Impact of Climate Change on Gironde Estuary

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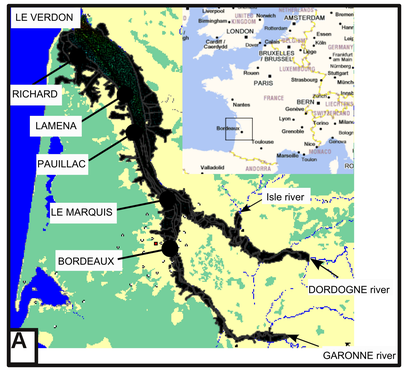
Background and objectives

Within THESEUS European project, an **overflowing numerical model** of Gironde Estuary (see figure A) has been used :

- to **calculate water levels** along Gironde Estuary and especially in the floodplain by studying the period [1960 ; 2100],
- analyse the **influence of climate change** on average and extreme water levels in the Gironde Estuary,
- map the **change in the extent of floodplains** with a special focus on **Bordeaux** region,
- using the pessimistic assumption of the French national institute for sea level rise: 60 cm in 2100 and the IPCC scenario A1B
- without any breaching nor modification of the geometry of the dikes.



Methodology

Data sources

The model was fed by several data sources :

- **wind fields** interpolated from the European Climatolologic Model CLM/SGA,
- a **global signal** (tide level given by PREDIT® + surge level) at Le Verdon,
- **river flows** of Garonne, Dordogne and Isle over [1960 ; 2009].

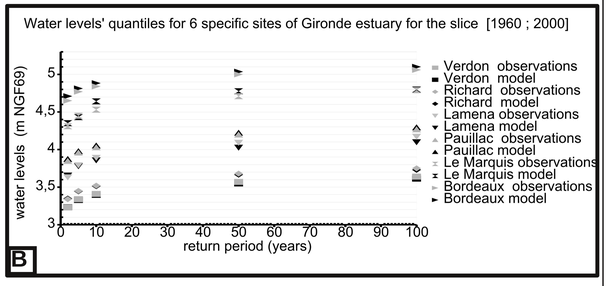
Construction of a **simplified model of surge levels δ at Le Verdon**

$$\delta = a_{CLM} * v_{moy}^2 + b_{CLM} * p_{moy} + c_{CLM}$$

- a_{CLM}, b_{CLM}, c_{CLM} adjusted by using wind (v_{moy}) and pressure fields (p_{moy}) given by CLM/SGA and instantaneous surge levels measured for 10 events

Validation of the numerical model of Gironde Estuary for [1960 ; 2000]

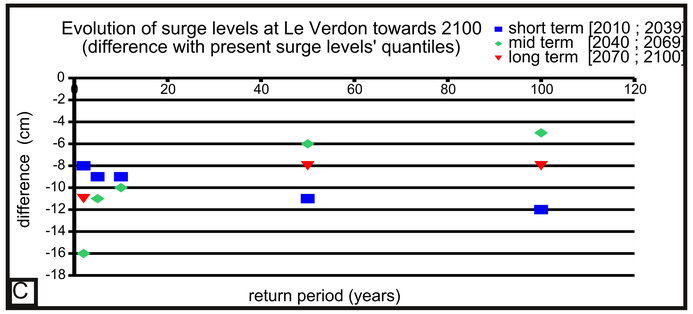
- difference between quantiles based on measurements and numerical results less that 6 cm at 6 validation sites (located on Figure A) (3 cm downstream of the Marquis) (Figure B)



Results

Evolution of surge levels at Le Verdon towards 2100 for A1B scenario

- a decrease in quantiles of surge levels at Le Verdon (Figure C) coherent with the analysis of the evolution of climatologic fields
- ~ 10 cm of decrease in quantiles of surge levels for short and long term periods



