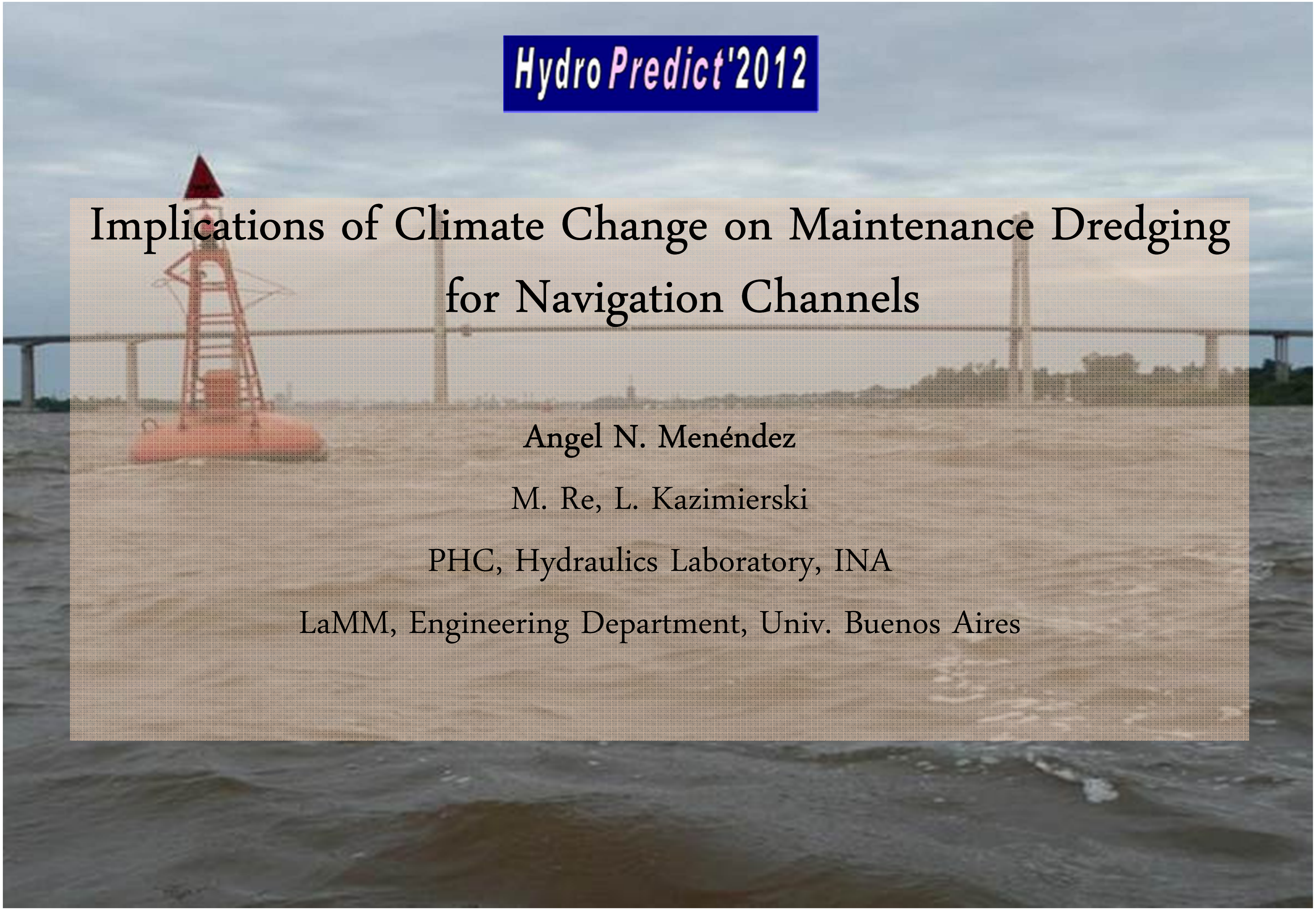

HydroPredict'2012

Implications of Climate Change on Maintenance Dredging for Navigation Channels

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OUTLINE

- INTRODUCTION
- TOOLS
- DREDGING DATA
- SCENARIOS
- CONCLUSIONS

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DESCRIPTION OF THE PROBLEM

- Dredging of navigation channels: *key activity* to sustain international commerce
- *Benefits* from allowing larger vessel droughts must overcome *cost* of dredging
- This economical trade-off can be significantly modified by *Climate Change*

DESCRIPTION OF THE PROBLEM

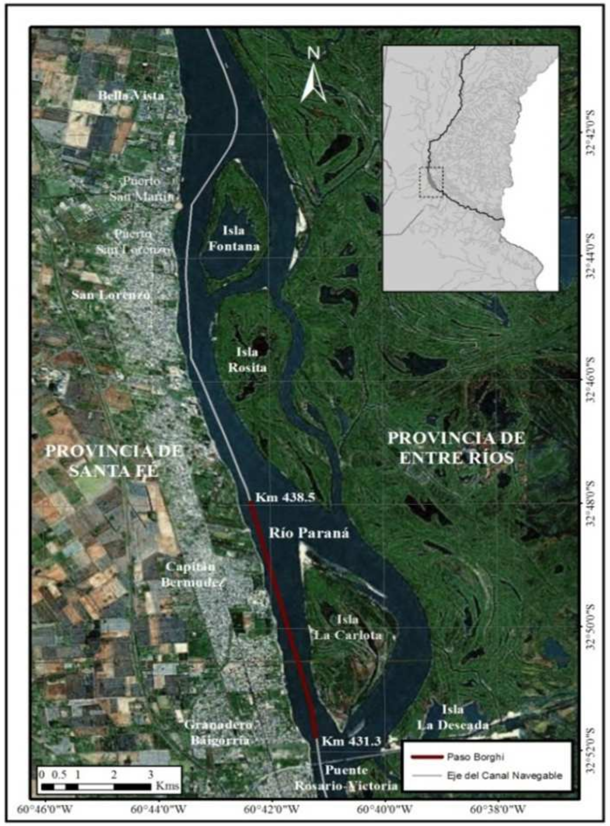
- Sedimentation in navigation channels depends on prevailing hydrodynamic conditions (*hydrologic regime*) and characteristics and quantity of *available sediment*
- Hydrologic regime: critical for *rivers*
- Sediment provision: critical for *estuaries*

GOAL OF PRESENT WORK

- Establishment of *methodology to determine influence of potential changes in flow regime*, due to Climate Change, on sedimentation in navigation channels
- *Application:* stretch of the navigation route of the Paraná River ('Paso Borghi'), in Argentina, a key transportation waterway for export of grains, the main source of economic wealth of the country

Navigation Route

680 km



~ 7 km

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TOOLS

Numerical modeling:

