Improve water exchange between river water and groundwater at the floodplain scale with SWAT model

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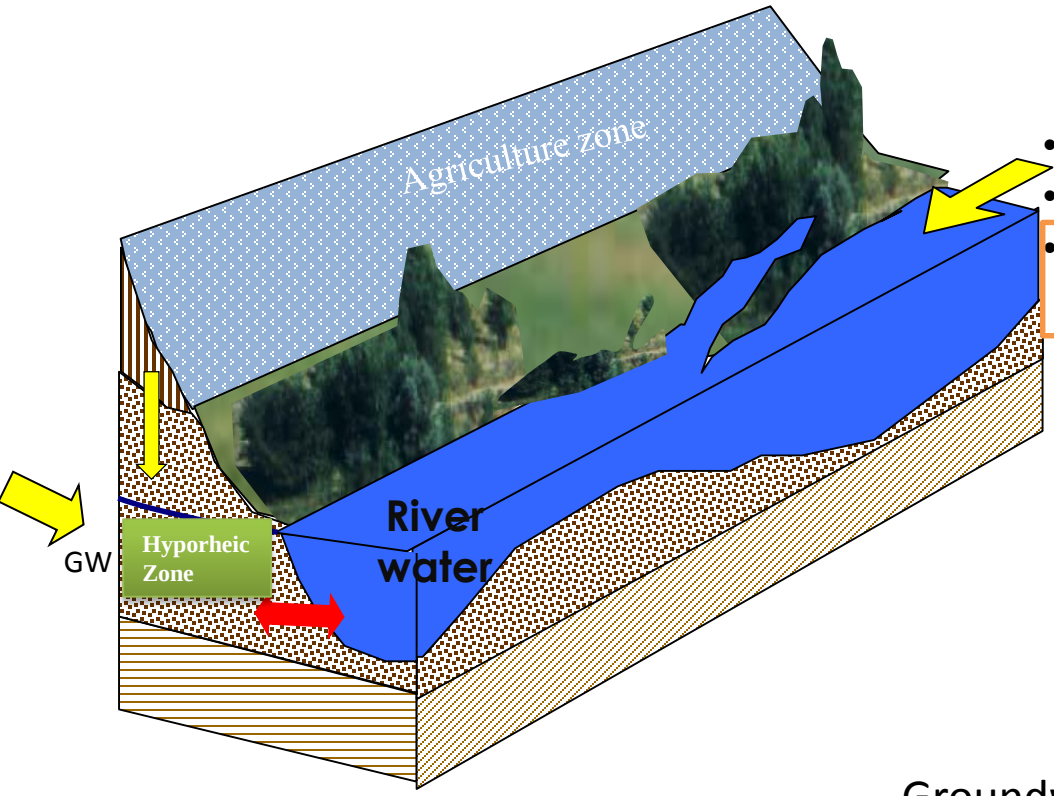
Introduction



Floodplain areas provide **Ecosystem Services**

- Biodiversity conservation
- Flood water retention
- Water quality control
  - e.g. NO_3 removal from agricultural area

