ENGEES
L'école de l'eau et de l'environnement

SWAT Soil & Water Assessment Tool

International SWAT Conference – Strasbourg – July 2024

Climate change impacts on the **river-sea interface** of a large **French catchment delta** undergoing multiple anthropogenic pressures

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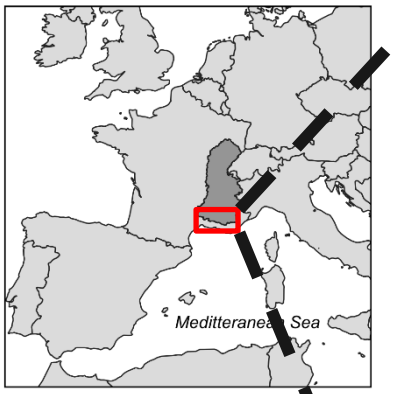
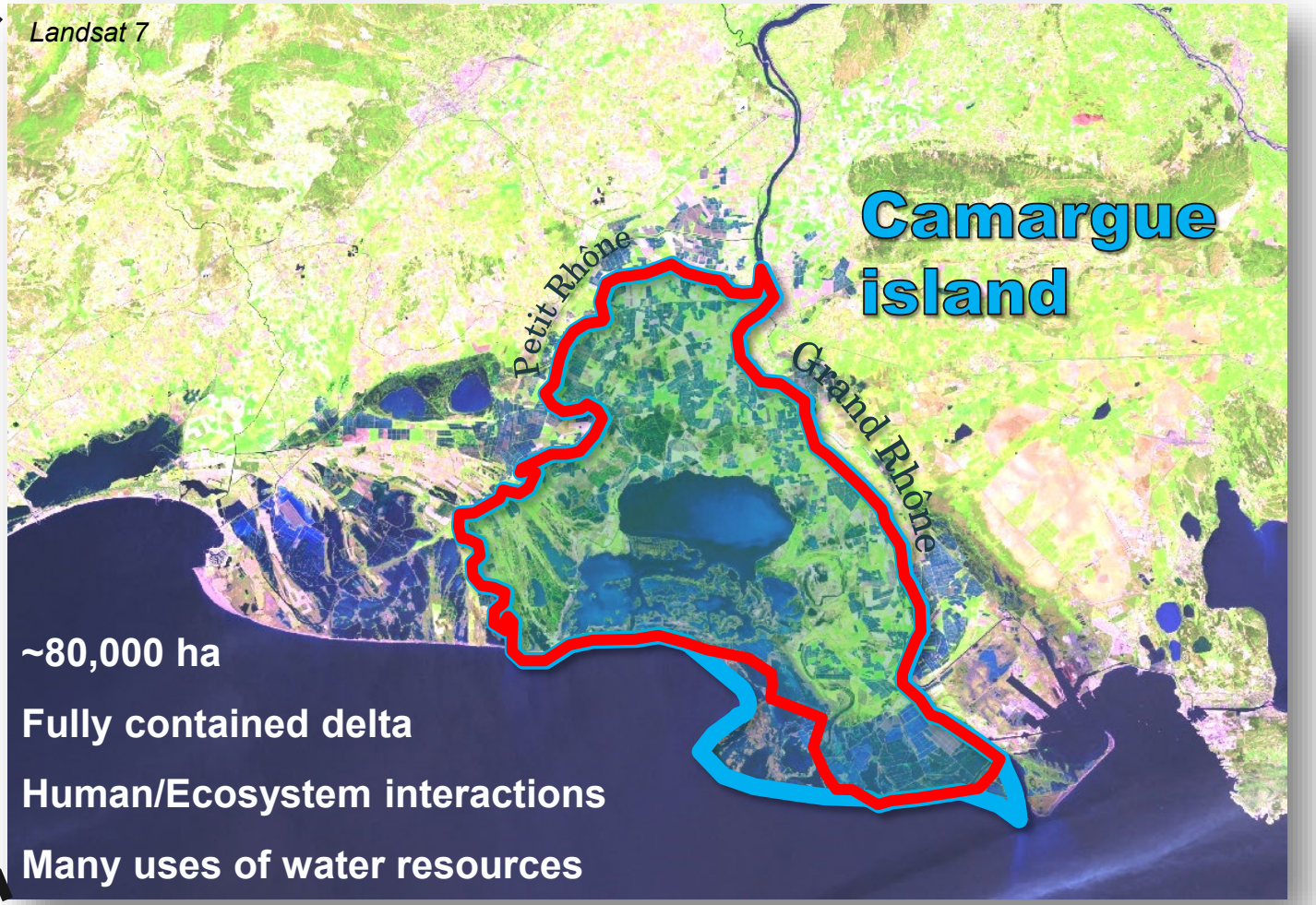


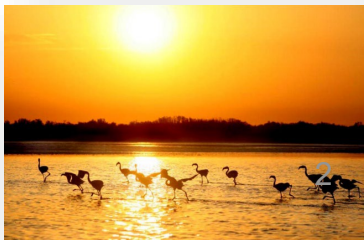


Agriculture

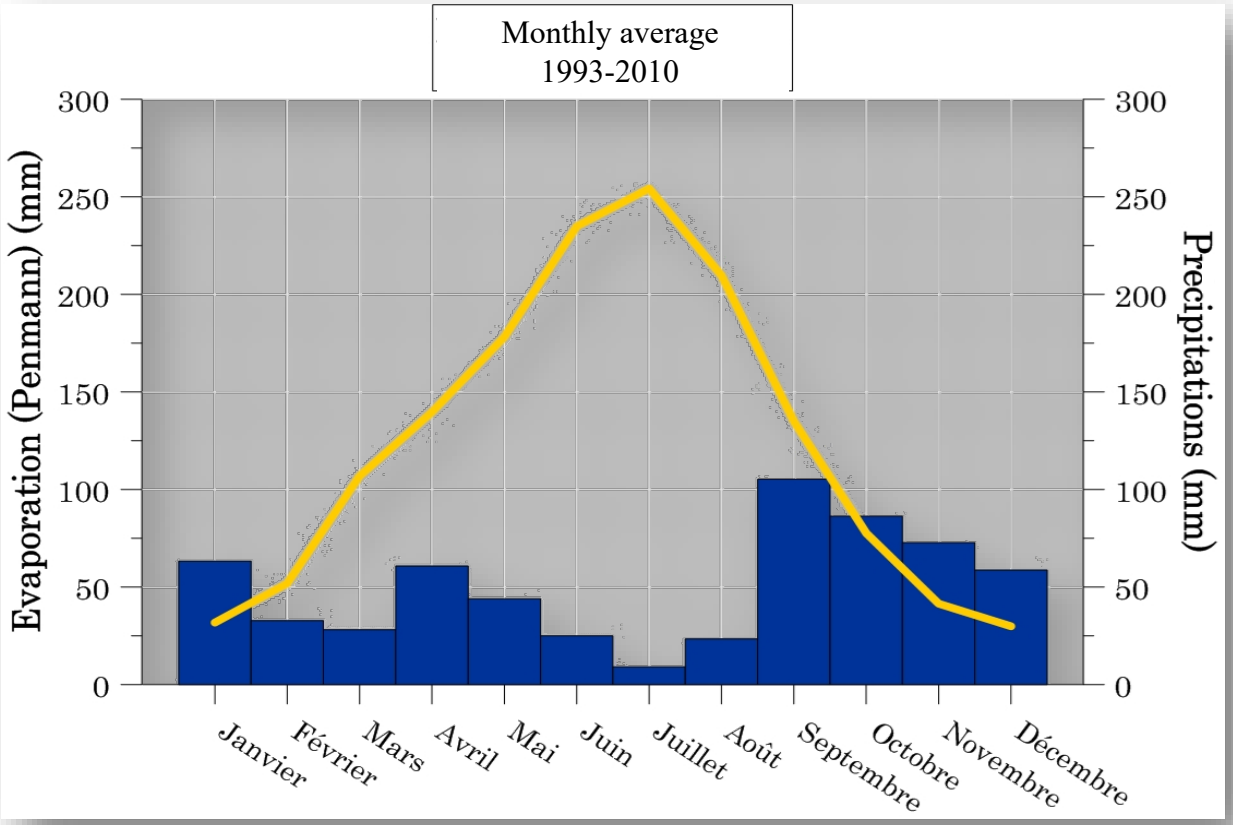
Fishing

Salt production

Wildlife (migrator birds)