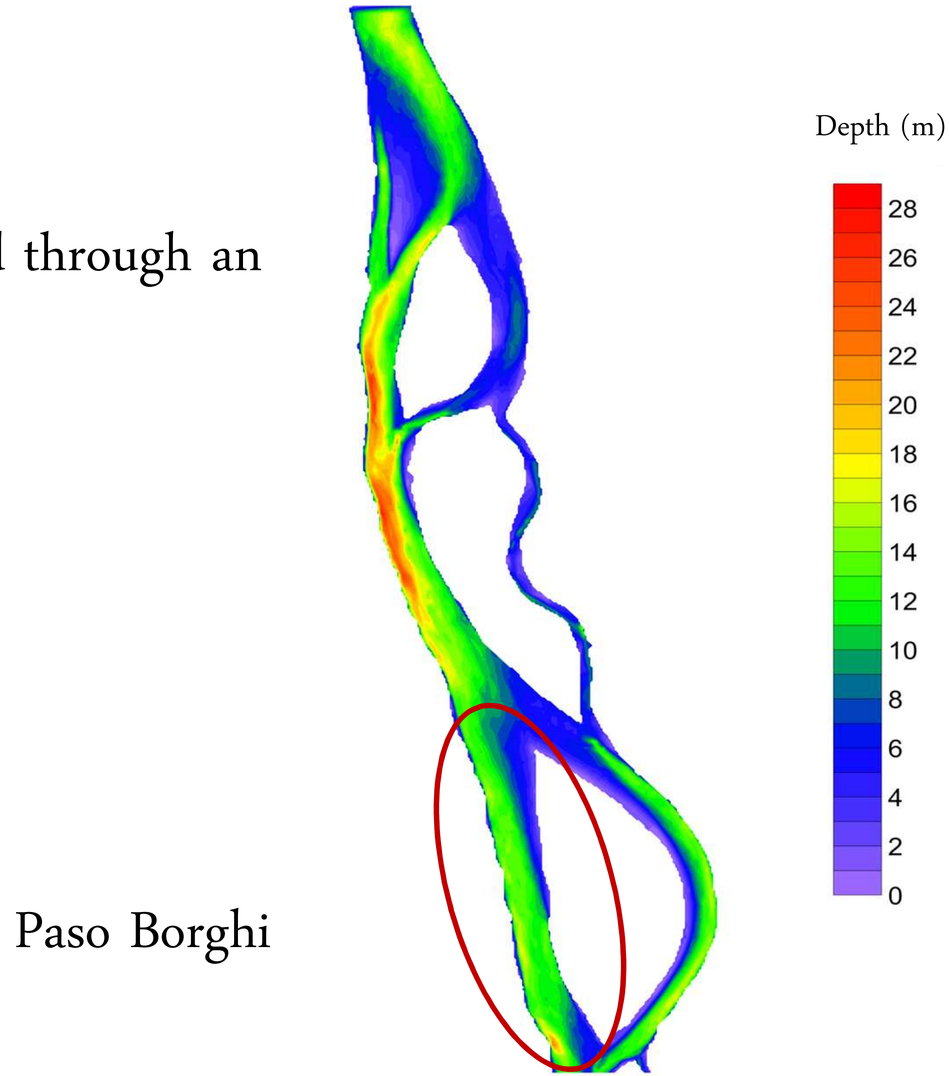
- Digital Elevation Model
- Hydrodynamic Model
- Sediment Transport Model

DIGITAL ELEVATION MODEL

Based on bathymetric data obtained through an ad-hoc survey

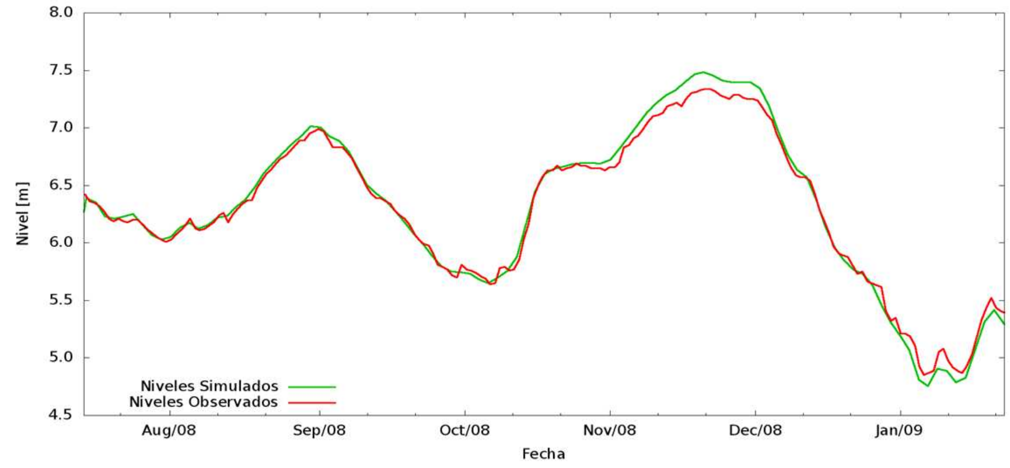
(UNIBO-FICH,

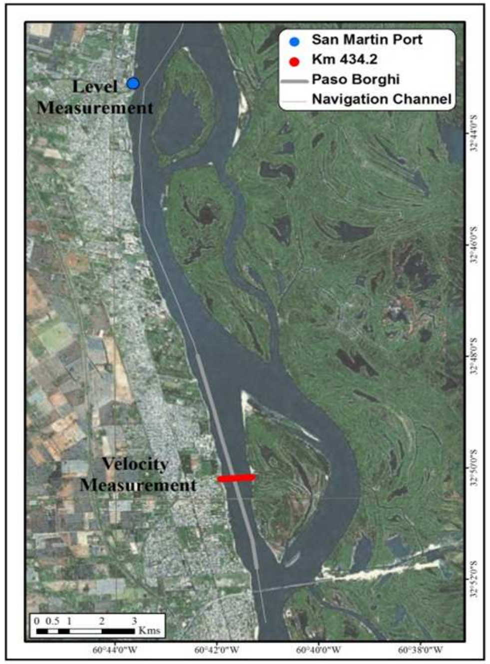
29/Jun to 03/Jul 2009)

