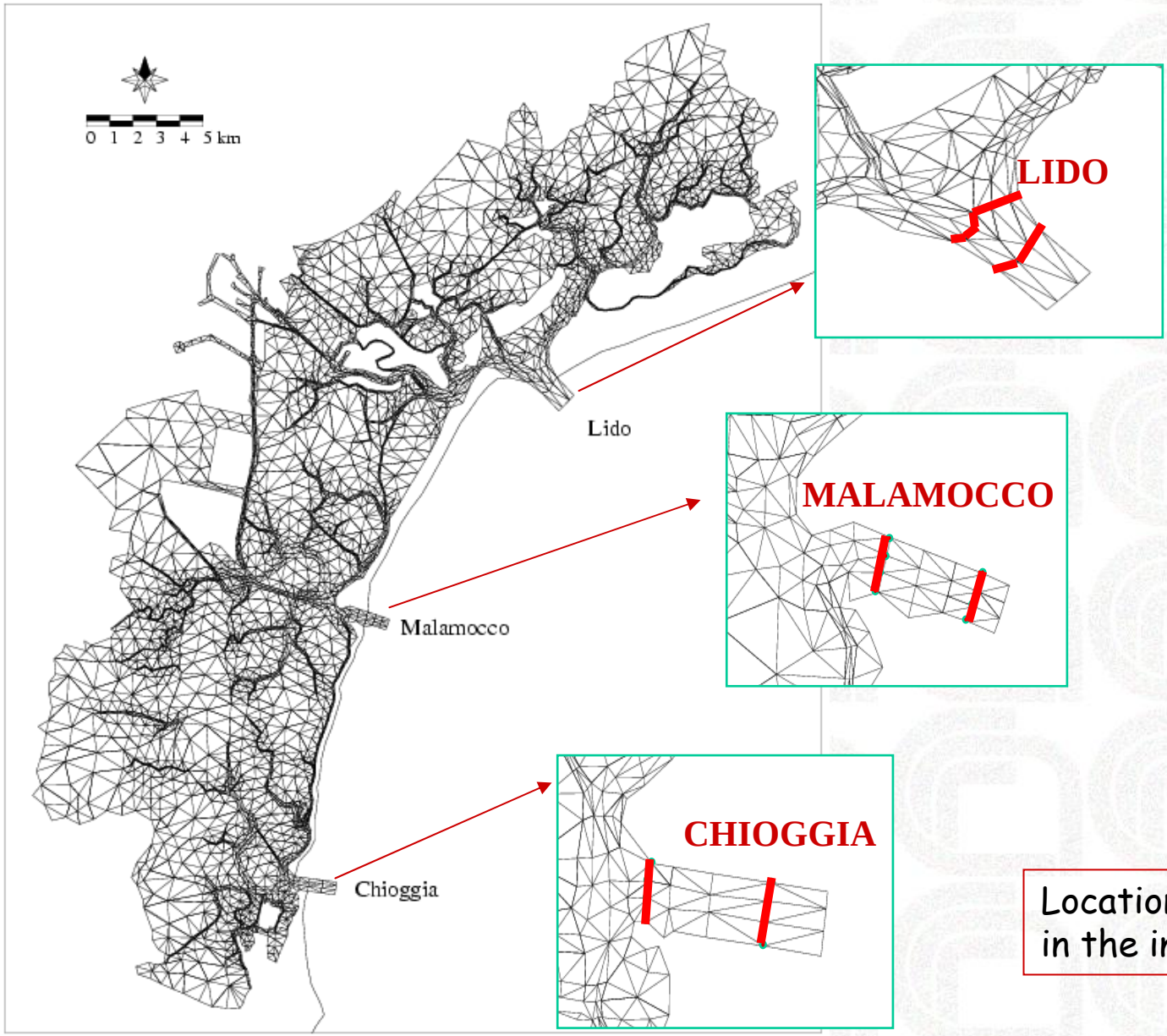
Residual Circulation





Phase 2

Finite element grid of the Venice Lagoon

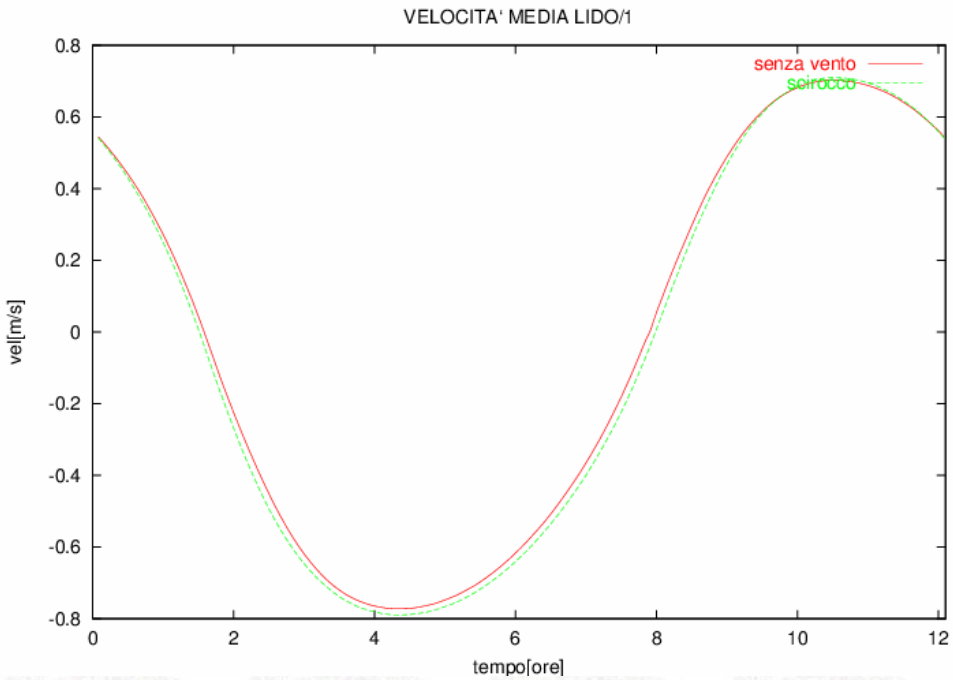


Location of transects in the inlets.