Hyporheic Zone

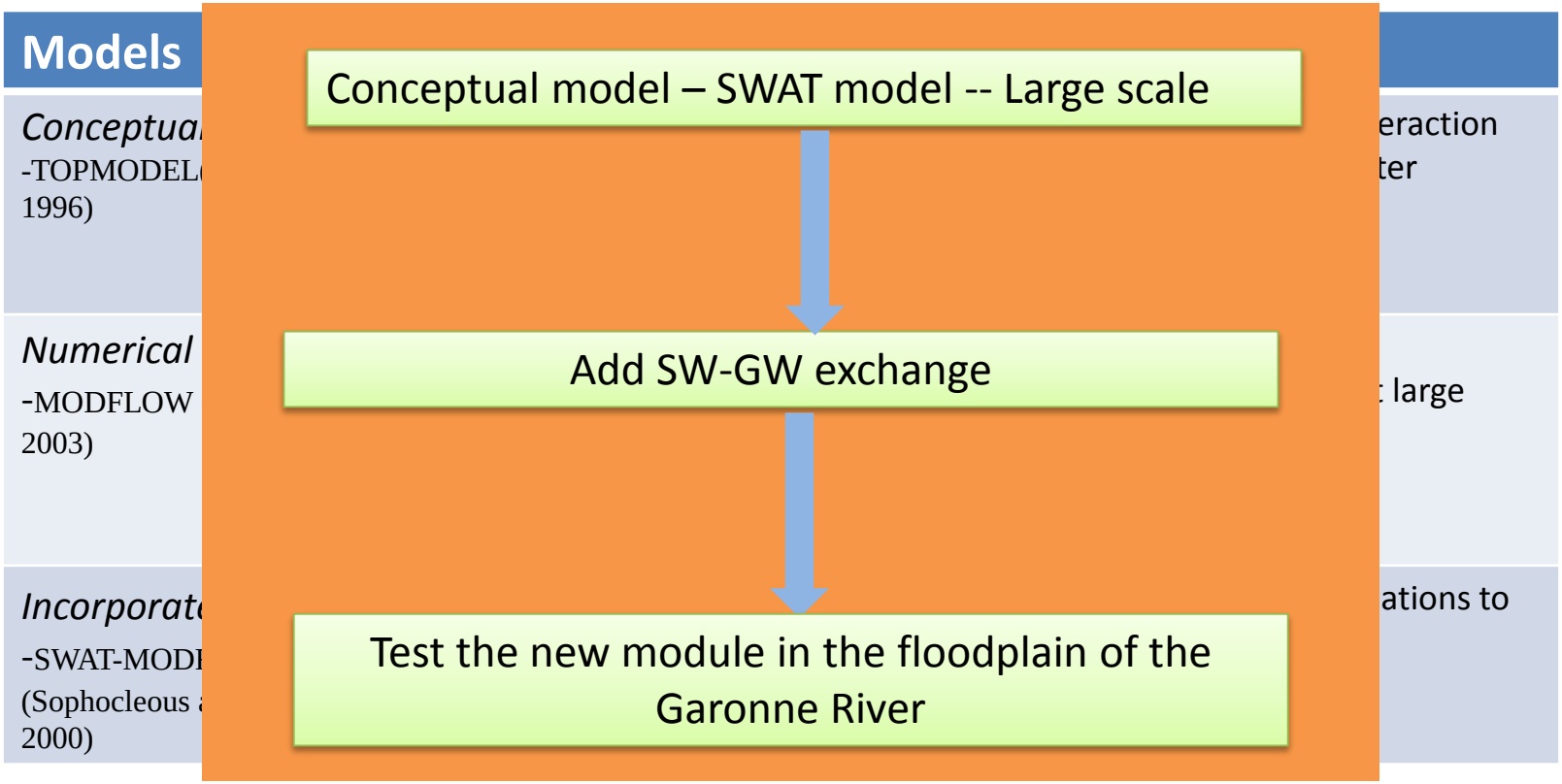
Groundwater ⇄ River water

nutriment elements

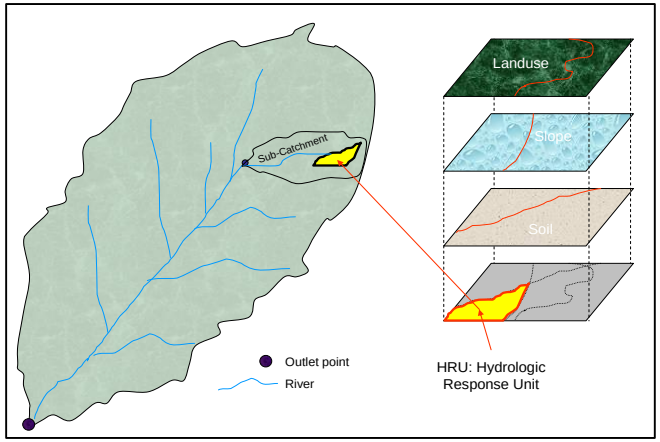
oxygen and organic matters

Objective

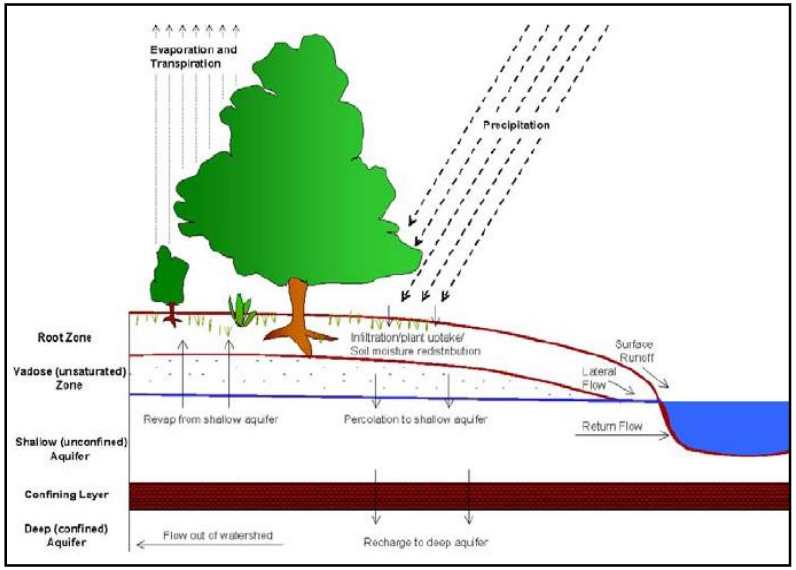
Modelling can help understanding processes occuring in floodplain area