Delta climatology



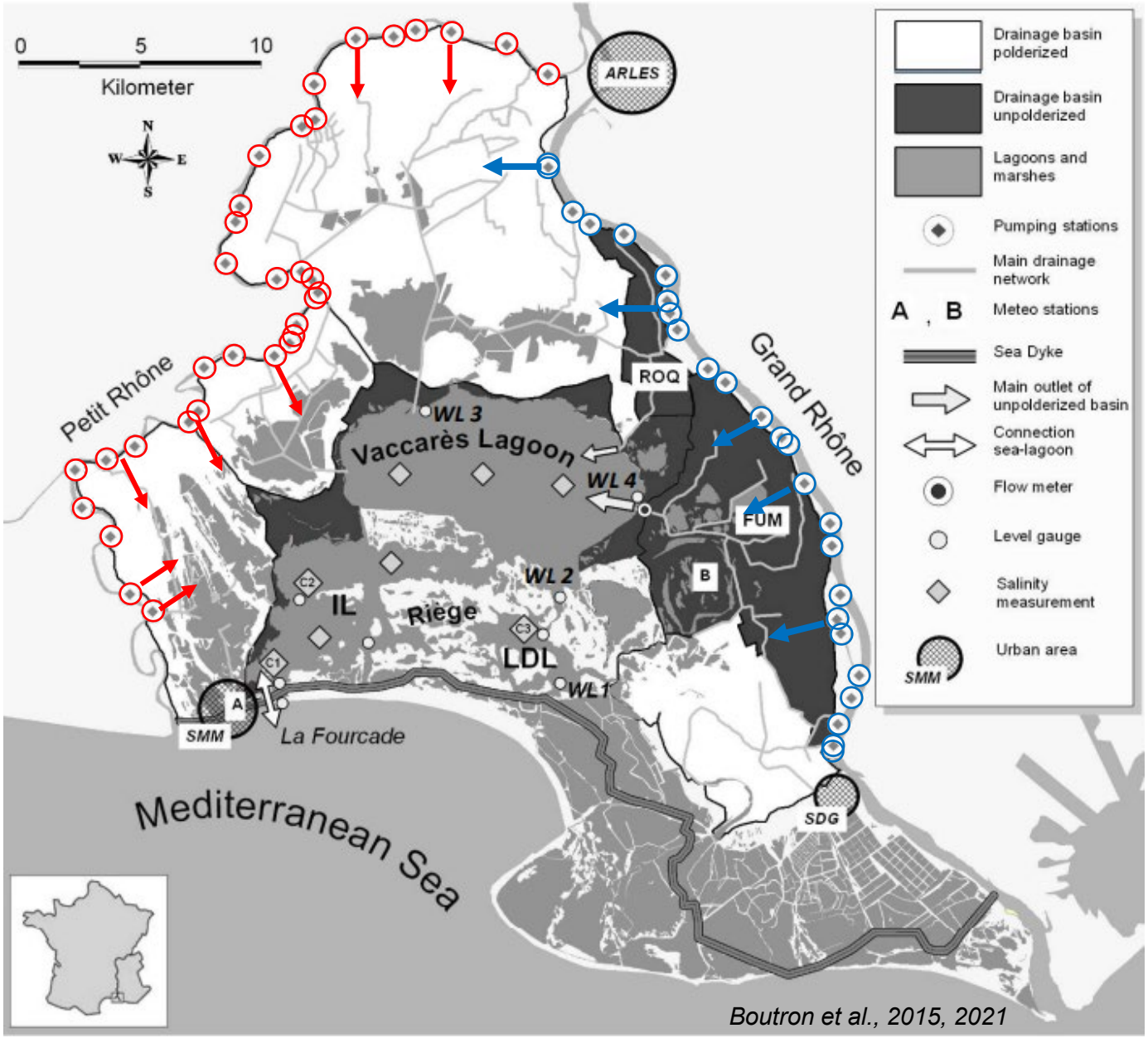
Precipitation amount = **600 mm**

Evaporation = **1500 mm**

Water deficit
= **900 mm**

⇒ With current activities, inputs from the Rhône river are needed for the stability of ecosystems and of human activities

Camargue island and interactions with the Rhône River



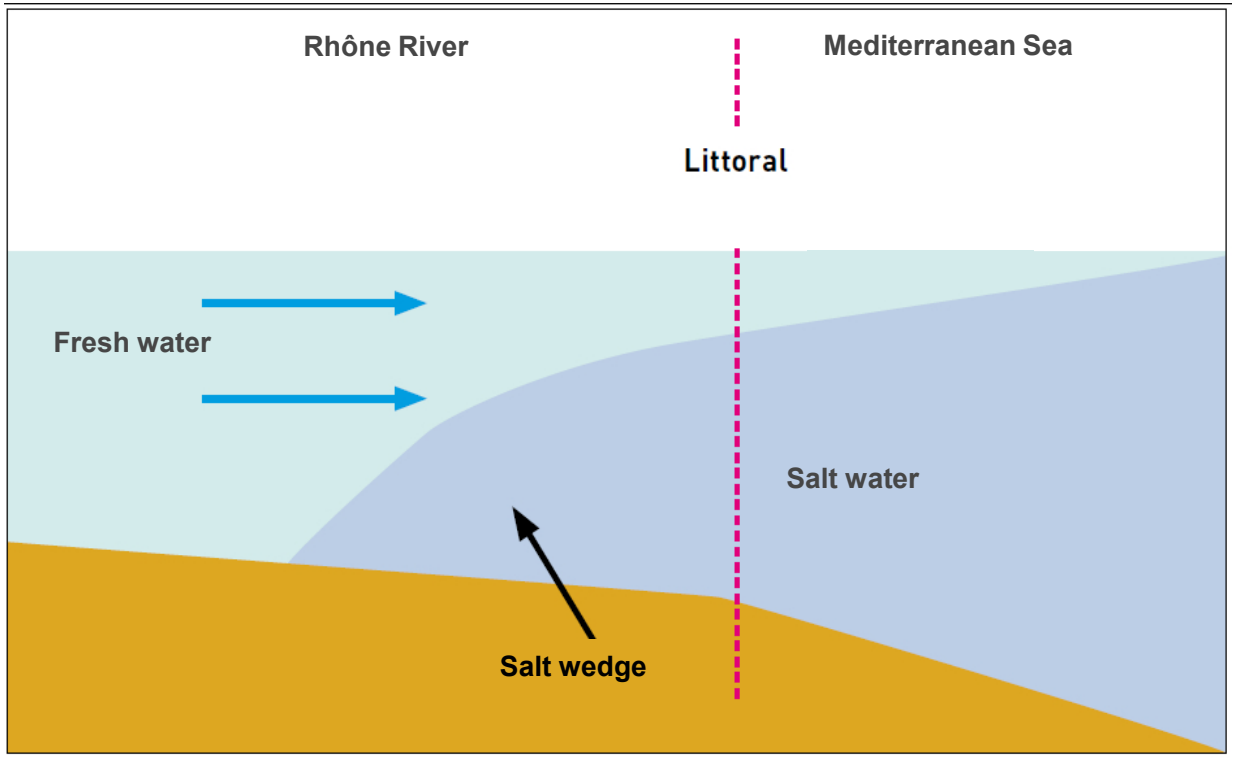
Boutron et al., 2015, 2021

300 to 400 M m³ each year

- 25 stations on the Grand Rhône
- 34 stations on the Petit Rhône

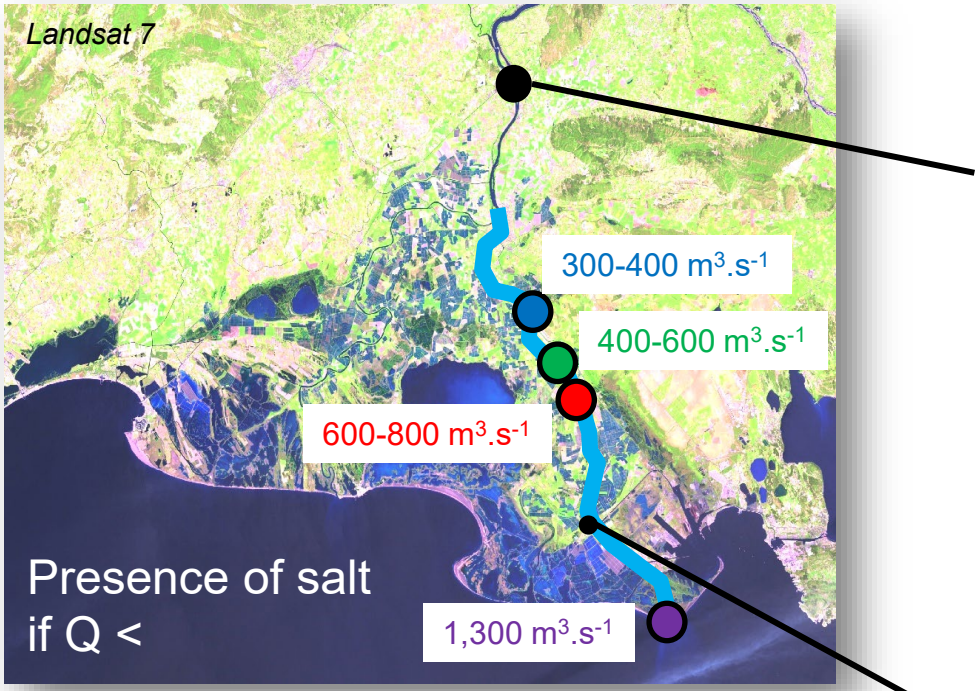
⇒ many ecosystems, species and human activities depend on the water of the Petit Rhône and the Grand Rhône