Evolution of water levels towards 2100 for A1B scenario

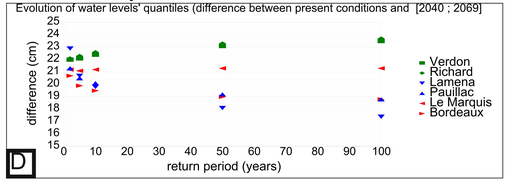
- sea level rise (60 cm towards 2100) directly responsible for the increase of water levels and particularly at its maritime boundary at Le Verdon

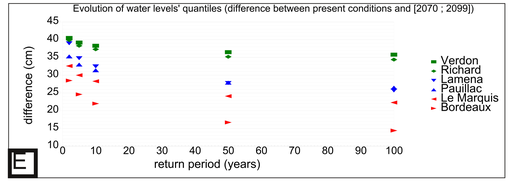
► short term ([2010 ; 2039]): 4 to 8 cm except at Bordeaux

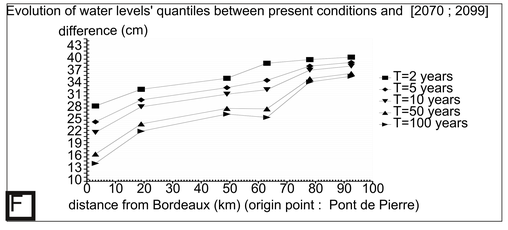
► mid term ([2040 ; 2069]): around 20 cm (see Figure D)

► long term ([2070 ; 2099]): around 38 cm at the maritime frontier, 30 cm in the middle part of the estuary and 25 cm near Bordeaux (Figure E)

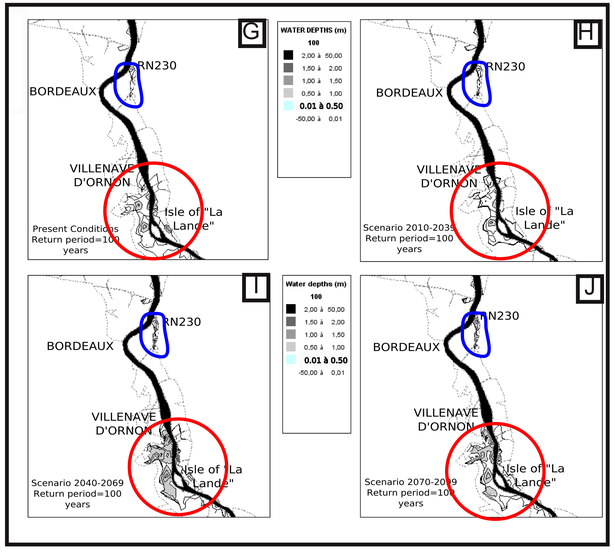
- the impact of sea level rise seems to decrease from the maritime boundary of the model to the upstream (Figure F)







Evolution of floodplains in Bordeaux region towards 2100 for A1B scenario



Figures G, H, I, J : Quantiles of water-depths for a 100-year event in the region of Bordeaux for the current time period and in the short, medium and long term

boundary of the model

isolines of water depth

- **deep impact of the mean sea level rise** during the slice considered.
- no major change towards 2100, but **areas not flooded today for weak return periods become submerged towards 2100**.
- **significant effects (+80 cm) along the road RN230** towards 2100 (blue circle on Figures G to J).
- **steep-sided areas more filled** (in red and blue on Figures G to J)
- area south of Villenave d'Ornon strongly affected : + 25 cm until 2100 (red circle on Figures G to J).

Conlusions and perspectives

- a **big influence of climate data** (wind and pressure) on results will lead to perform the study with **other climate forcing sources** and a **bidimensionnal surge level model** calibrated with them
- necessity of a future study on the effects of the discharges and dike breaching

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Acknowledgments

This work has been financially supported by the EU through the FP7 project THESEUS.

Special thanks to the CETE South-West, METEO-FRANCE, the SPC Littoral Atlantique and SOGREAH.

EGU General Assembly 2014
April 2014