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## **Integrating human water uses in a regional scale distributed hydrological model : model evaluation**

Flora Branger, Louise Mimeau, Louise Crochemore, Jeremie Bonneau, Baptiste Lévêque, Nathan Pellerin, Emilie Chaix, Ruben Kubina, Eric Sauquet, Marielle Montginoul, et al.

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# Integrating human water uses in a regional scale distributed hydrological model : Model evaluation

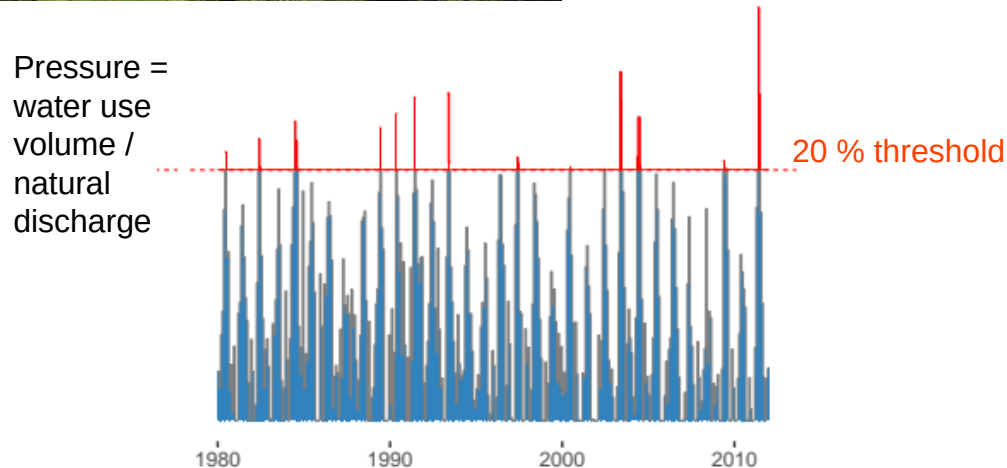
F. Branger, L. Mimeau, L. Crochemore, J. Bonneau, B. Lévêque, N.  
Pellerin, E. Chaix, R. Kubina, E. Sauquet, M. Montginoul, and M. Rabotin