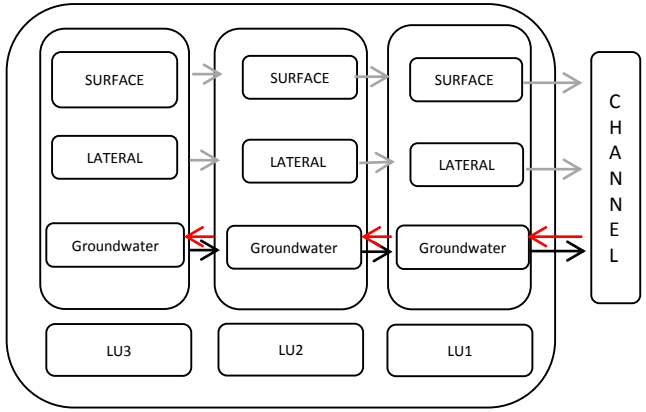


SWAT-LU model



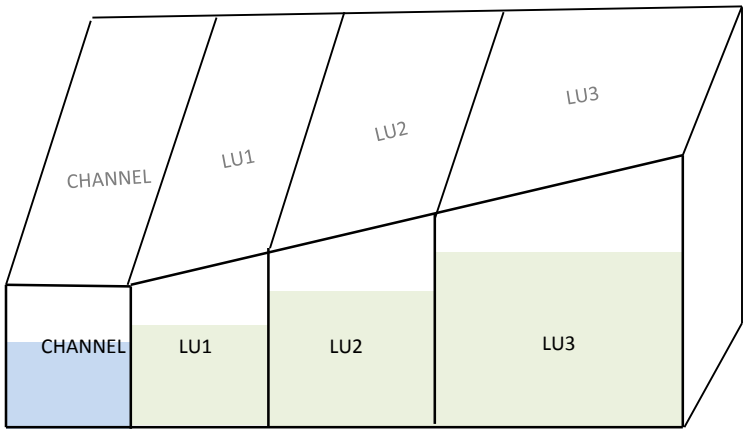
HRU→Subbasin→Basin





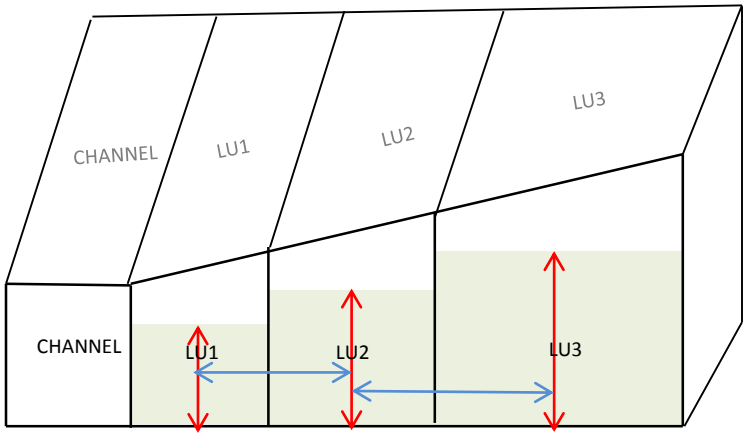
SWAT-LU model--Darcy's Equation

$$Q = K \times A \times \frac{\Delta H}{L}$$