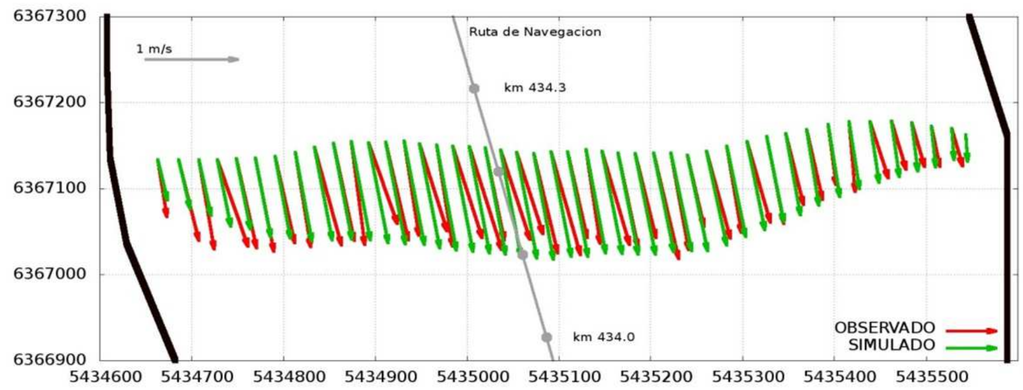


HYDRODYNAMIC MODEL

- 2D horizontal (vertically averaged) model
- Numerical code: HIDROBID II

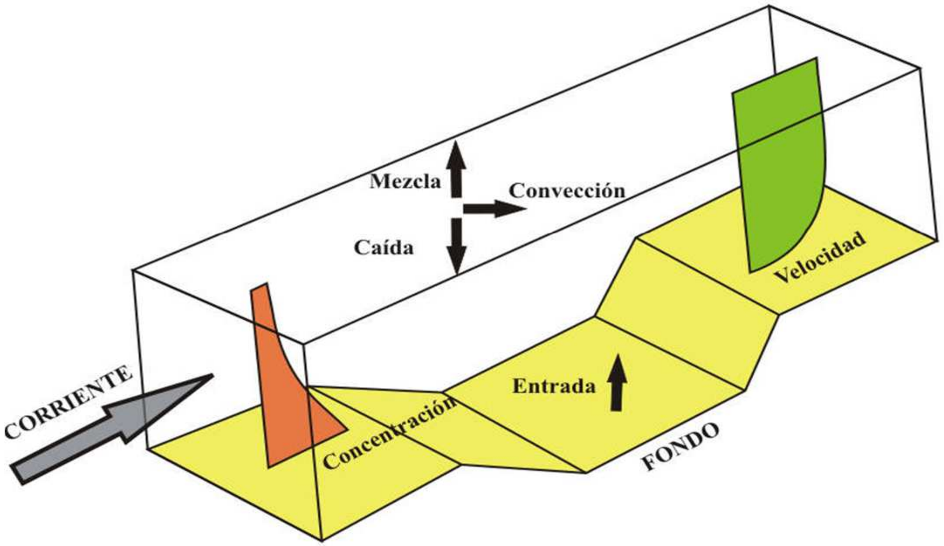


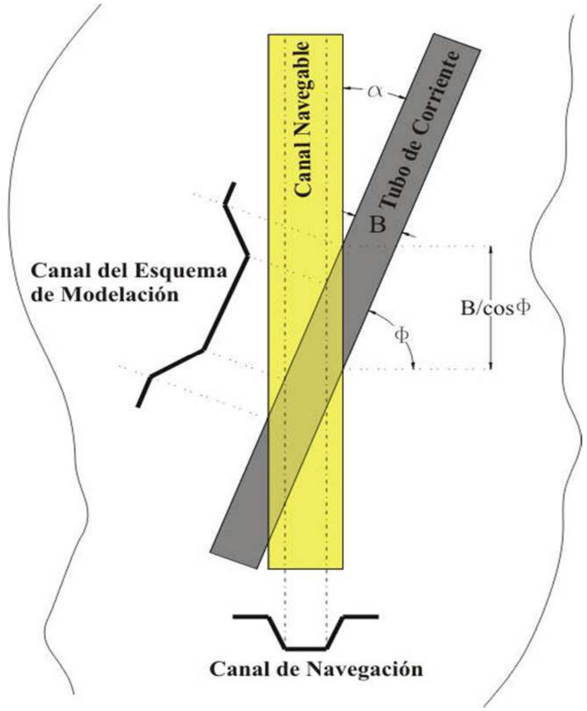




SEDIMENTOLOGIC MODEL

- 2D vertical (laterally averaged) model
- Numerical code: AGRADA

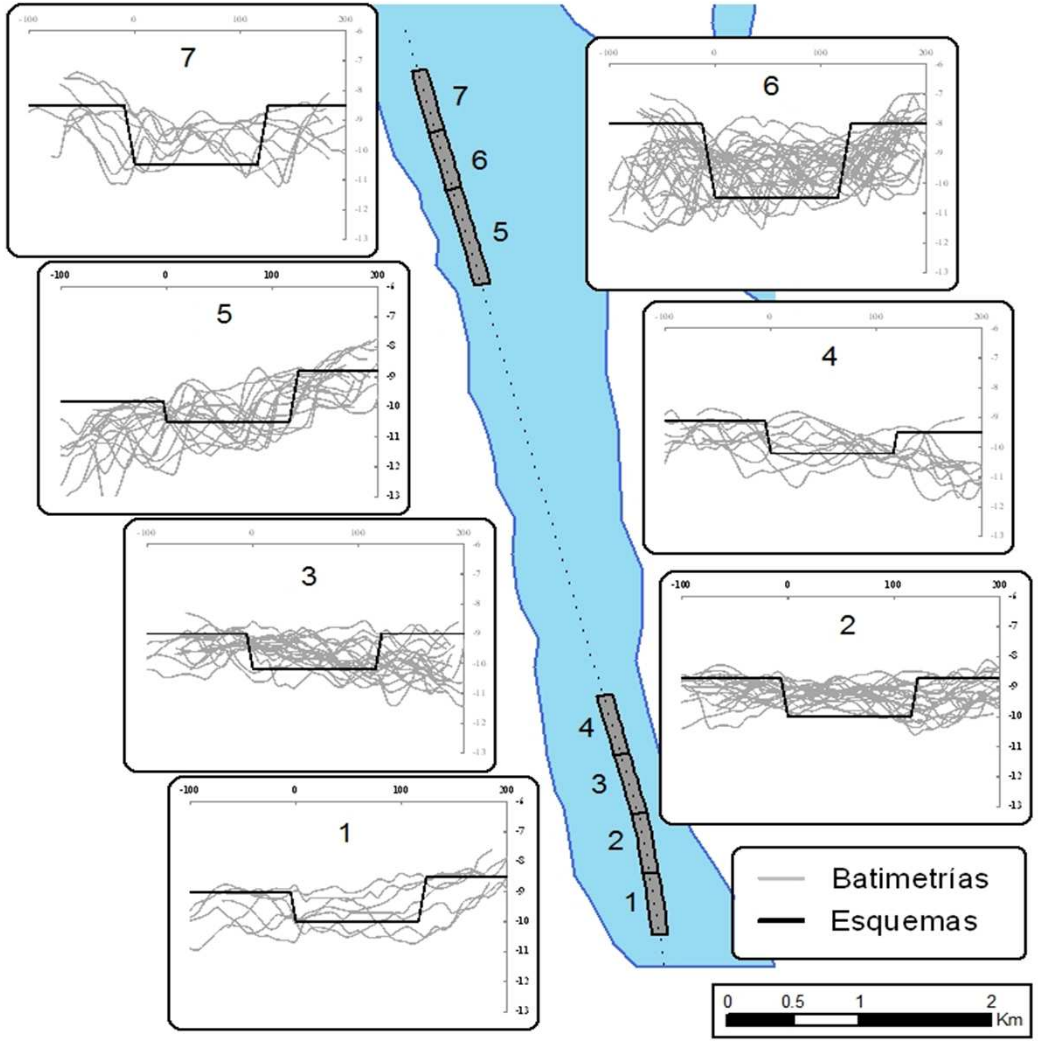




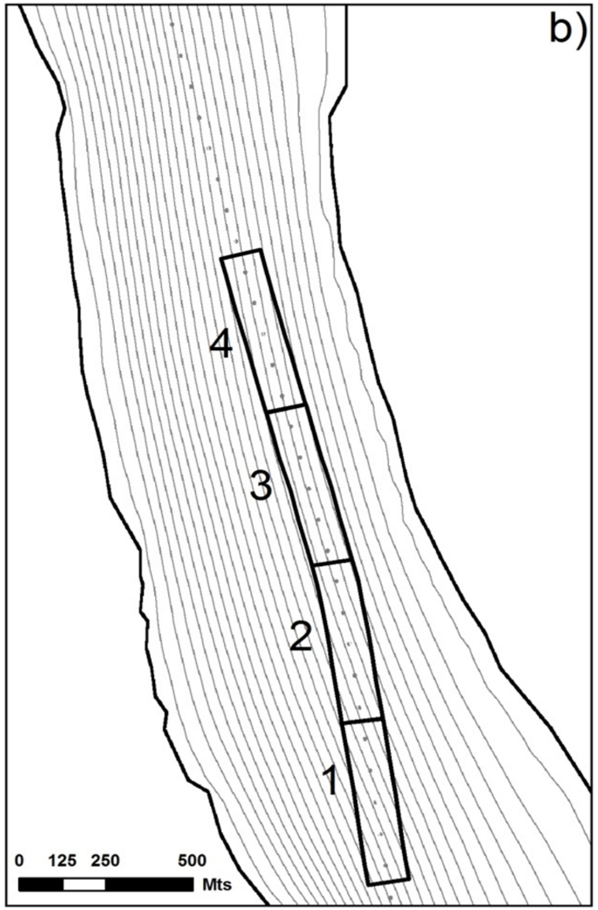