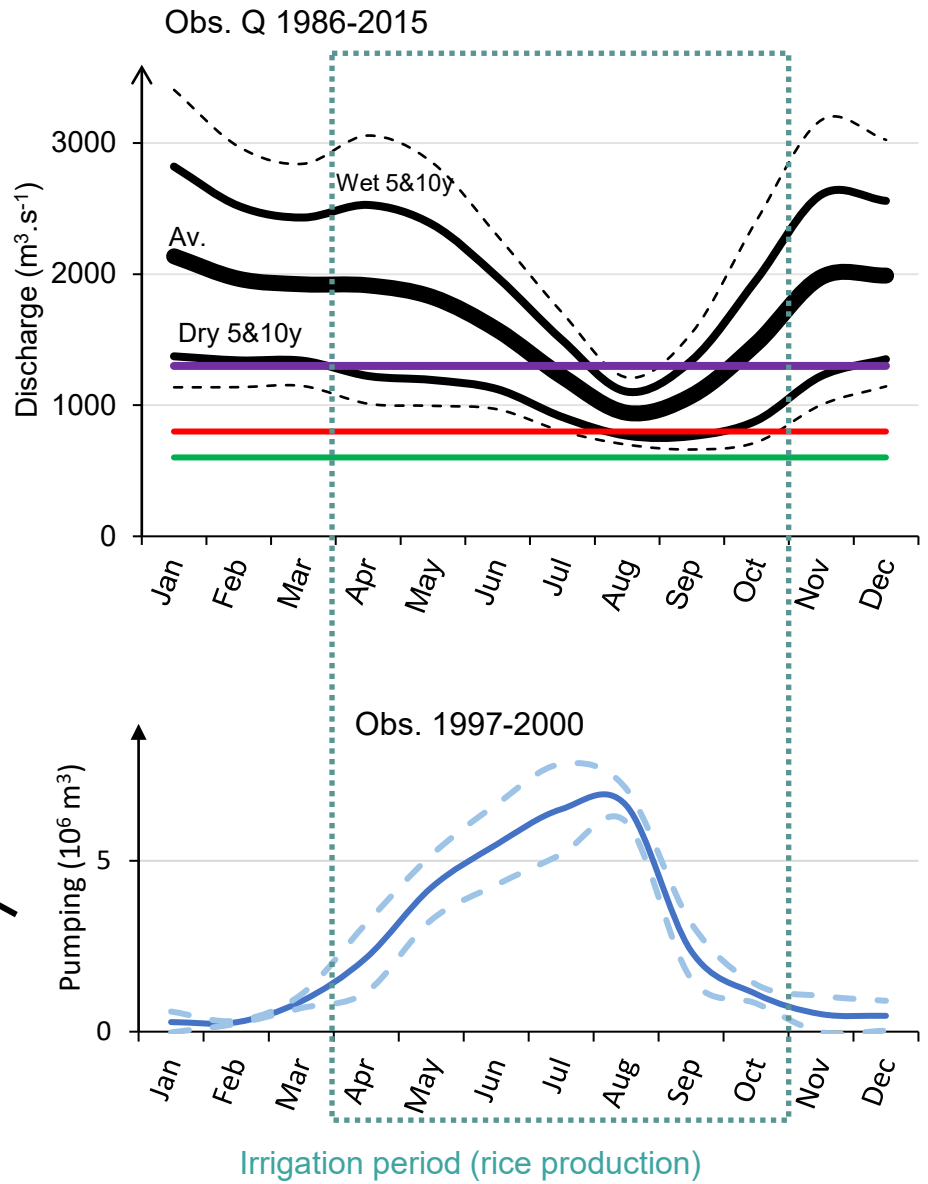
Pumping stations disabled with the presence of salt



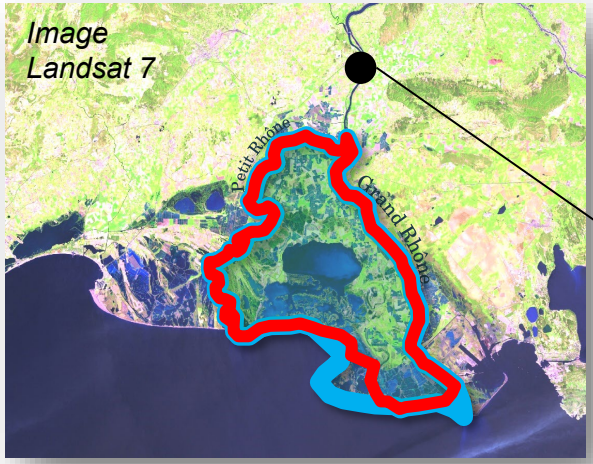
Delaval, 2021

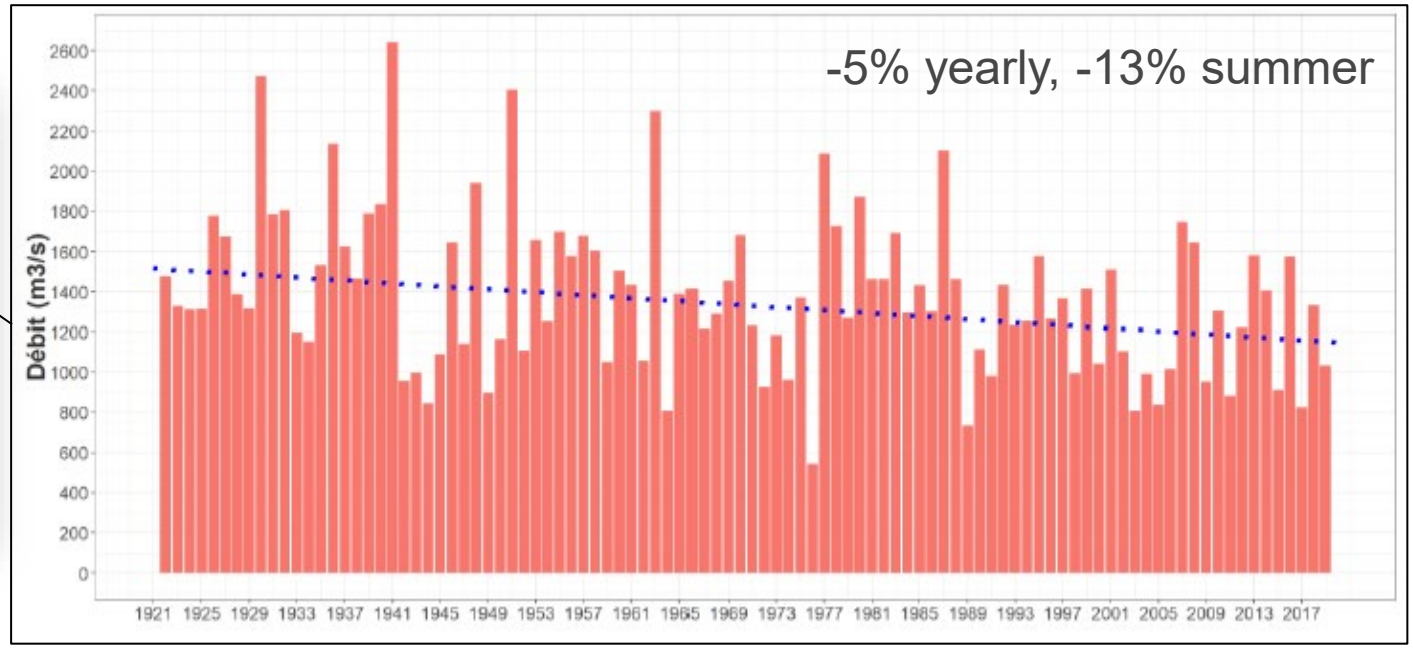
- Freshwater controls salt entrance (Krvavica and Ruzic, 2020; Delaval, 2021)
- With lower freshwater exports, salt water could enter into the delta