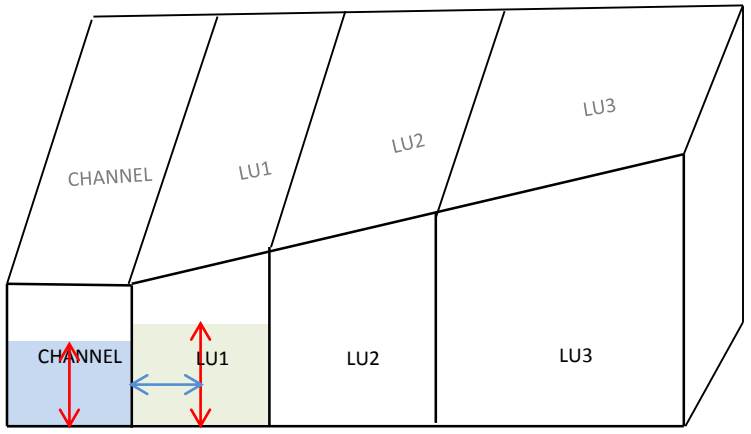
Between LUs

$$Q = 2 \times K \times A \times \frac{(H_{lua} - H_{lub})}{L}$$

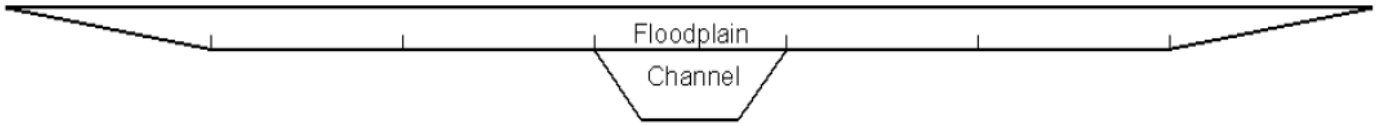


Between LU1--River

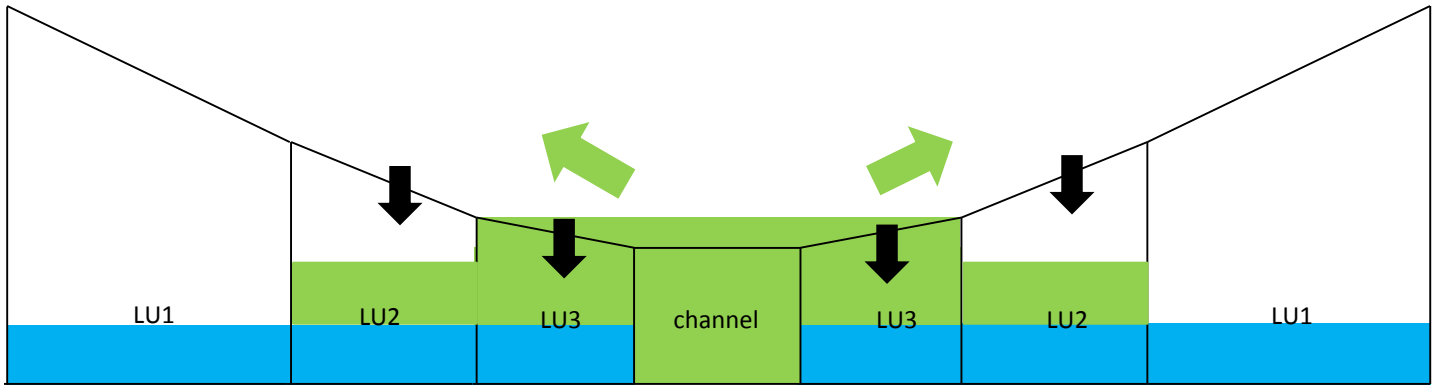
$$Q = 2 \times K \times A \times \frac{(H_{lu} - H_R)}{L}$$