Phase 2

Currents and sediment transport at the Lido inlet

case of no wind and Scirocco



Currents:

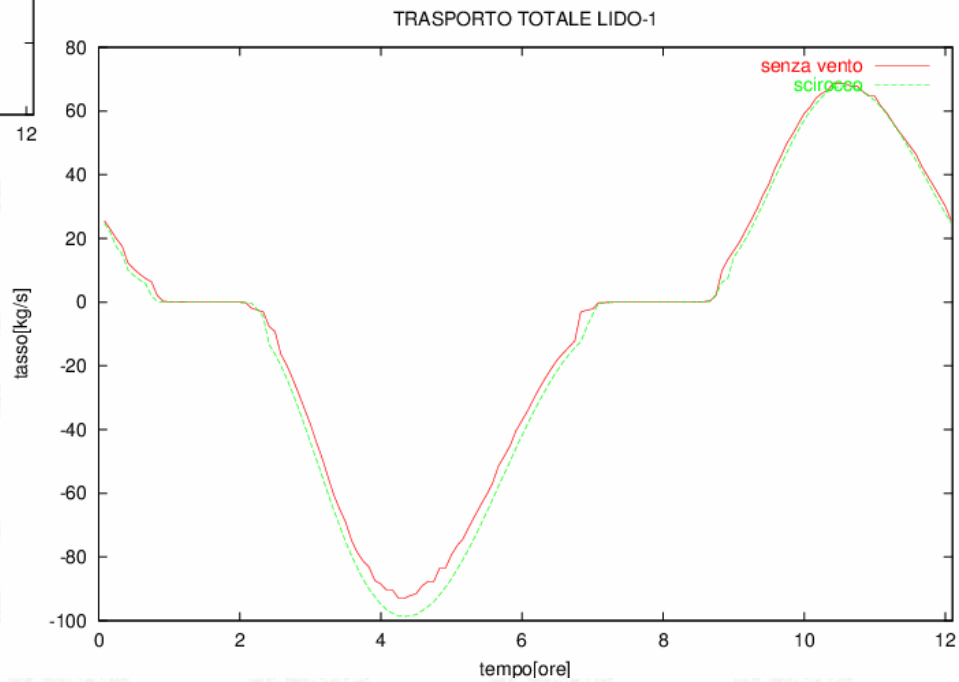
- similar values for both cases
- higher values during outflow