SEDIMENTOLOGIC MODEL

Schematization

- Paso Borghi was divided in Upper Borghi and Lower Borghi, separated by a non-dredging stretch
- Lower Borghi was subdivided into 4 stretches (#1 to 4)
- Upper Borghi was subdivided into 3 stretches (#5 to 7)



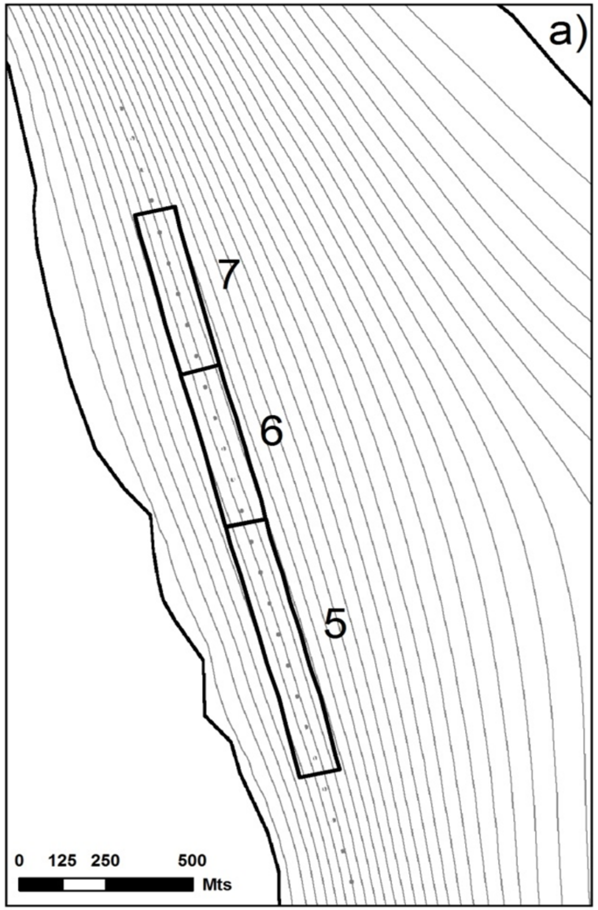
SEDIMENTOLOGIC MODEL



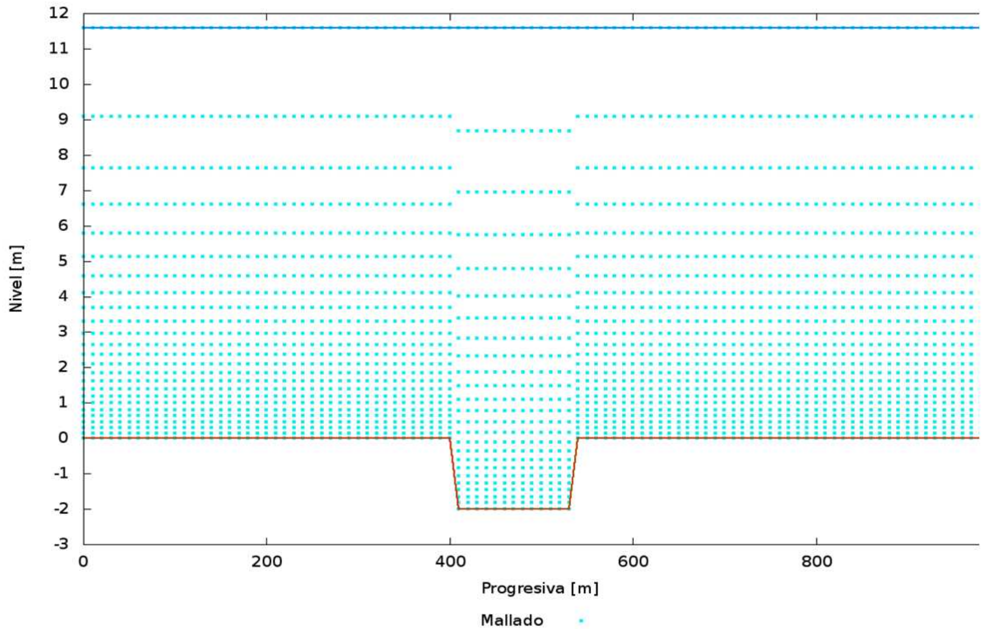
Feeded by hydrodynamic model:

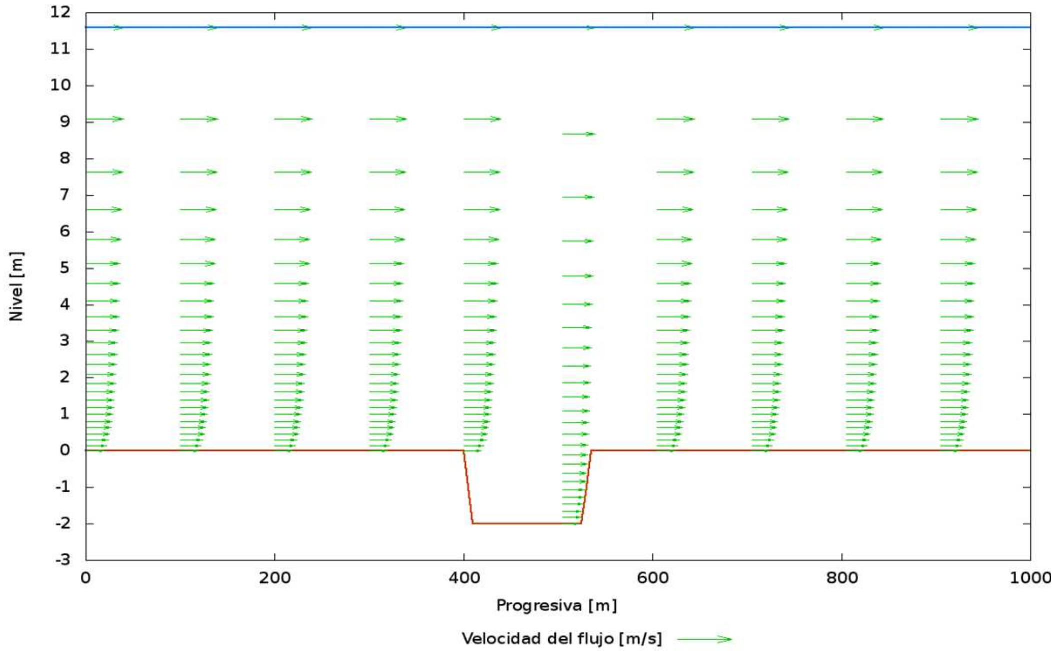
- **Water depth**
- **Unit discharge**
- **Angle**

N°	Subtramo [km]	Caudal Específico [$m^3/m/s$]	Nivel sobre cero local [m]	Ángulo [°]
1	431.25 – 431.75	12.4	2.507	11.6
2	431.75 – 432.25	12.3	2.515	5.0
3	432.25 – 432.75	13.0	2.528	0.0
4	432.75 – 433.25	13.4	2.541	4.3
5	436.75 – 437.55	12.4	2.658	1.8
6	437.55 – 438.05	11.1	2.680	2.0
7	438.05 – 438.55	11.9	2.687	1.0



SEDIMENTOLOGIC MODEL





- Vertical discretization: 25 cells logarithmically distributed
- Horizontal discretization: 500 cells 2 m long
- d_{50} = 260 µm

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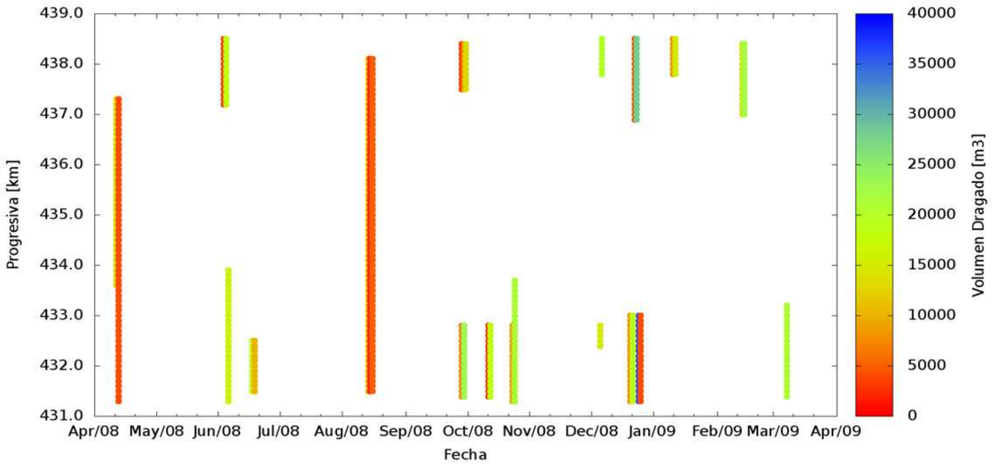
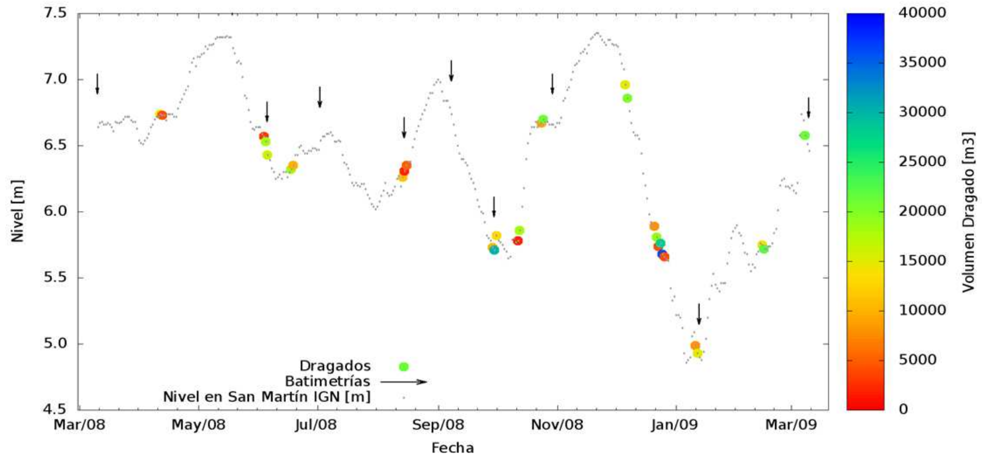
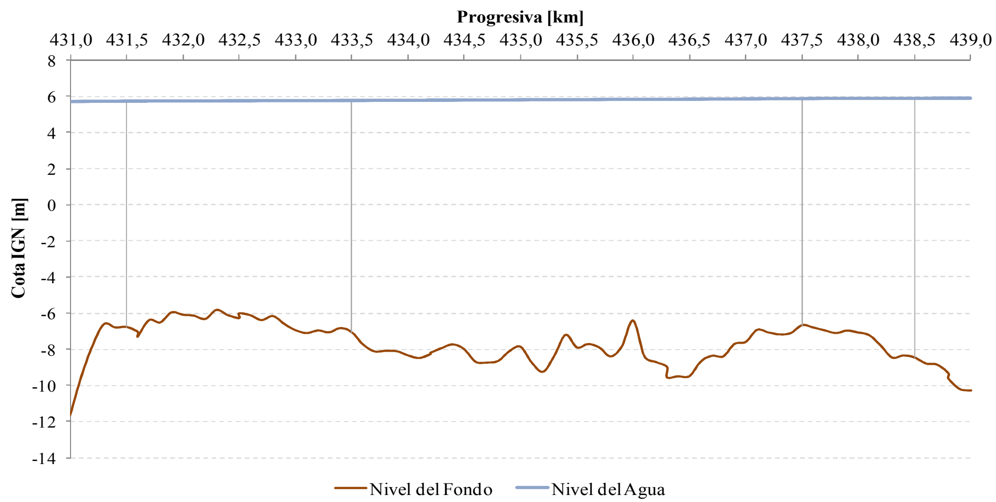
DREDGING DATA

- Dredging operations between **11/March/2008 to 11/March/2009** (from *Subsecretaría de Puertos y Vías Navegables*).