# Natural water resources and human water uses

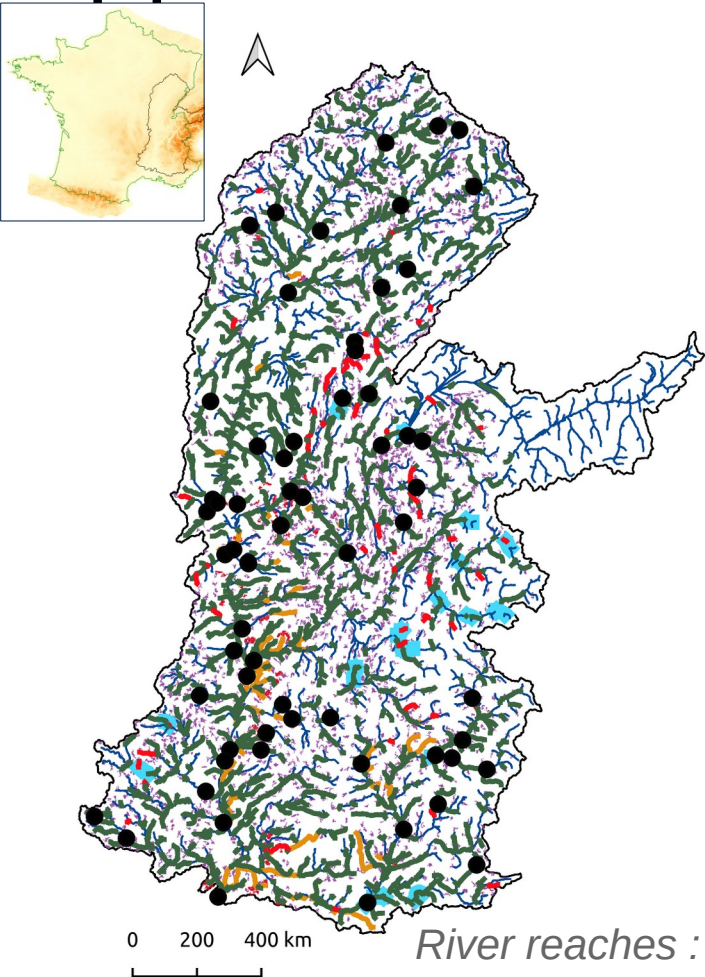


- Multiple human water uses
- Pressure on natural resource already visible even in large river systems
- **How will these interactions evolve with climate change ?**
- **Integration of water uses in hydrological models :**
  - improve our understanding of the system
  - test water management adaptation scenarios





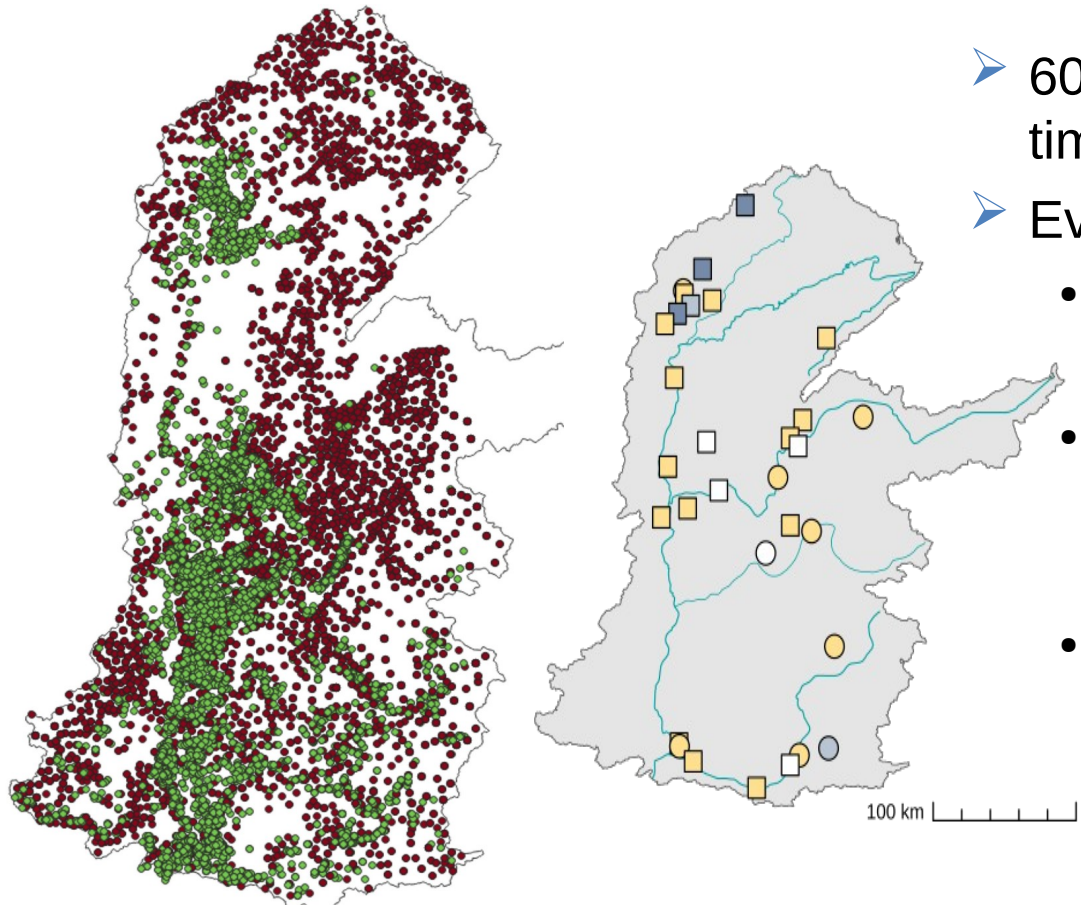
# Application to the Rhône catchment



- Natural hydrology validated on 254 gauging stations  
(*Branger et al., 2016 ; Morel et al., 2023*)
- Parameterisation of water uses based on national and regional databases :
  - BNPE : locations of water withdrawal points + sources (surface water / groundwater) for drinking water and irrigation
  - Water Agency database on WWTPs
  - RGA : irrigated surfaces, main irrigated crops and irrigation types
- Econometric model of water consumption
- Reconstruction of dam / derivation influences