No wind

SCIROCCO

Sediments:

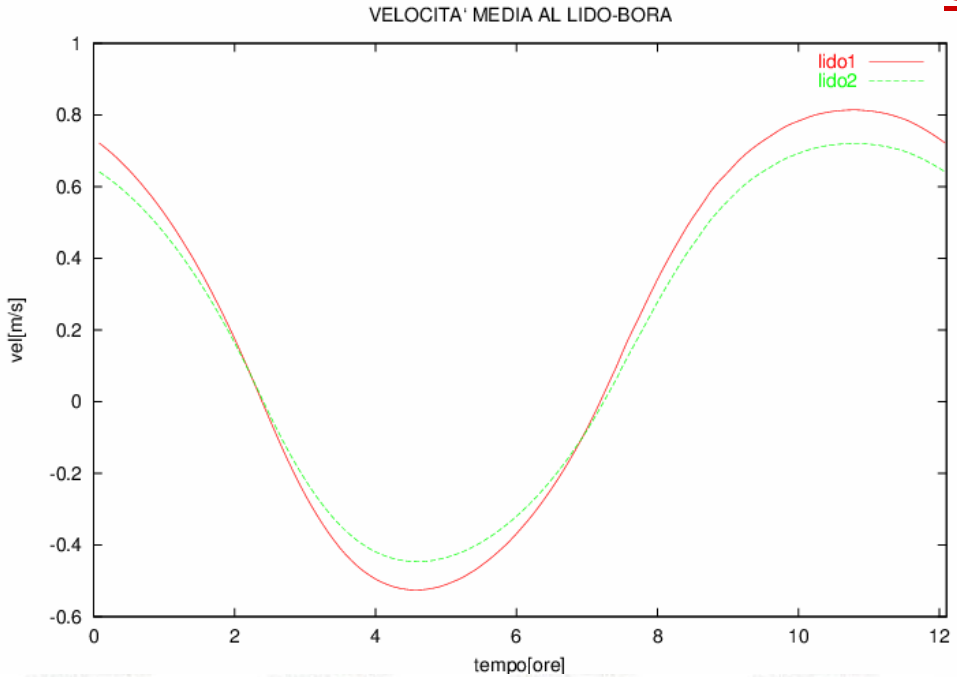
- similar as the current pattern
- higher values during outflow



Phase 2

Currents and sediment transport at the Lido inlet

case of Bora



Currents:

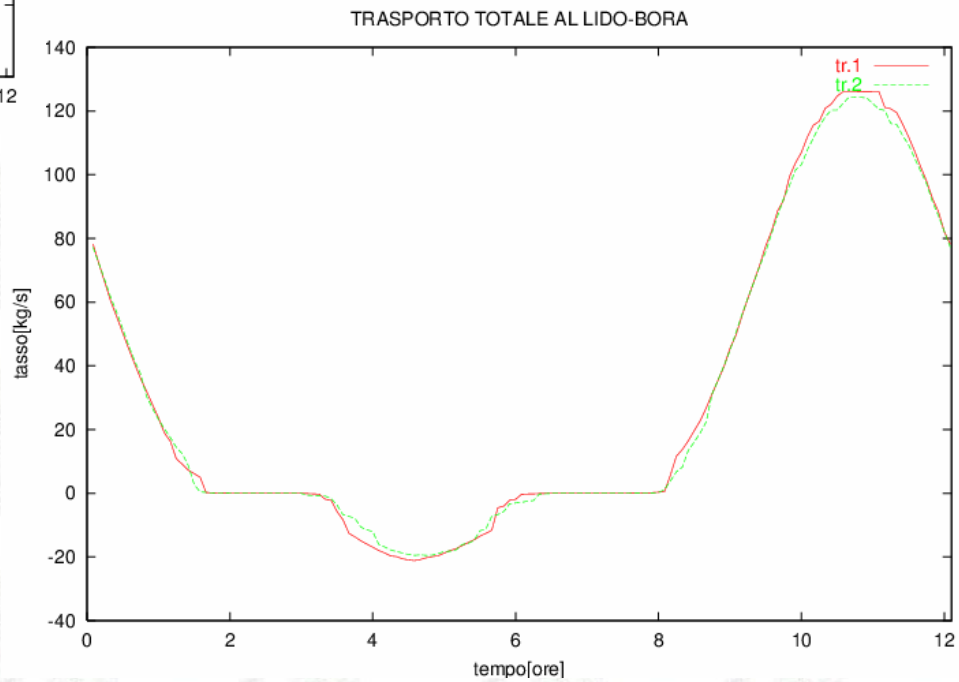
- minor intensity in internal transect (2)
- strong differences between inflow and outflow (0.3m/s)

transect 1

transect 2

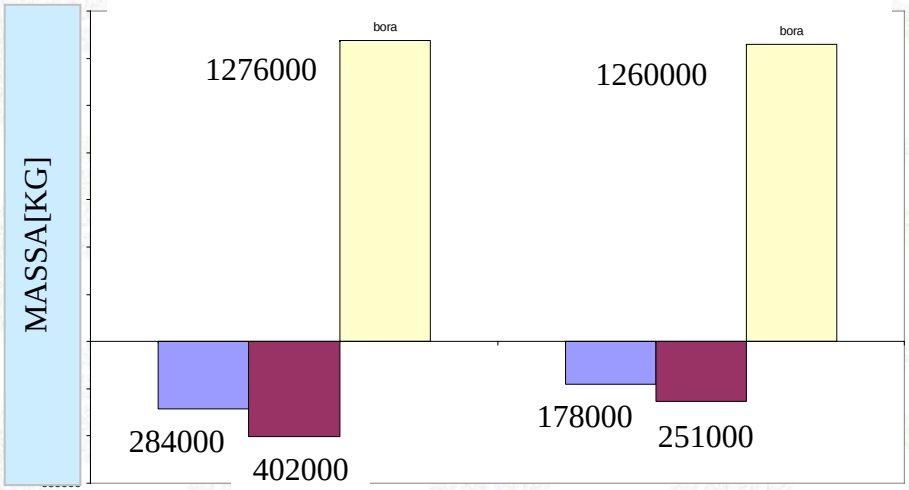
Sediments:

- highly biased to incoming sediments
- current asymmetry is amplified due to highly non-linear nature of sediment transport formulae