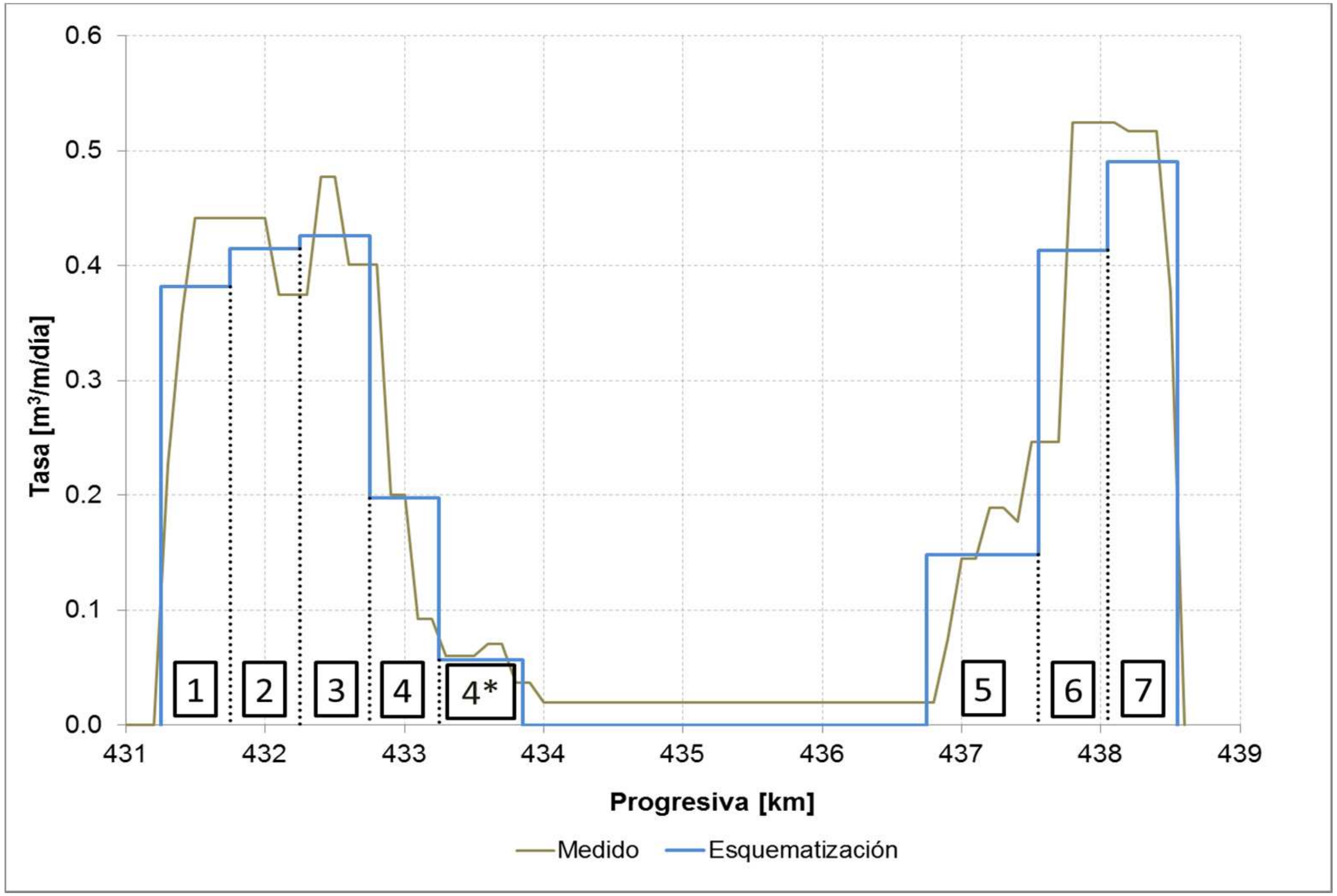
Fecha, volumen y tramo de realización de operaciones de dragado.