SWAT-LU model—Flooding

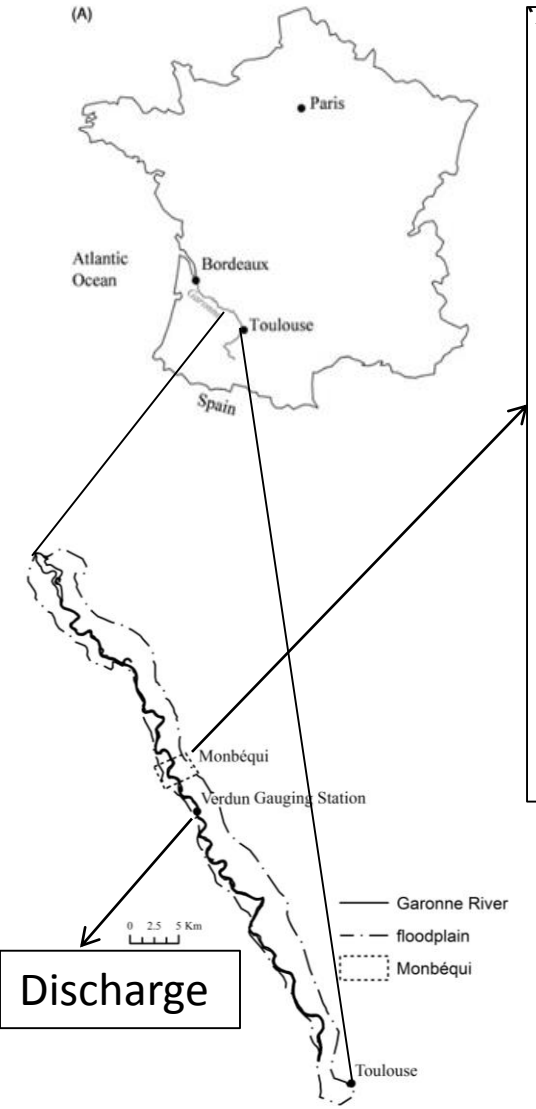


- Assume flooded distance is 5 times of channel top width
- Doesn't consider influence to GW