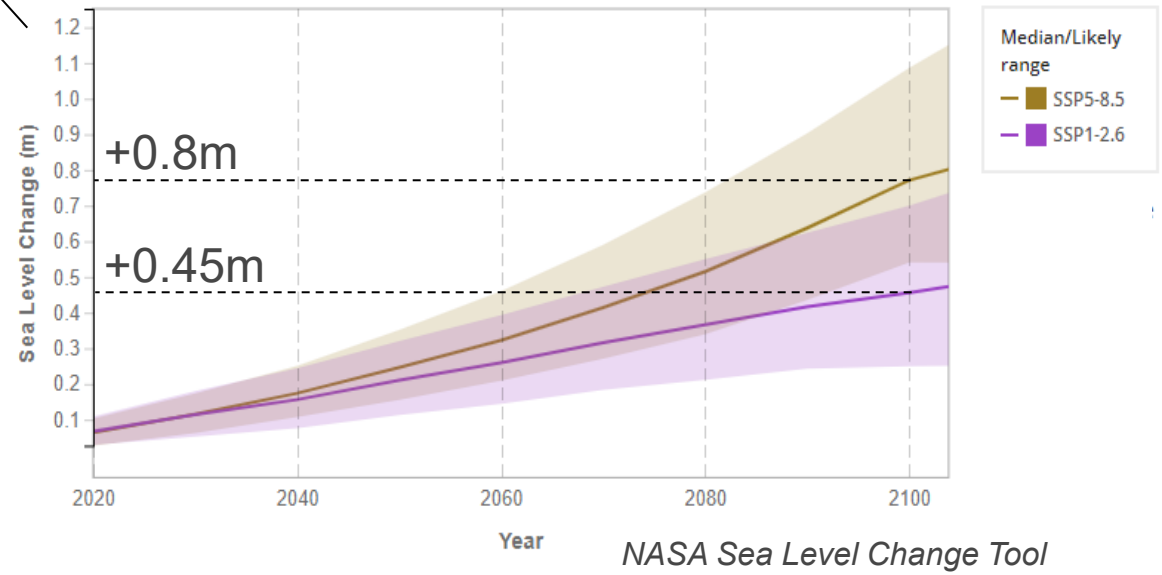


BRLi, 2004; 2023





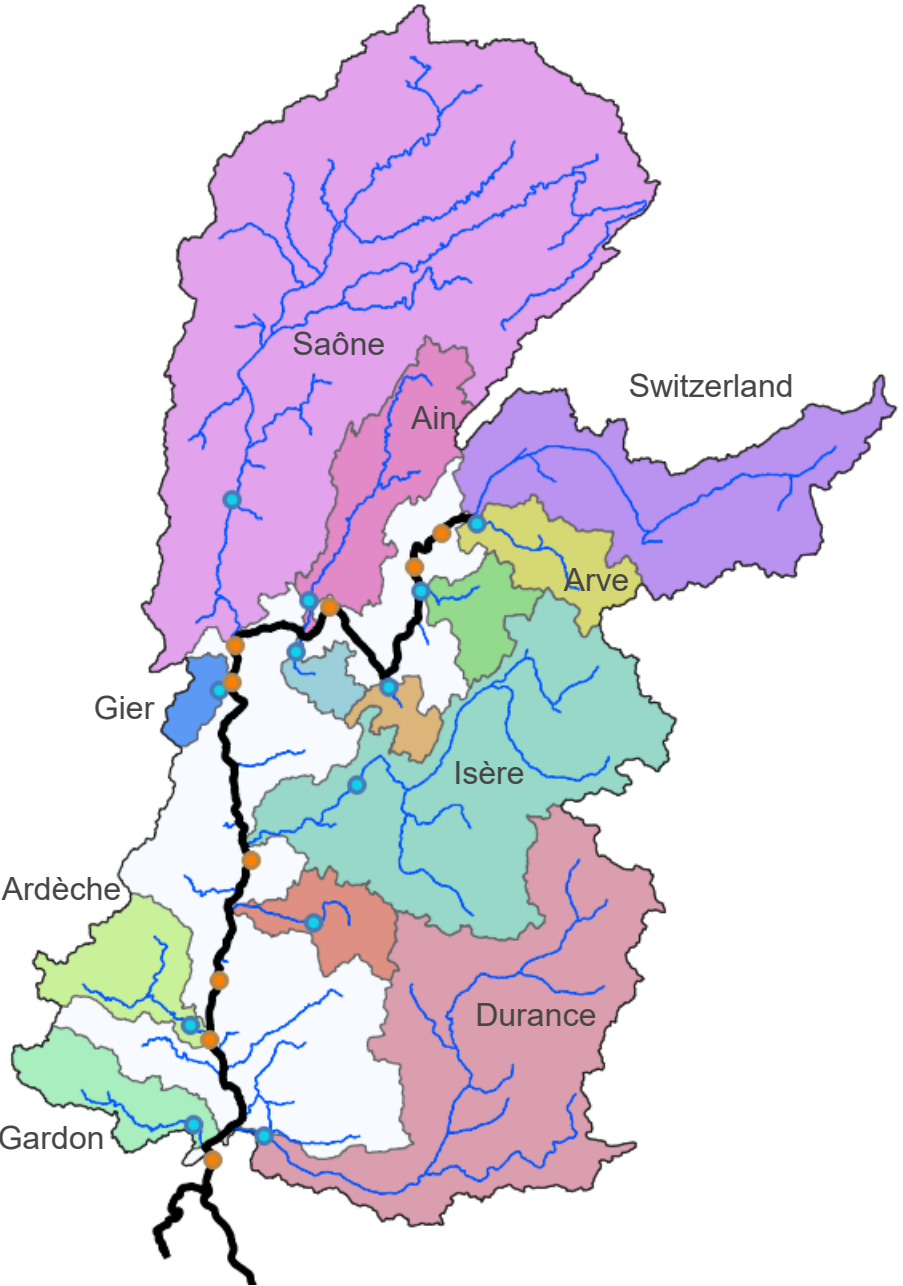
BRLi, 2023



NASA Sea Level Change Tool

- What are the impacts of climate change on the Rhône River discharge?
- How future variations of the Rhône River discharge (and sea level rise) will affect salt entrance in the Rhône delta?
- Which pumping stations will face salt issues in the coming century?

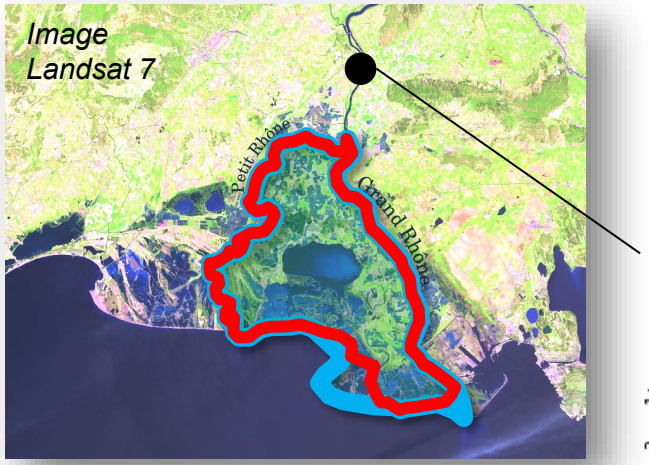
Main subcatchments & observed data selected for calibration