River reaches : **drinking water** and **irrigation** withdrawals, **WWTP release**  
 HRUs (groundwater) : **drinking water** and **irrigation** withdrawals

# Model evaluation



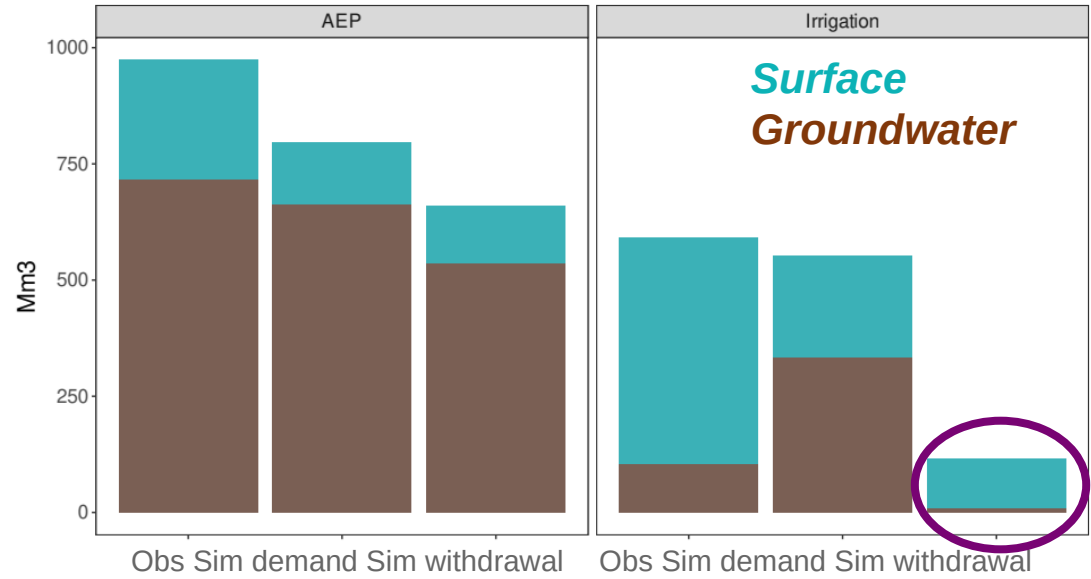
- 60 years simulation (1960-2019) at daily time step
- Evaluation against :
  - Observed daily discharge at 63 gauging stations 1980-2010
  - Surface water and groundwater withdrawal total volume 2012-2017 (BNPE)
  - Monthly groundwater levels from 31 piezometers 2000-2019
  - SPLI = standardized piezometric level index