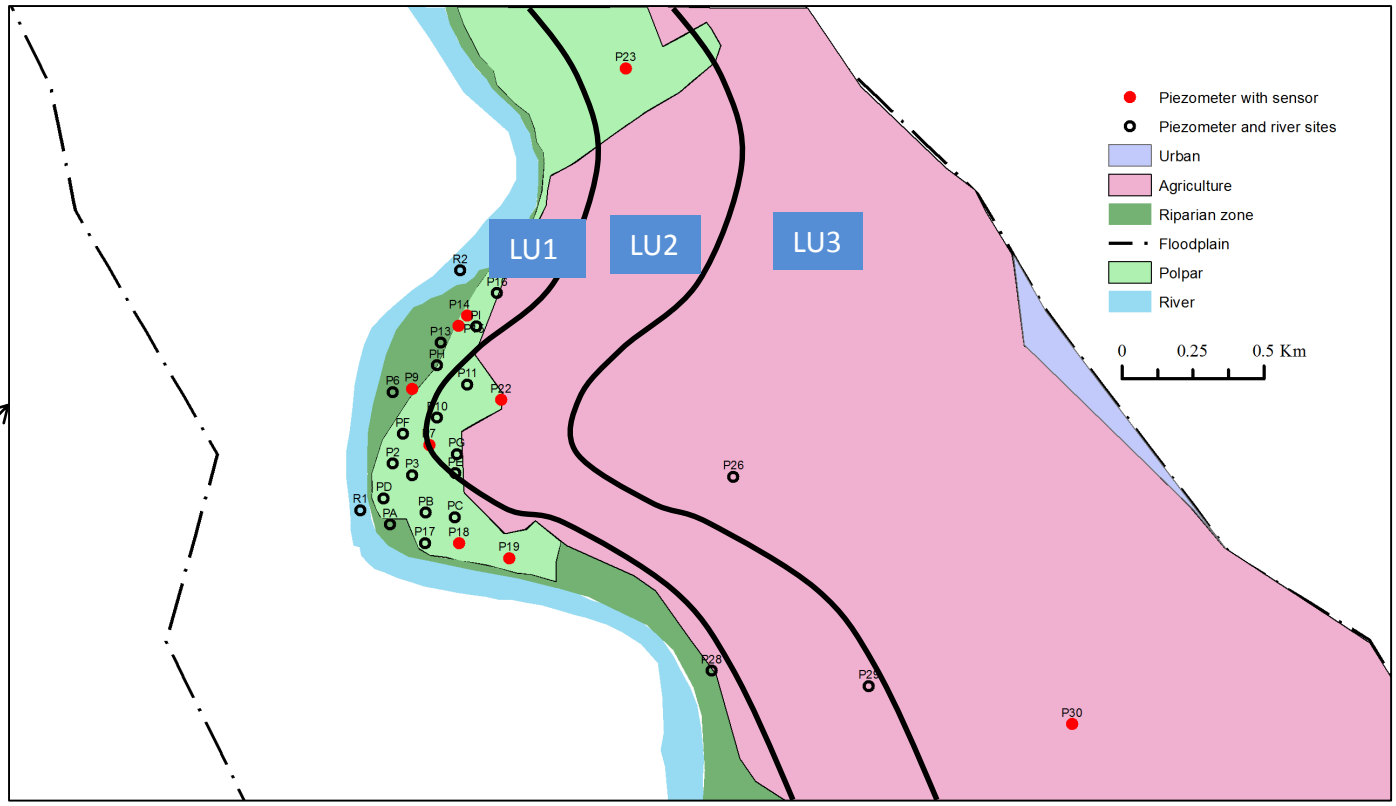


Based on flooded water volume

Study site – Monbéqui



Discharge



Parameters of LUs			
	LU 1	LU 2	LU 3
Width(km)	0.4	0.8	3.0
Length (km)	6.374	6.374	6.374
Slope	0.002	0.005	0.005
Porosity	0.1	0.1	0.1

Calibration and Validation

Manually calibrated parameters:

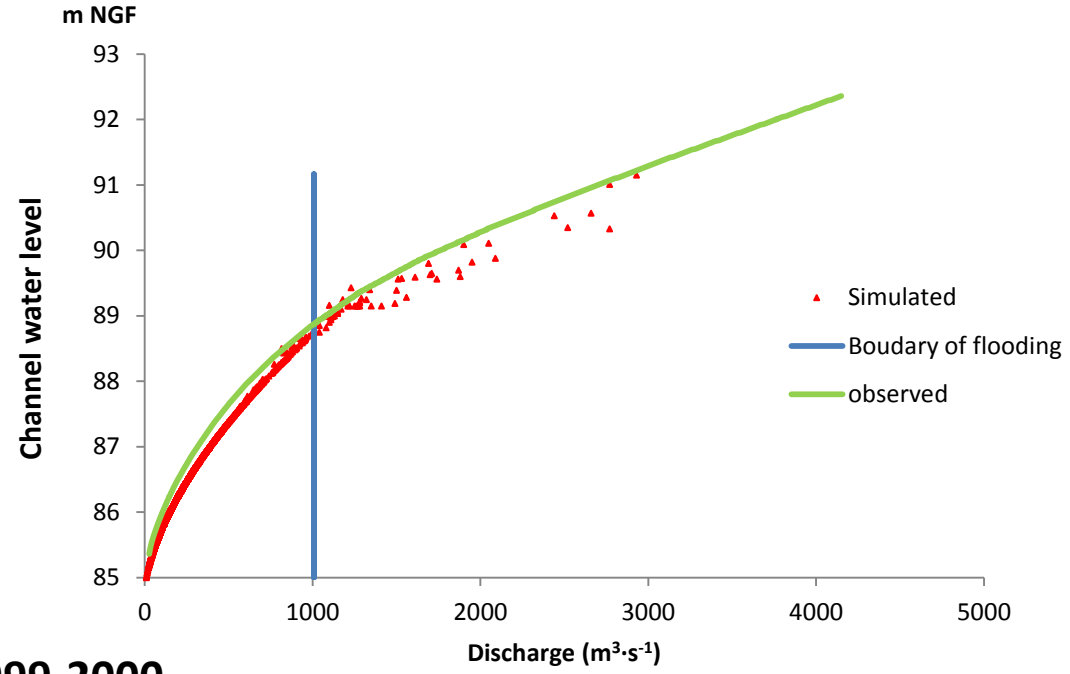
Parameters	Default value	Calibrated values
Manning roughness coefficient	0.014	0.065
Hydraulic conductivity (LU1) ($m \cdot d^{-1}$)	0	300
Hydraulic conductivity (LU2) ($m \cdot d^{-1}$)	0	100
Hydraulic conductivity (LU3) ($m \cdot d^{-1}$)	0	100