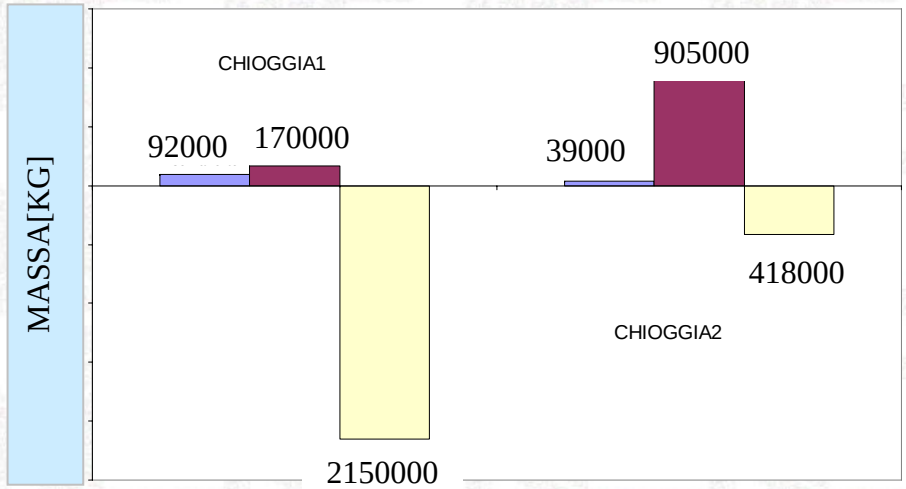


Phase 2 Sediment budget based on 12 hours of simulation

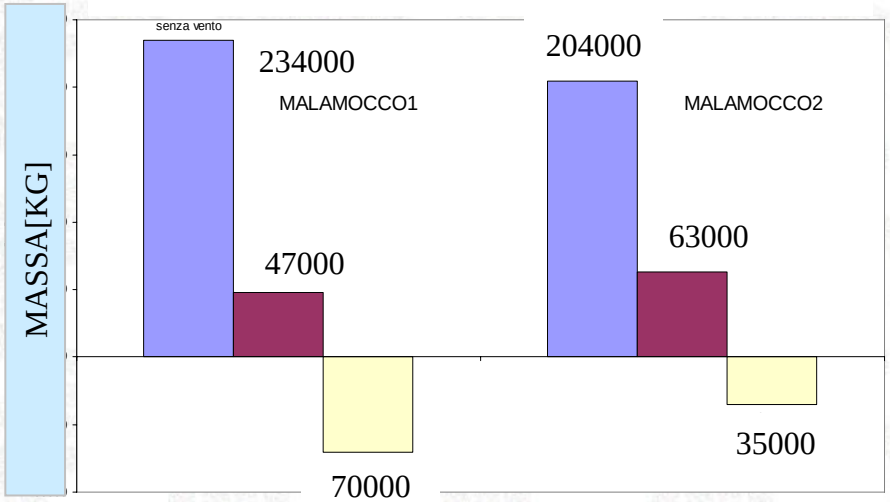
LIDO



CHIOGGIA



MALAMOCCO

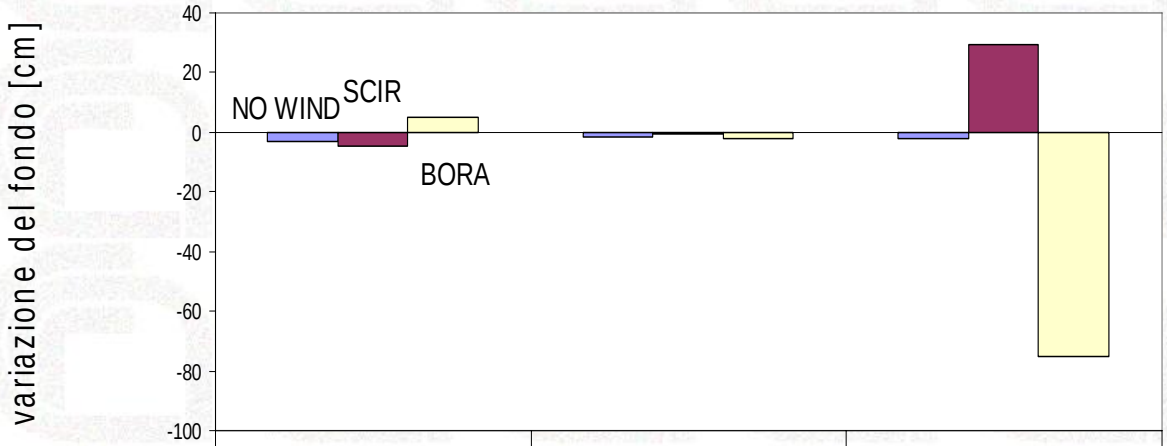


NO WIND
SCIROCCO
BORA

Phase 2

Bed variation based on 12 hours of simulation

Bed level variation

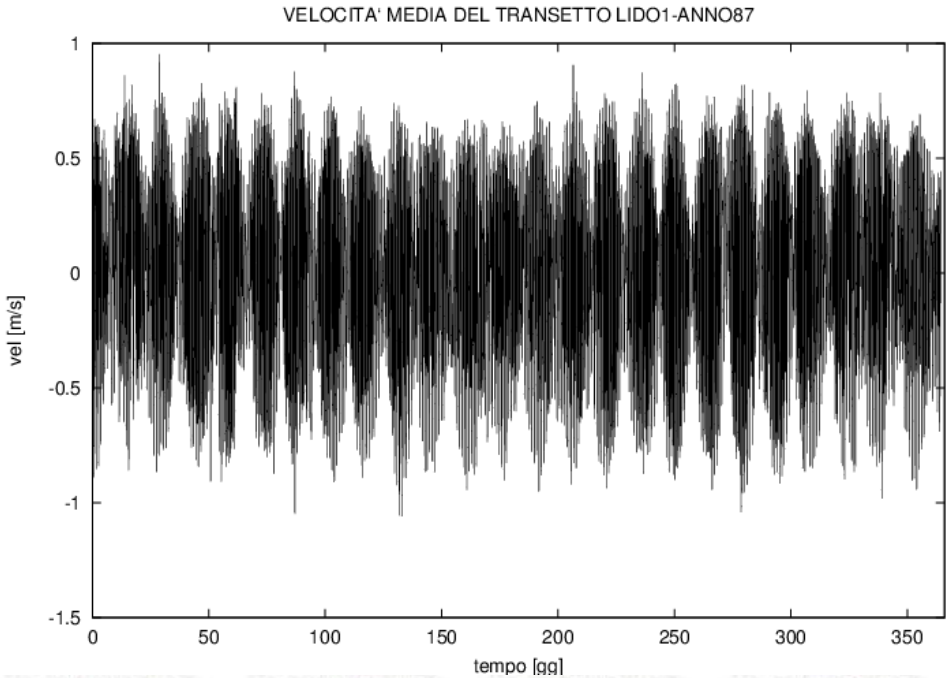