*Drinking water and irrigation withdrawal points (data source : BNPE)*

 *Piezometers*  


# Results : model evaluation

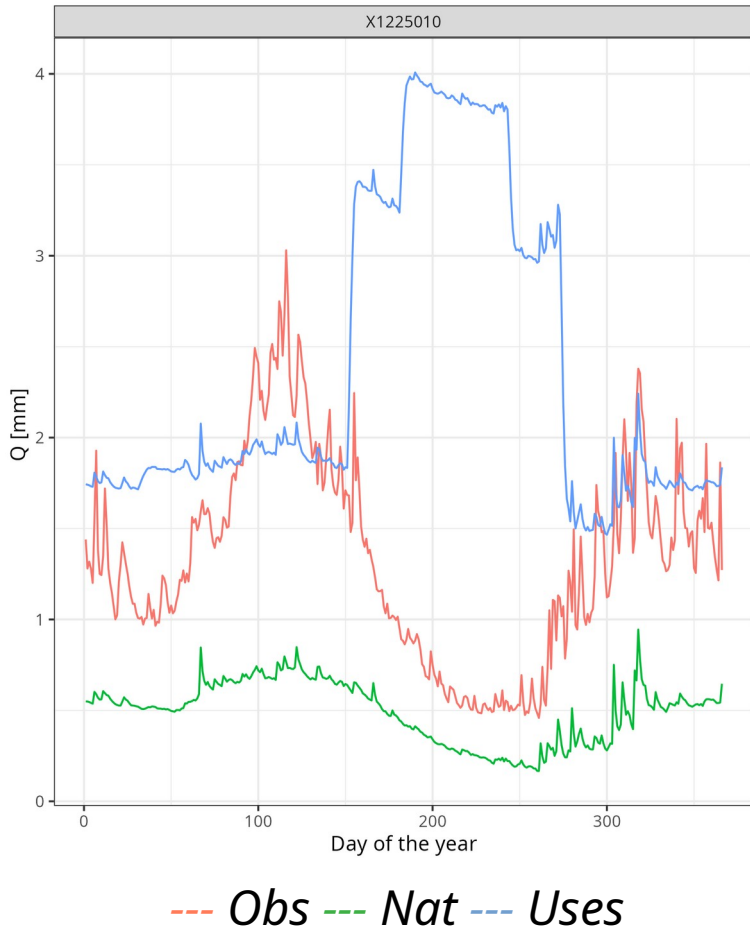
Discharge	KGE	
	with uses	natural
Min	-0.37	-0.37
Max	0.88	0.88
Median	0.62	0.64
Mean	0.54	0.55



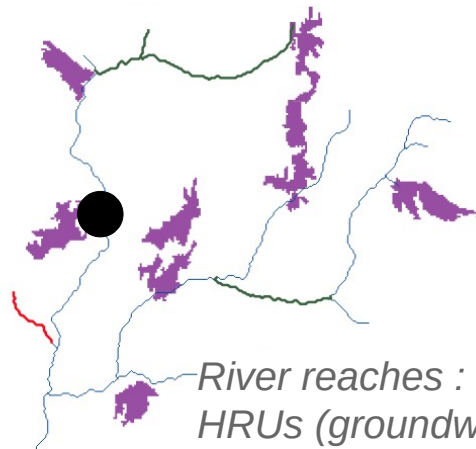
- No significant model performance modification regarding discharge
- Correct reproduction of water withdrawal for drinking water
- BUT :
- The model **severely underestimates** water withdrawal for irrigation (especially in groundwater)
- A few **unexpected results** !

station	Precip [mm]	Obs [mm]	Sim_nat [mm]	Sim_uses [mm]
X1225010	900	487	181	870

# Reason #1 : parameterisation of water uses components : release from WTPs



- Setpoint values for water release from WTPs disconnected from water withdrawal :
- Release volume based on drinking water demand setpoint values
- Location of points



- Artificial addition of water in some river reaches !