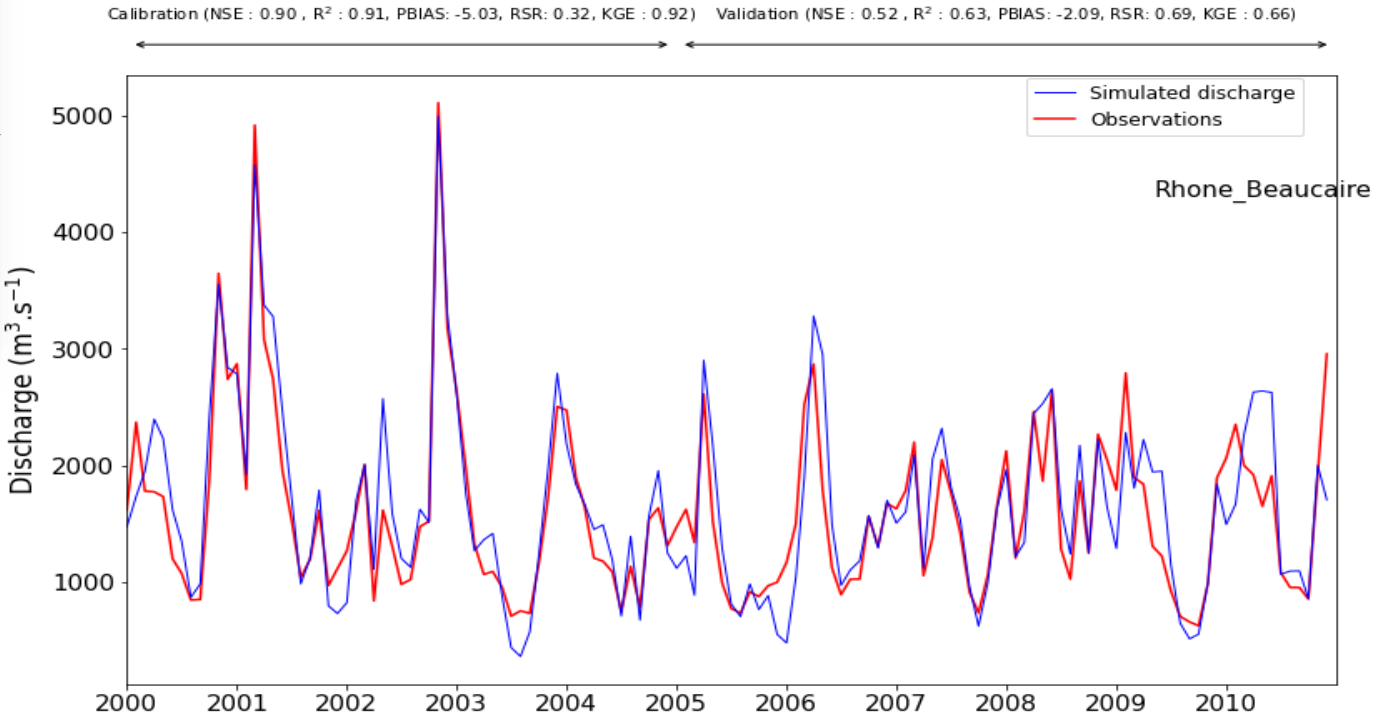


- 9 gauging stations on the Rhône corridor
- 12 gauging stations to calibrate the main subcatchments

Calibration from upstream to downstream & independant for each subcatchment

Fabre et al., in prep.





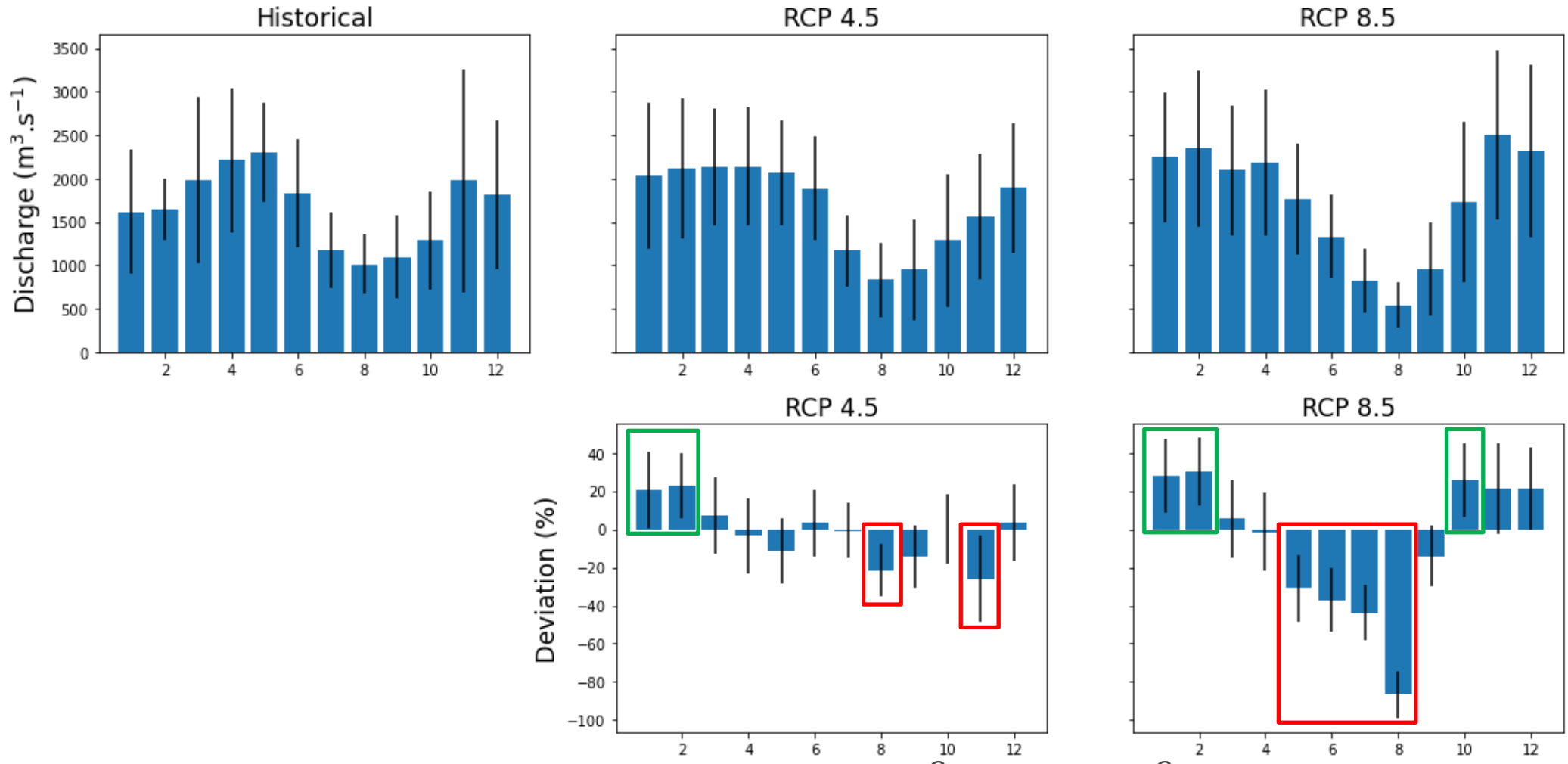
Based on calibration from Fabre et al. (*in prep.*)

- Run with 3 climate models: CNRM, ICHEC, MPI and 2 RCPs: 4.5 & 8.5 (1996-2100)

Discharge variations under RCPs 4.5 and 8.5 at the Rhône outlet (2071-2100)