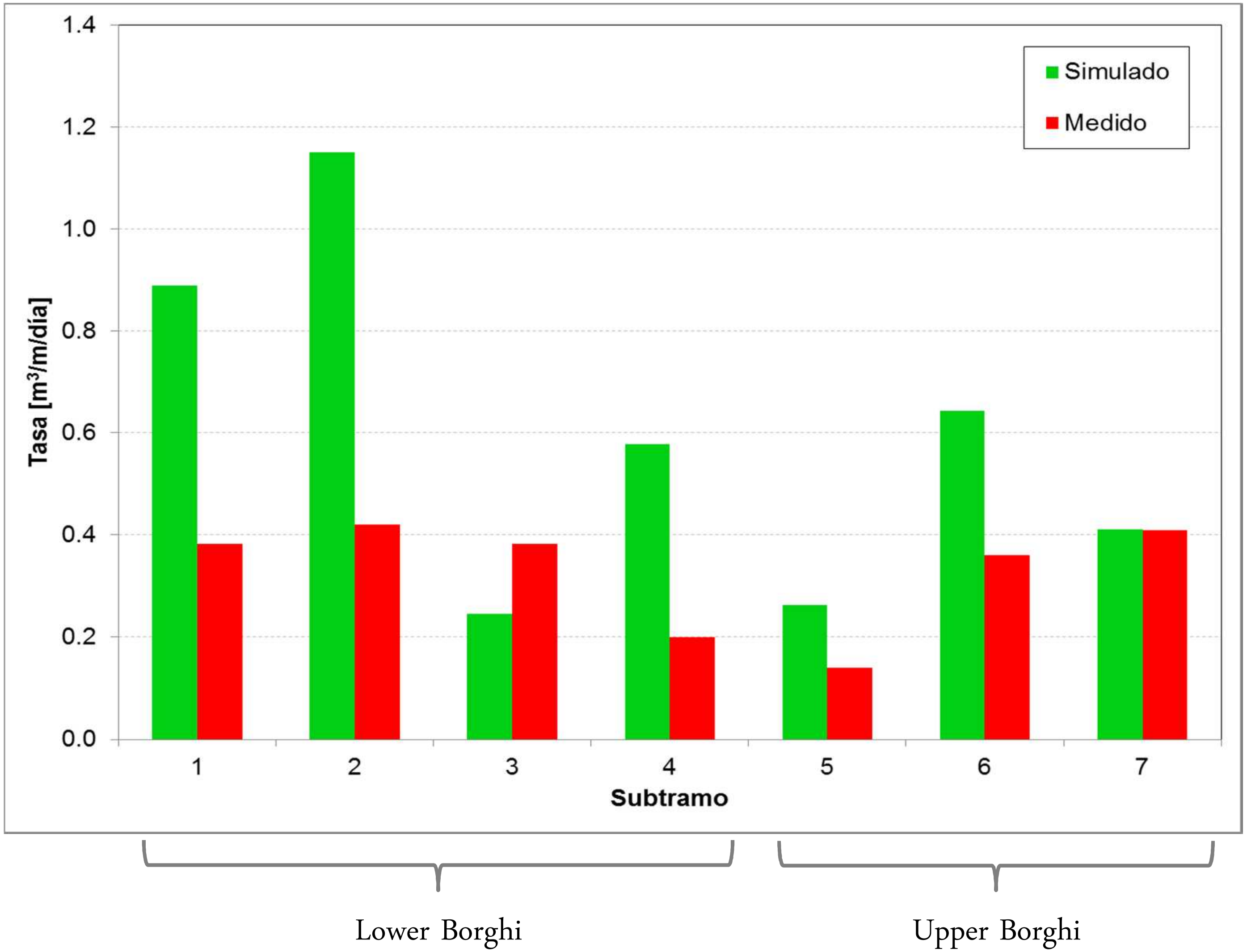


DREDGING DATA

Mean annual dredging rate



SEDIMENTOLOGIC MODEL



Assumption:

Dredging rate

=

Sedimentation rate

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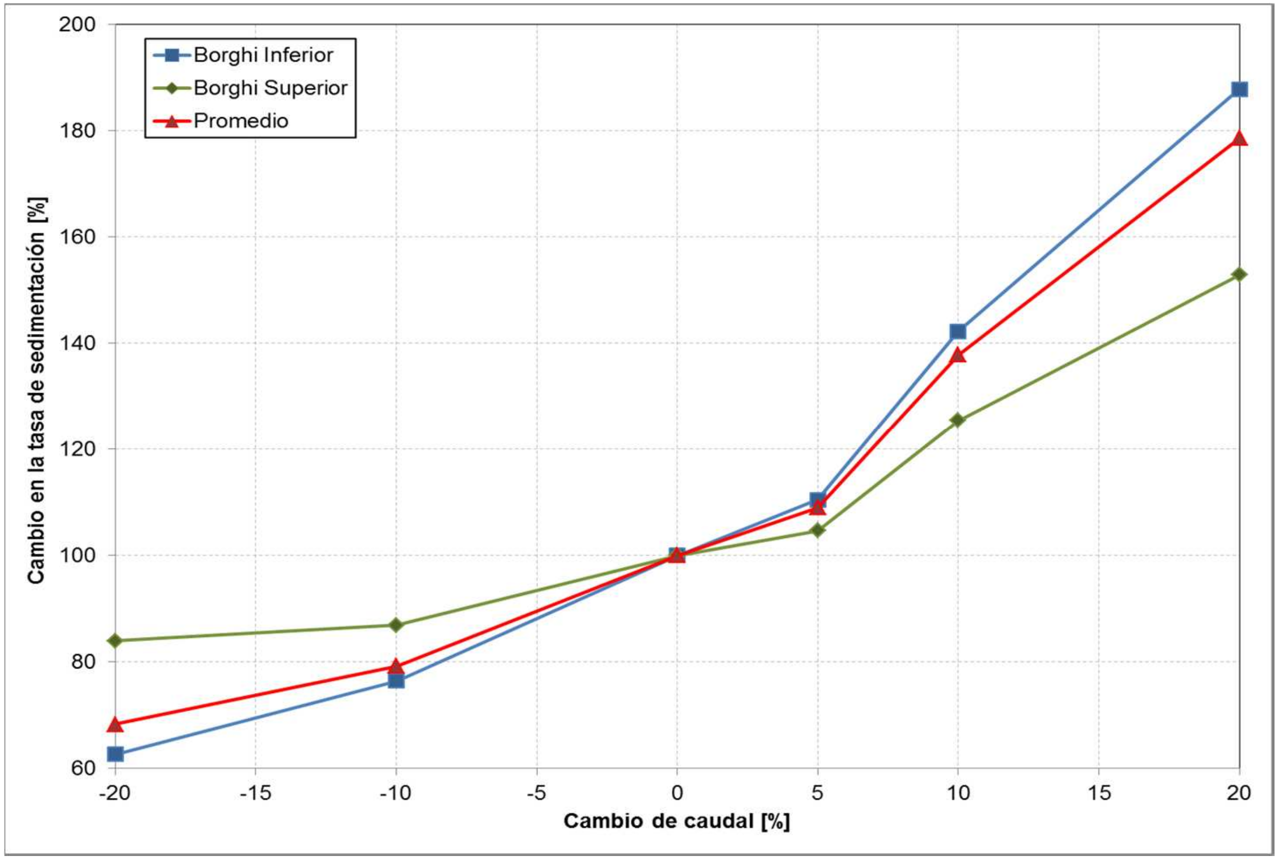
SCENARIOS