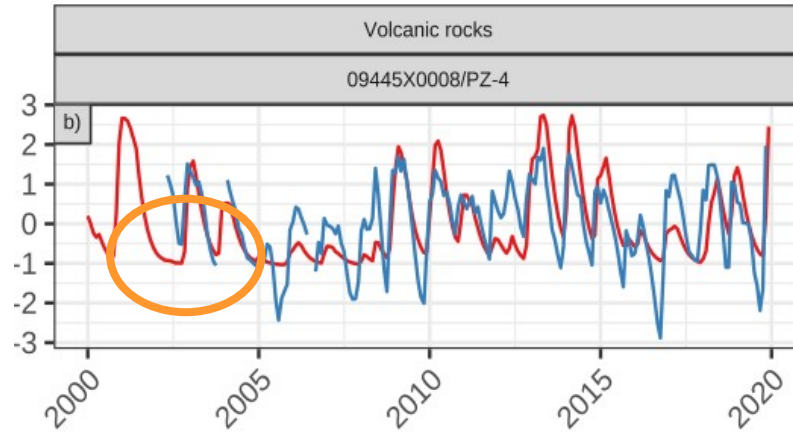
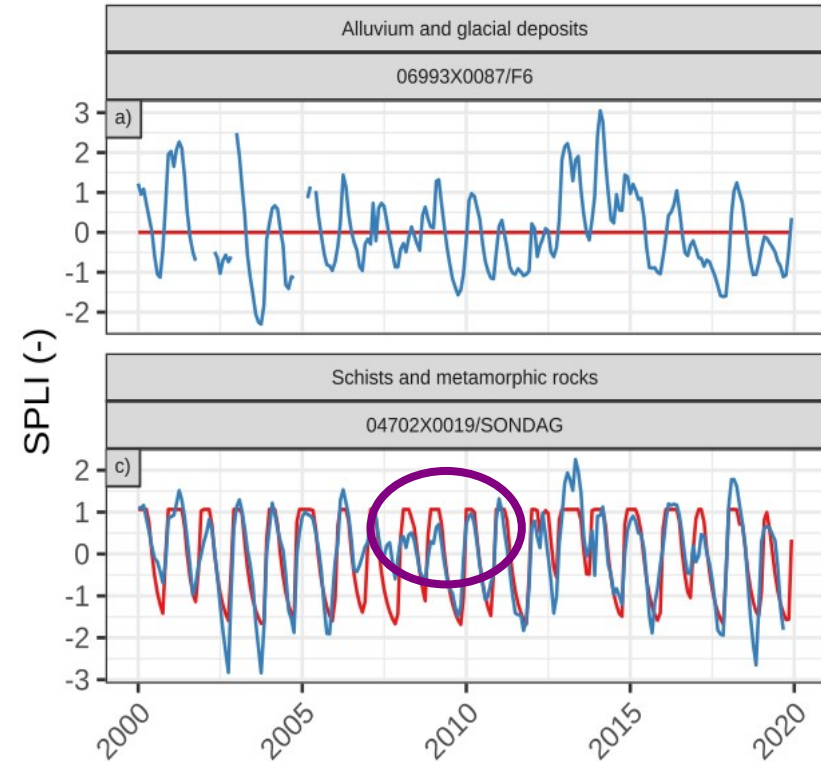
River reaches : **drinking water** withdrawal, **WTP release**  
HRUs (groundwater) : **drinking water** withdrawal

# Reason #1 : parameterisation of water uses components : irrigation

	BNPE		J2000		
	Nb	Water withdrawal (Mm3/year)	Nb	Water demand (Mm3/year)	Water. Withdrawal (Mm3/year)
Reach AEP	102	2,7	63	2,2	2
Reach irrigation	<b>561</b>	1,1	<b>114</b>	1,9	0,93
HRU AEP	2608	0,4	2628	0,26	0,2
HRU irrigation	<b>1494</b>	<b>0,097</b>	<b>197</b>	<b>1,7</b>	<b>0,05</b>

- 311 irrigated HRUs vs 2055 withdrawal points in the BNPE database
- Assumption of 1 irrigation point per HRU
- Concentration of withdrawal points : **too much water demand for a single HRU**

# Reason #2 : missed natural hydrological processes : groundwater



- J2000 values hit **min** or **max** thresholds → reservoirs either full or dry
- Not enough storage in the groundwater compartment for most geology classes
- Worsens the problem of water availability for irrigation

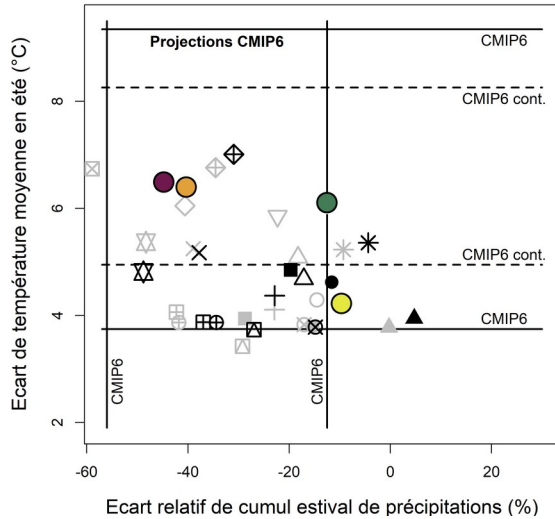
# Conclusions

- Incorporation of water uses in a regional hydrological model
  - Adding equations in the model is one thing, parameterisation is another !
  - Additional difficulty due to the scale of the model : need to make simplifying assumptions
  - Problems don't necessarily show in the simulated discharge
- Lessons learned
  - Interest of using additional variables for model evaluation
  - Need to design parameterisation strategies adapted to regional scale models and make sure they are consistent
  - Still some work to do on natural hydrology