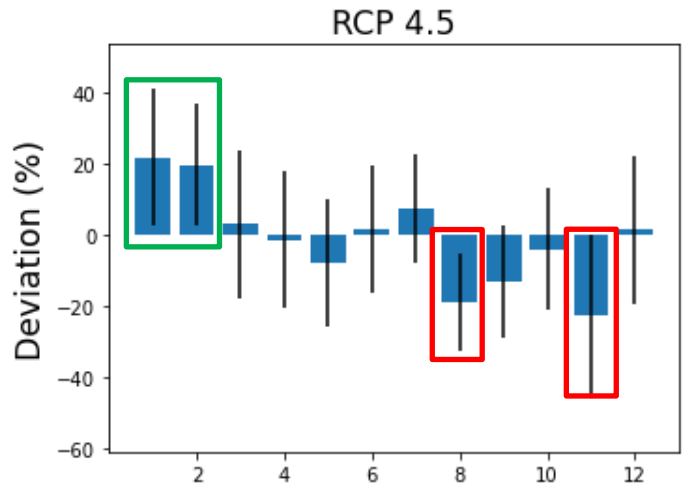
1996-2005

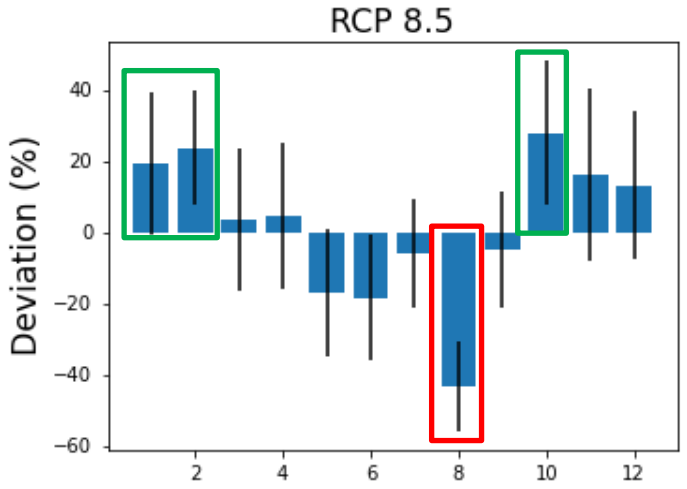
2071-2100

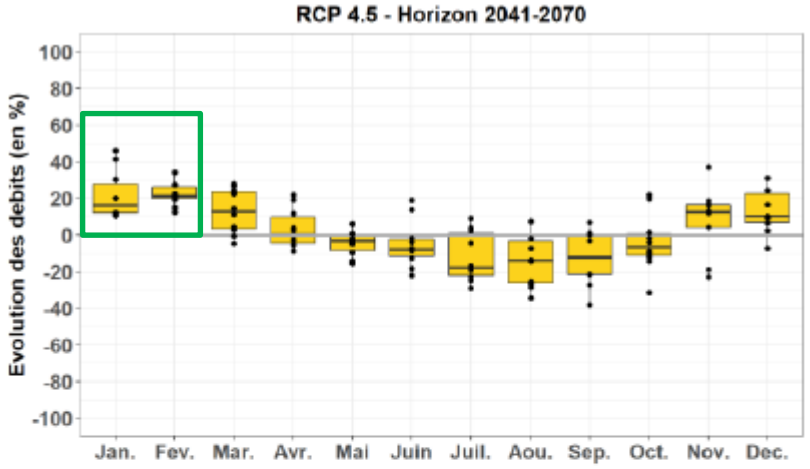


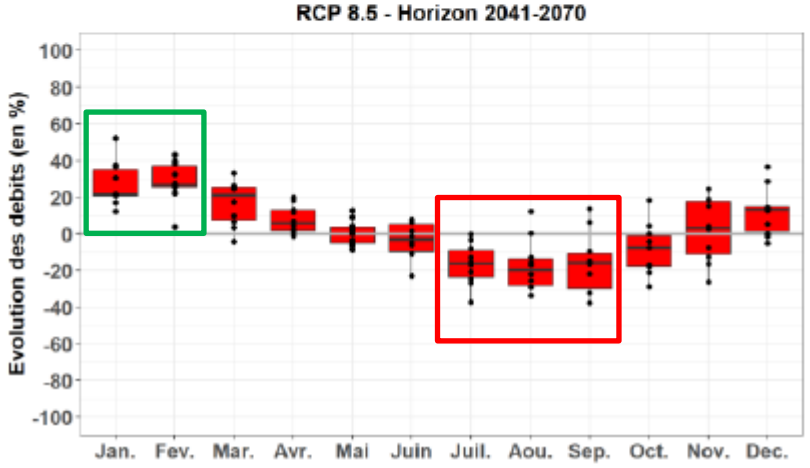
$$Dev\ (\%) = \frac{Q_{2071-2100} - Q_{1996-2005}}{Q_{1996-2005}}$$

Discharge variations under RCPs 4.5 and 8.5 at the Rhône outlet (2041-2070)

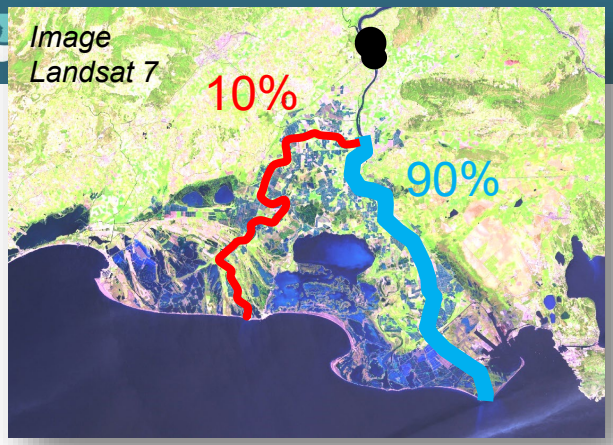








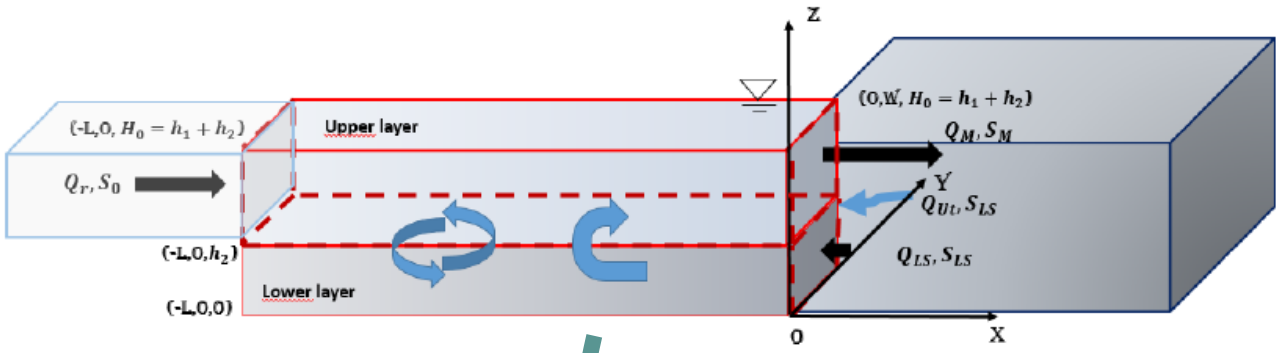
BRLi, 2023, J2000-Rhône model, 10 climate models