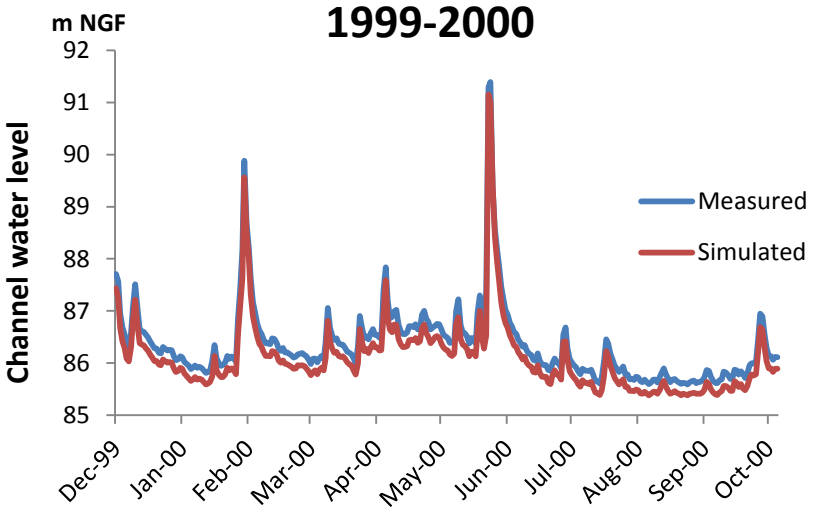
Conservative elements: EC(Electrical conductivity) and Chloride

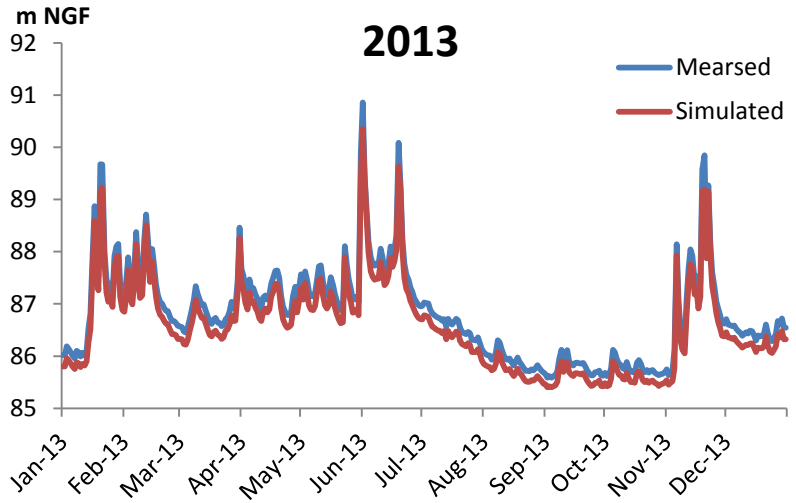
Measured in 2013

Zone		EC($\mu s \cdot cm^{-1}$)	Chloride($mg \cdot l^{-1}$)	Constant EC($\mu s \cdot cm^{-1}$)	Constant chloride ($mg \cdot l^{-1}$)
River	R1	274±42	8.97±2.54		
	R2	280±50	9.38±2.78	275	9.00
LU 2	P22	1063±29	78.22±7.86	1050	75.00
LU 3	P26	847±17	54.88±6.84	800	50.00
	P30	749±5	38.28±3.82		