	LIDO	Malamocco	Chioggia
NO WIND	-3,2	-1,5	-2,2
SCIR	-4,7	-0,8	29,2
BORA	5,2	-1,9	-75,1

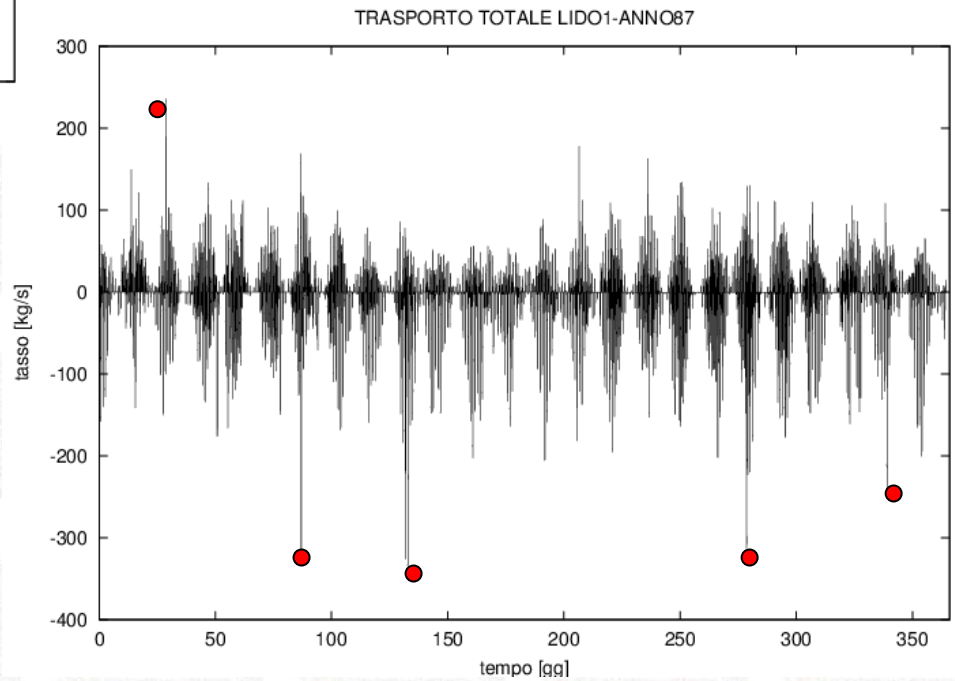
- Erosion and deposition are computed with idealized forcings kept constant for the whole simulation
- The results are not representative of a real world situation
- Real forcings must be taken into account