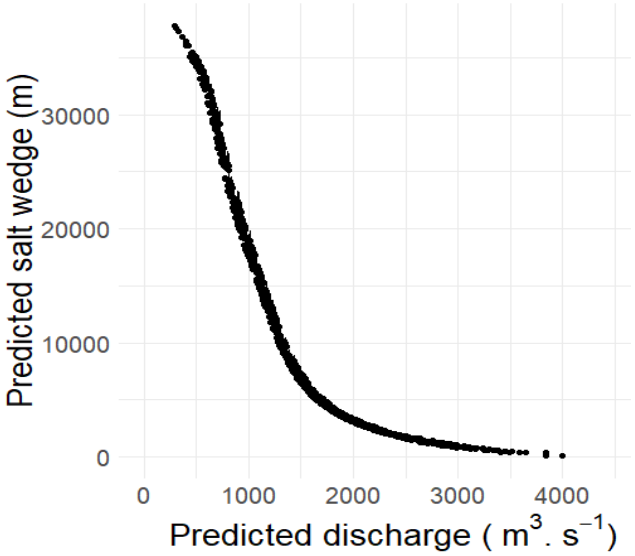


NASA Sea Level Projection Tool

SWAT with $Q_{Grand\ Rhône}$ = 90% $Q_{outlet\ SWAT}$

River model — DRACAR : Estuarine « box-model » — Marine Model



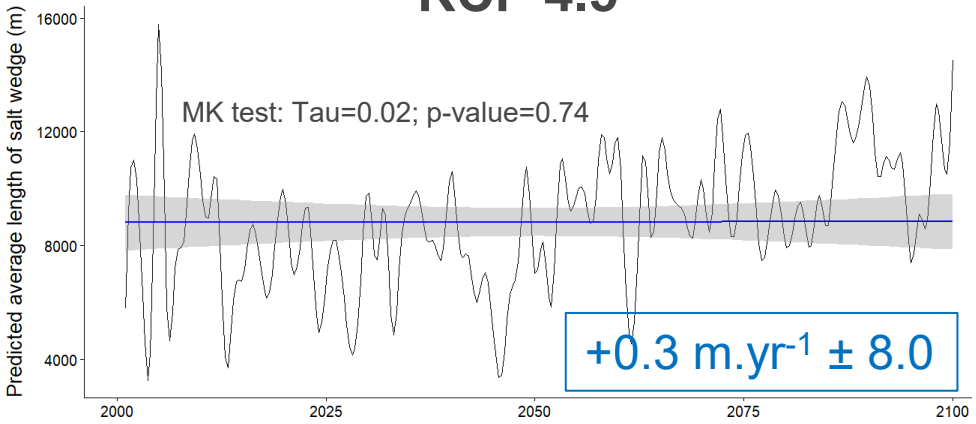


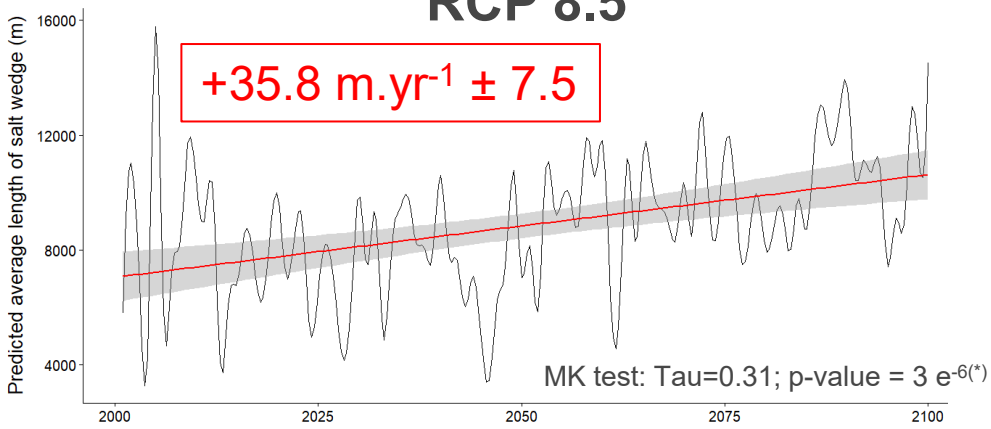
Delaval, 2021

RCP 4.5

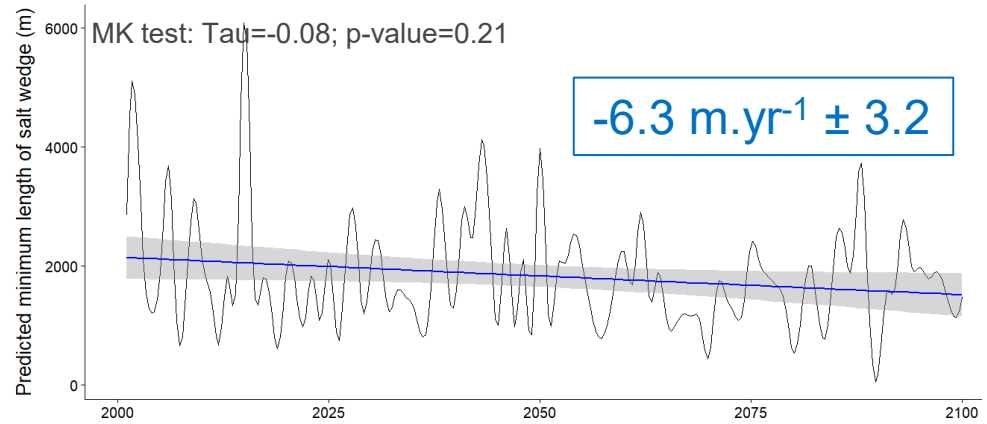
RCP 8.5

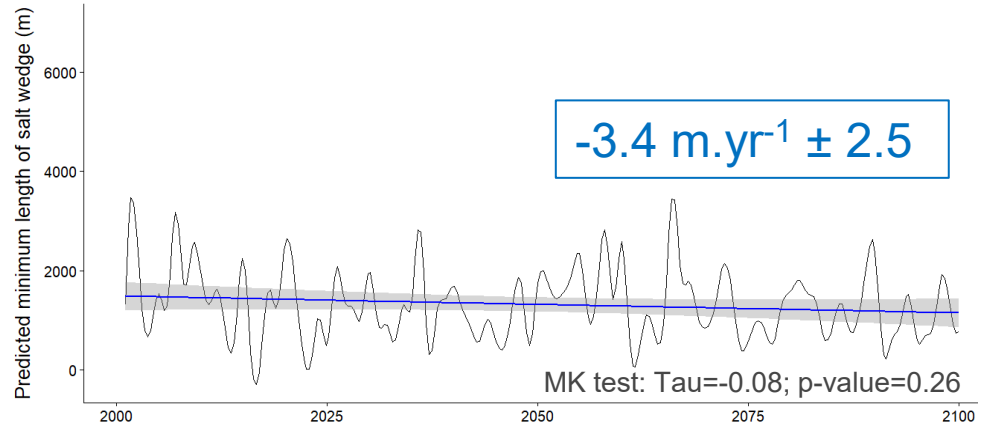
Yearly Average



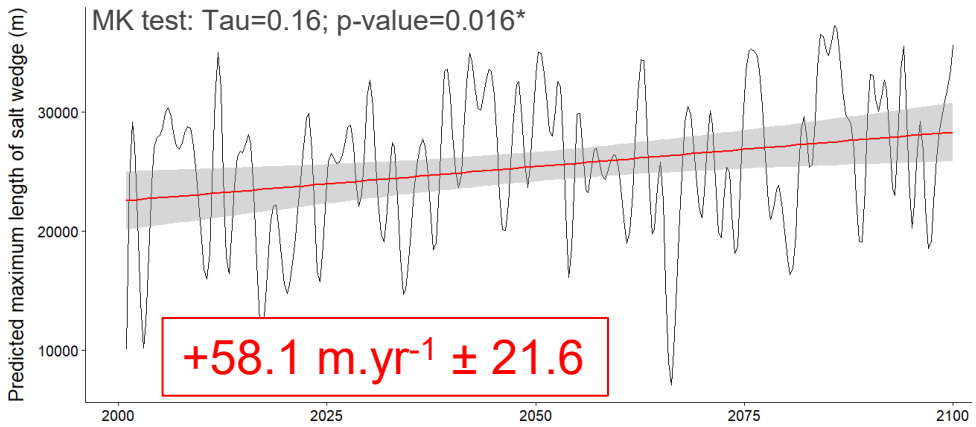


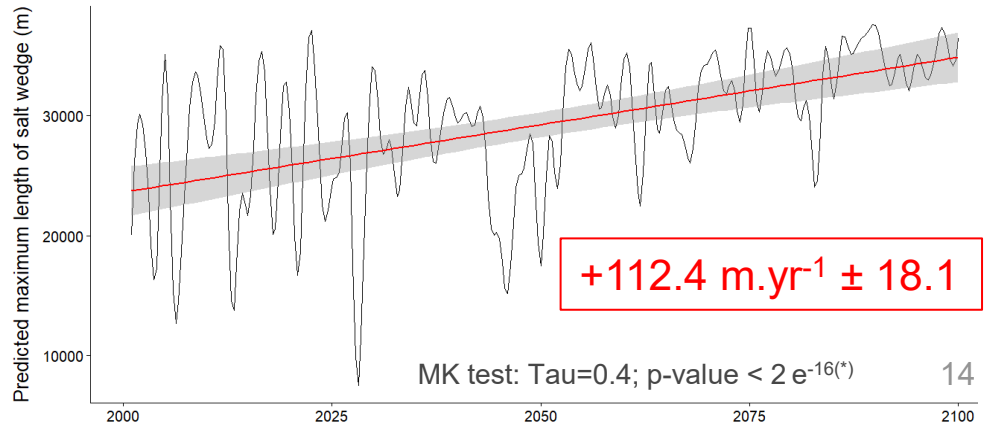
Yearly Minimum

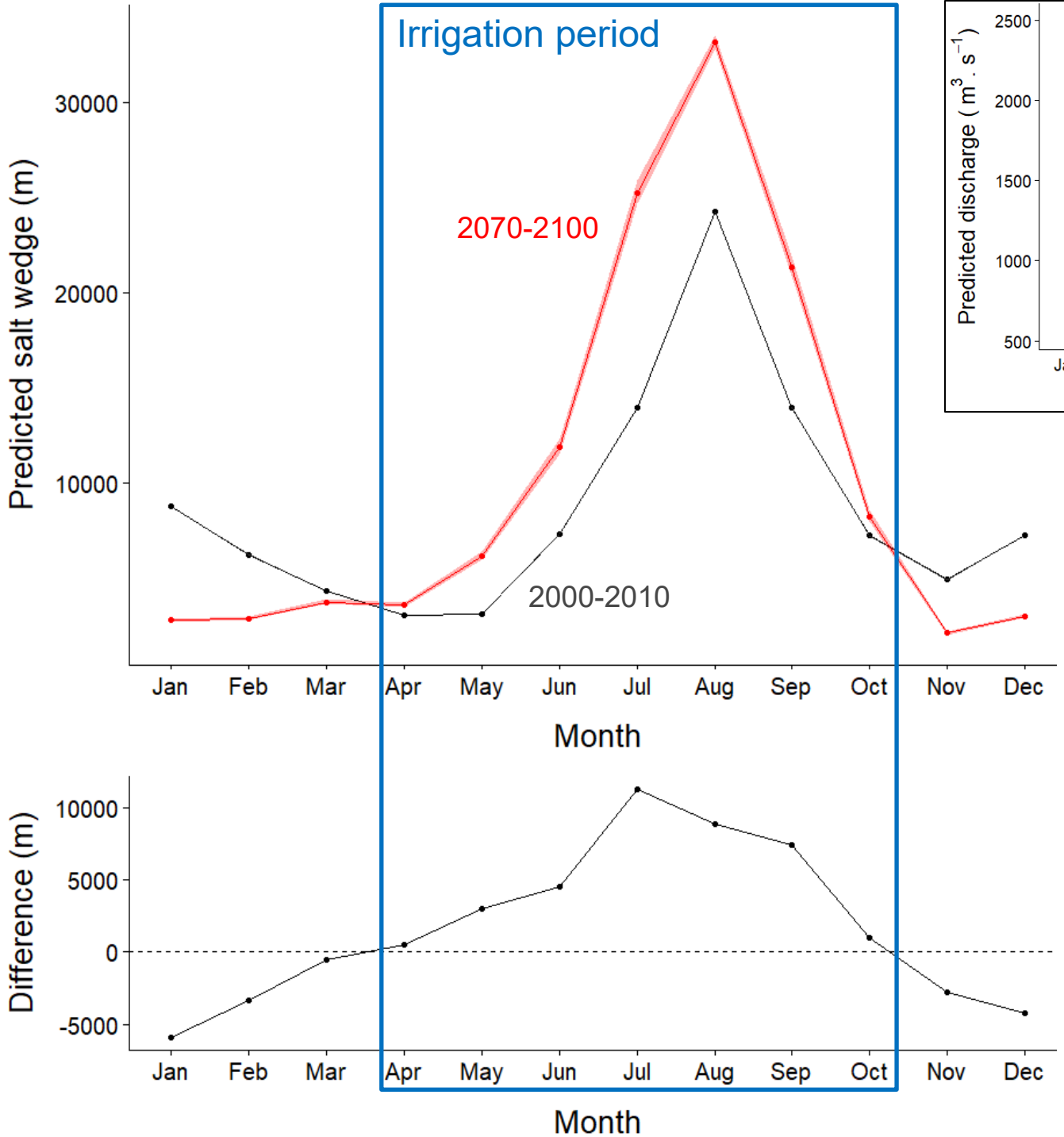


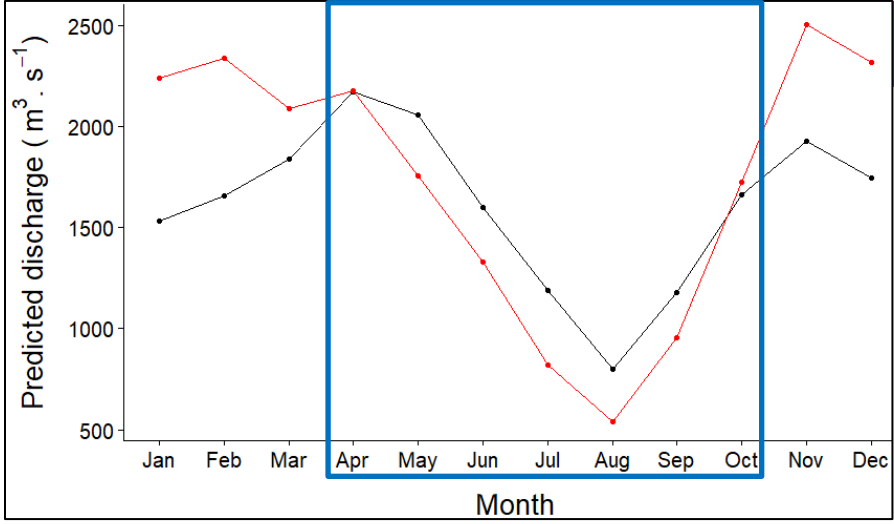


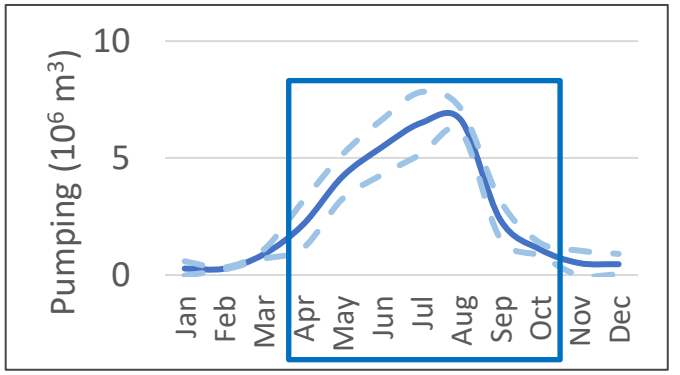
Yearly Maximum





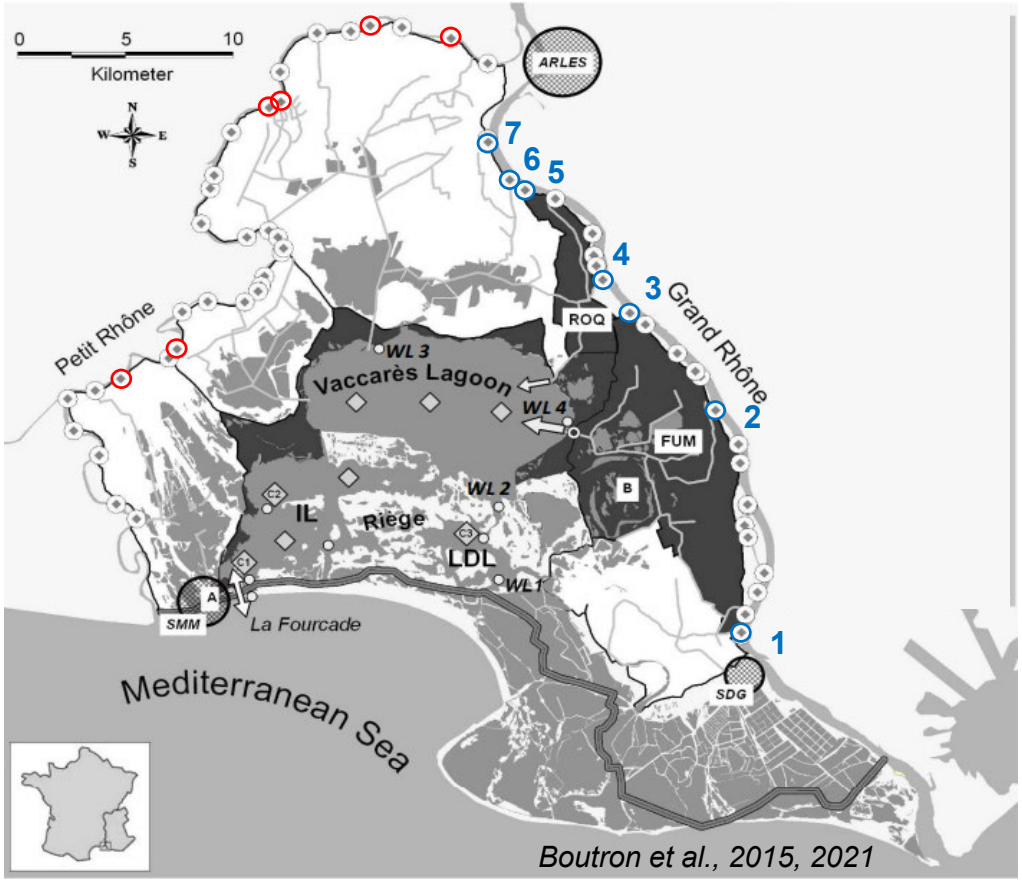






Rice period: April-October

Collective irrigation stations



Boutron et al., 2015, 2021

% of months with presence of salt

RCP 4.5

Current

Station	Distance to sea (km)	Apr	May	Jun	Jul	Aug	Sep	Oct
7	44.26	0	0	0	0	0	0	0
6	42.38	0	0	0	0	0	0	0
5	41.45	0	0	0	0	0	0	0
4	34.92	0	0	0	0	0	0	0
3	32.96	0	0	0	0	0	0	0
2	26.6	0	0	0	0	30	10	20
1	14.85	0	0	0	40	70	60	40

Future

Station	Distance to sea (km)	Apr	May	Jun	Jul	Aug	Sep	Oct
7	44.26	0	0	0	0	0	0	0
6	42.38	0	0	0	0	0	0	0
5	41.45	0	0	0	0	0	0	0
4	34.92	0	0	0	0	13	10	3
3	32.96	0	0	0	0	17	20	7
2	26.6	0	0	0	7	50	33	10