*See presentation tomorrow on Mountain Hydrology HS2.1.1*



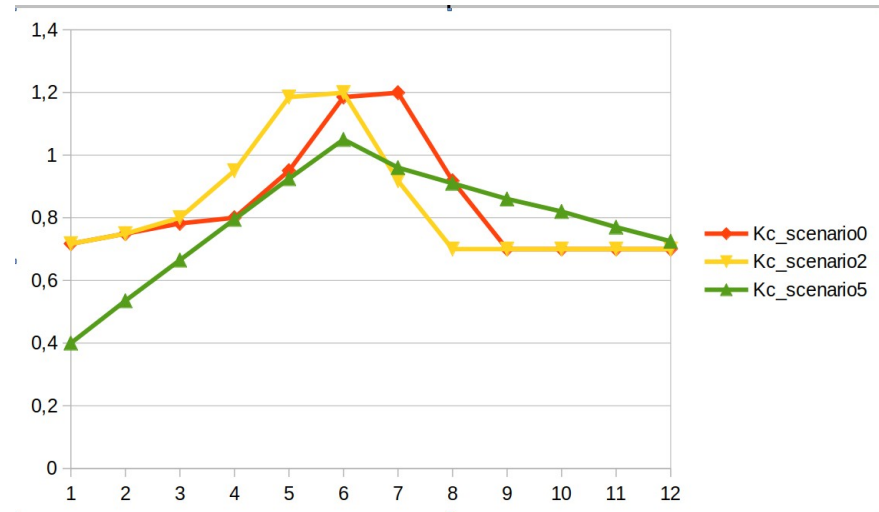
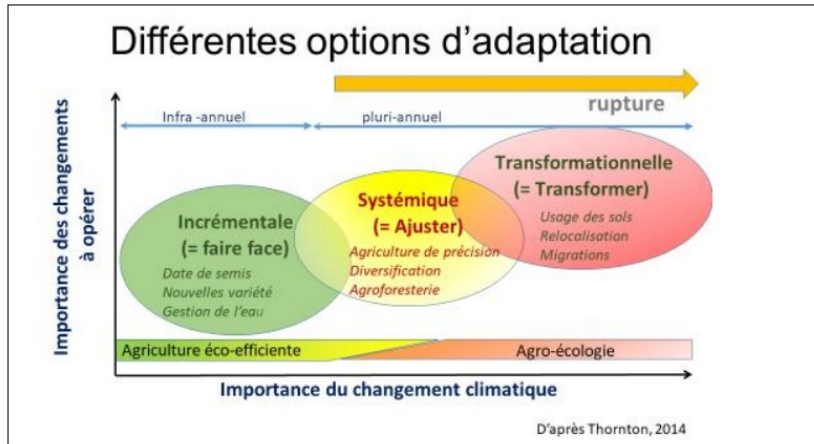
# Perspectives : future irrigation scenarios



- HadGEM2-ES rcp85 CCLM4-8-17 ADAMONT  
Fort réchauffement et fort assèchement en été
- EC-EARTH rcp85 HadREM3-GA7 ADAMONT  
Sec toute l'année, recharge moindre en hiver
- CNRM-CM5 rcp85 ALADIN63 ADAMONT  
Modéré en réchauffement et changement de précipitations
- HadGEM2-ES rcp85 ALADIN63 ADAMONT  
Chaud et humide à toutes les saisons



- Climate change : « purple » trajectory (hot and dry in summer)
- Irrigation scenarios based on bibliographical work (Chaix 2024)



Thank you for your attention