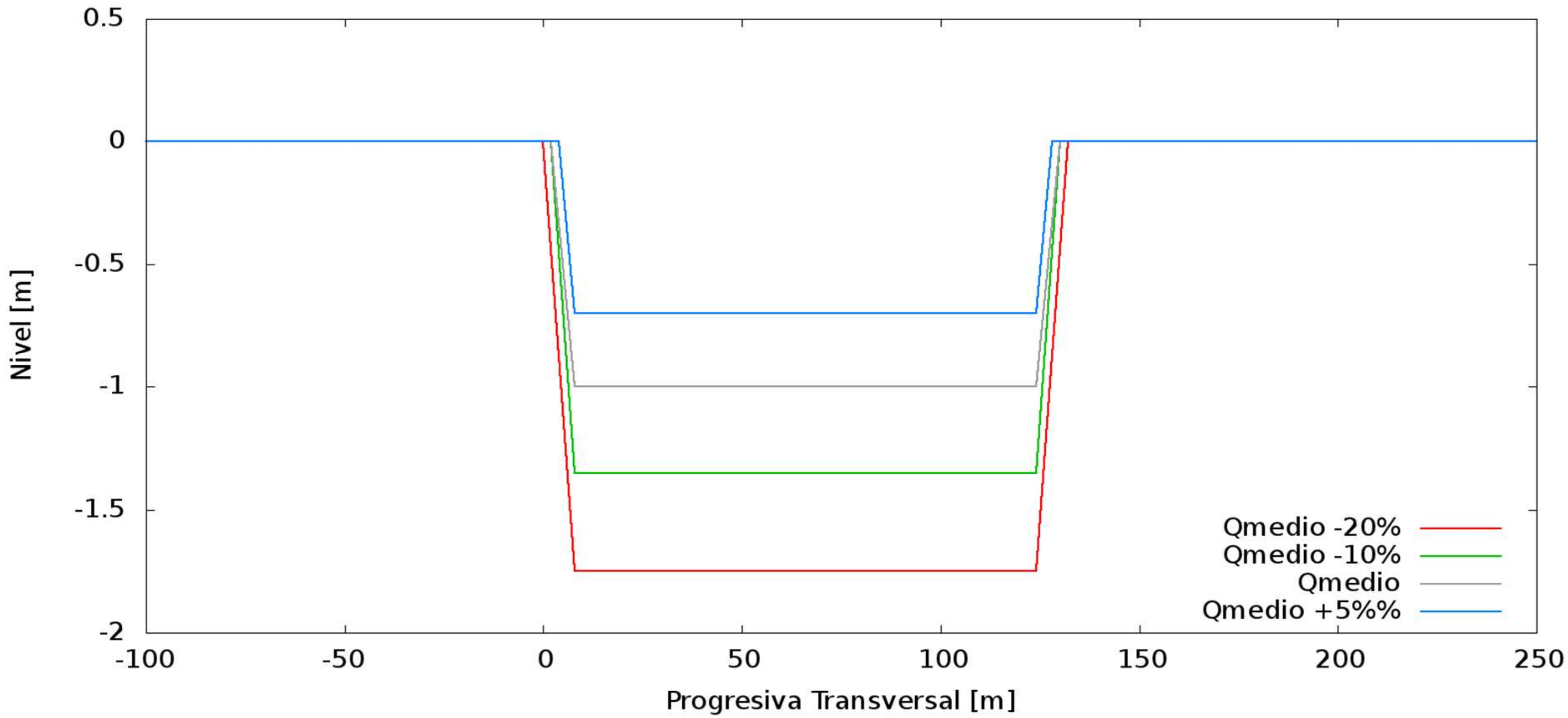
- Climate Change scenarios: *potential variations in mean river discharge*.
- Due to *uncertainties* in the future evolution of the hydrologic regime, both increment and decrement of river discharge were considered.
- Vessel drought:
  - maintaining present channel bottom elevation (no adaptation)
  - maintaining present vessel drought (adaptation)

FIXED BOTTOM ELEVATION

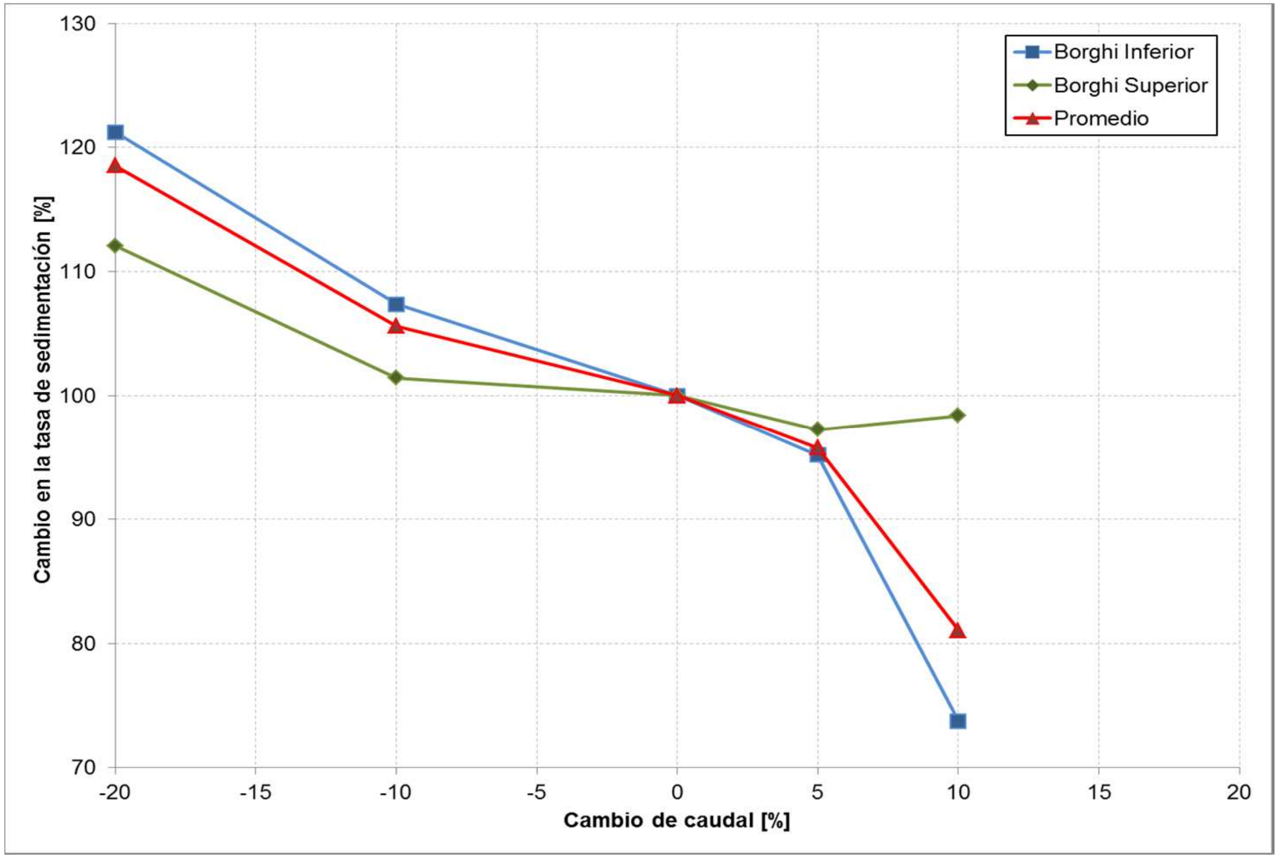


- Dredging rate increases with discharge
- Dredging rate variation significantly higher than discharge variation
- Higher increment for higher discharges

FIXED VESSEL DROUGHT



FIXED VESSEL DROUGHT



- Dredging rate decreases with discharge
- Dredging rate variation slightly higher than discharge variation
- Higher increment for higher discharges

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CONCLUSIONS

- Hydrologic changes, as a result of Climate Change, will lead to variations in *maintenance dredging* of navigation channels.
- These effects can be quantified through *numerical modeling* (hydrodynamic model + sediment transport model).
- Due to uncertainty in trends, both *positive and negative potential variations in discharge* should be studied.

CONCLUSIONS

- Dredging rate variation is always *higher* than discharge variation.
- If present dredging elevations are preserved (*no adaptation* to Climate Change), maintenance dredging would *increase* with discharge.
- If present vessel droght is preserved (*adaptation* to Climate Change), maintenance dredging would *decrease* with discharge.
- It was assumed that river morphology does not change. The evaluation of this effect is being performed elsewhere.


Hydro Predict'2012
Thank you...
http://laboratorios.fi.uba.ar/lmm