1	14.85	0	0	0	50	83	80	43

RCP 8.5

Current

Station	Distance to sea (km)	Apr	May	Jun	Jul	Aug	Sep	Oct
7	44.26	0	0	0	0	0	0	0
6	42.38	0	0	0	0	0	0	0
5	41.45	0	0	0	0	0	0	0
4	34.92	0	0	0	0	10	0	0
3	32.96	0	0	0	0	20	0	0
2	26.6	0	0	0	10	50	10	0
1	14.85	0	0	10	40	80	40	20

Future

Station	Distance to sea (km)	Apr	May	Jun	Jul	Aug	Sep	Oct
7	44.26	0	0	0	0	0	0	0
6	42.38	0	0	0	0	0	0	0
5	41.45	0	0	0	0	0	0	0
4	34.92	0	0	0	7	53	3	0
3	32.96	0	0	0	13	63	20	0
2	26.6	0	0	3	53	93	40	3
1	14.85	3	3	33	90	100	80	20

- This study coupled a watershed model (SWAT), an estuarine model (DRACAR), and a marine model (NASA Sea Level Projection Tool) to assess salt intrusion in the delta

- Average salt intrusion increases by +35.8 $m.yr^{-1}$ in RCP 8.5
- Maximum salt intrusion increases by +58.1 $m.yr^{-1}$ (RCP 4.5) and +112.4 $m.yr^{-1}$ (RCP 8.5)

- 4 out of 7 collective irrigation stations should face salt issues between June and September (during rice production)

- Watershed simulation do not include dams management: With decreases in water availability during summer:
  - Will dams store more leading to less water delivered to the delta during this critic period?
  - Will it induce too many issues for rice production?

Thank you for your attention

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