Phase 3

Current velocity and sediment transport at Lido during a one year simulation with real forcing

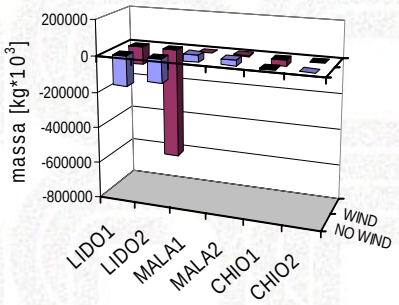


Results for transect 1.



Phase 3

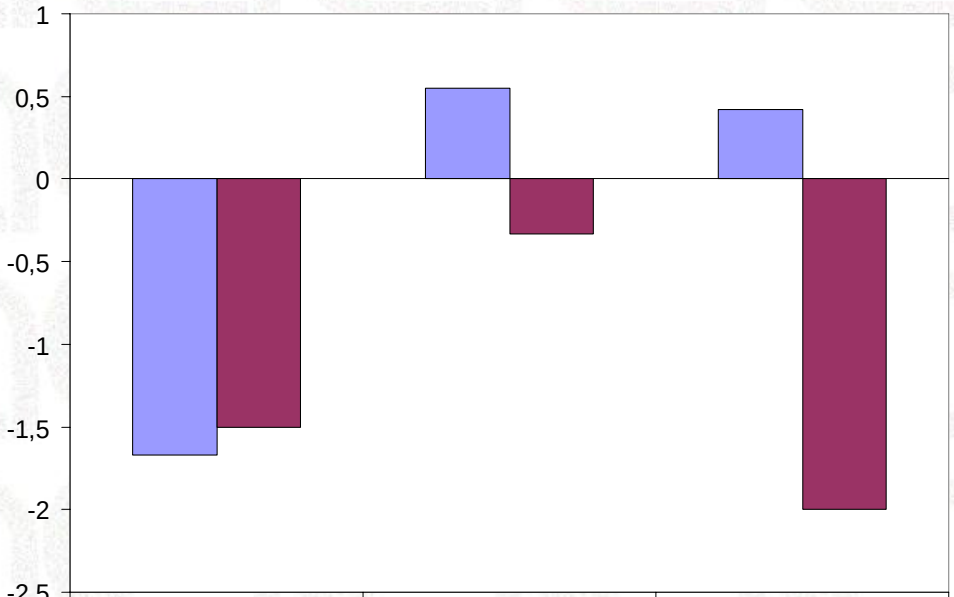
Mass balance and bed level variations in one year under real forcing



	LIDO1	LIDO2	MALA1	MALA2	CHIO1	CHIO2
NO WIND	-169752	-130697	38225	30601	-5394	1782
WIND	-97208	-611359	102	4745	-34905	-848

Mass balance allows the transformation into bed level variations

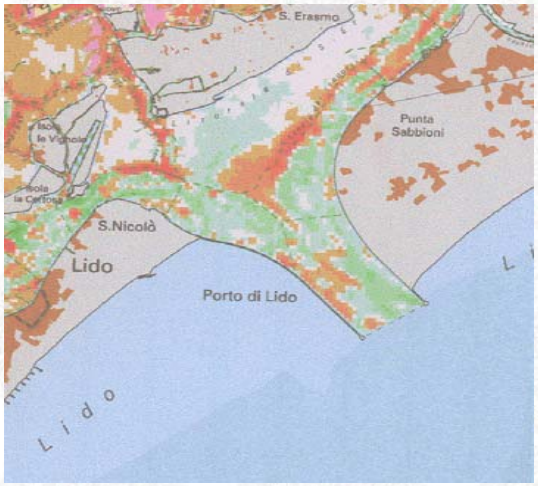
Bed level variations [cm]

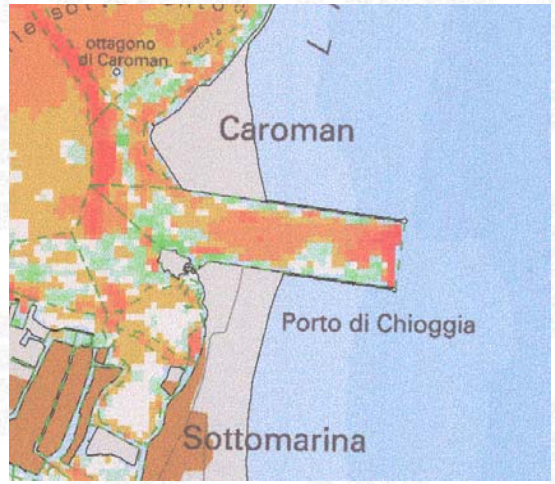


	LIDO	MALAMOCCO	CHIOGGIA
NO WIND	-1,67	0,55	0,42
WIND	-1,5	-0,33	-2

Comparison between data and simulation results

Erosion and Deposition maps of Venice Lagoon (CVN)





Sedimentazione

- Sedimentazione sup. a 10.00 m
- Sedimentazione da 5.01 a 10.00 m
- Sedimentazione da 2.11 a 5.00 m
- Sedimentazione da 1.11 a 2.10 m
- Sedimentazione da 0.51 a 1.10 m
- Sedimentazione da 0.11 a 0.50 m

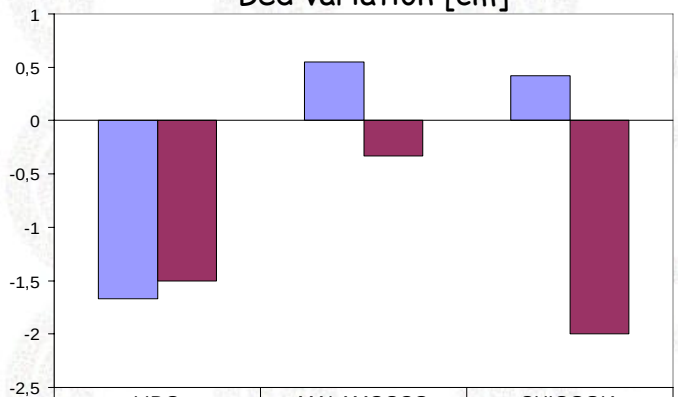
Erosione

- Erosione da -0.11 a -0.50 m
- Erosione da -0.51 a -1.10 m
- Erosione da -1.11 a -2.10 m
- Erosione da -2.11 a -5.00 m
- Erosione da -5.01 a -10.00 m
- Erosione sup. a -10.00 m

Confronto tra batimetria 1970 - (1990-1993)

Model results

Bed variation [cm]



	LIDO	MALAMOCCO	CHIOGGIA
NO WIND	-1,67	0,55	0,42
WIND	-1,5	-0,33	-2

Conclusions

- Mass balance and bed level variations have been simulated using both idealized and realistic forcings
- The computed results seem in good agreement with the erosional trend in the Chioggia and Malamocco inlet; results for the Lido inlet are not convincing

Future Plans

- Use of more detailed grid in the inlets, especially in the inlet where the bathymetry shows great heterogeneity
- Use of more grain size fractions
- Modeling of the cohesive sediments originating from the internal of the lagoon