Results—Channel water level

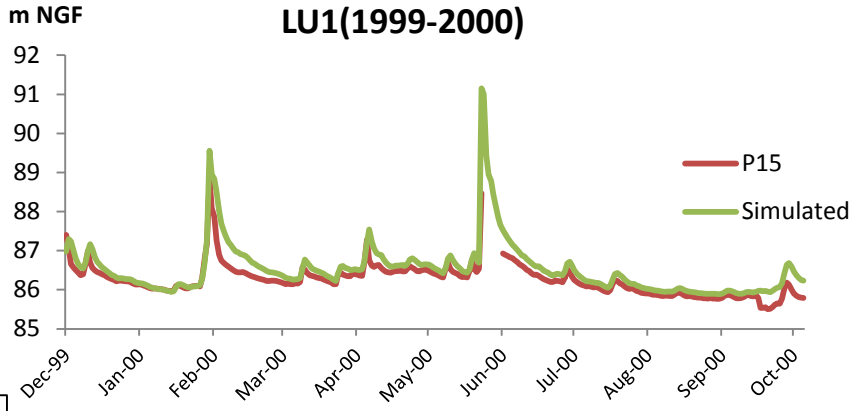


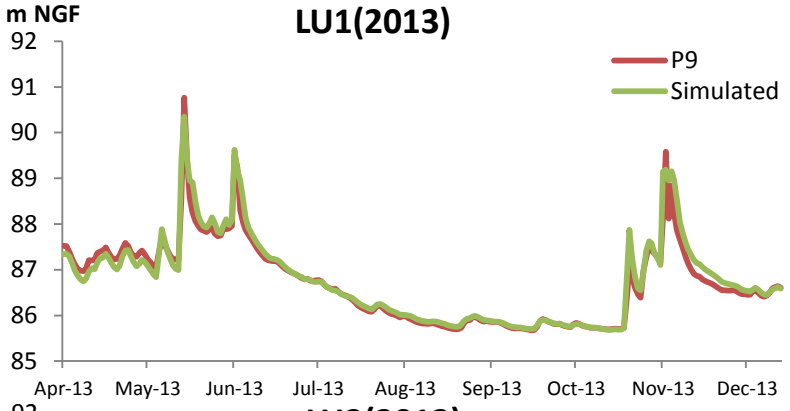


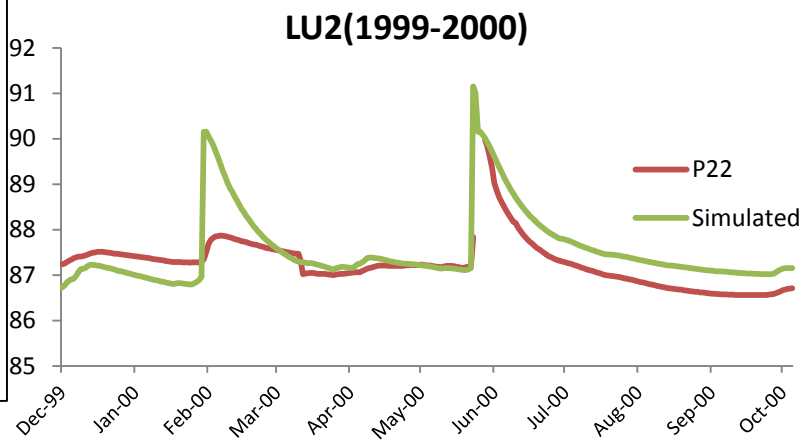


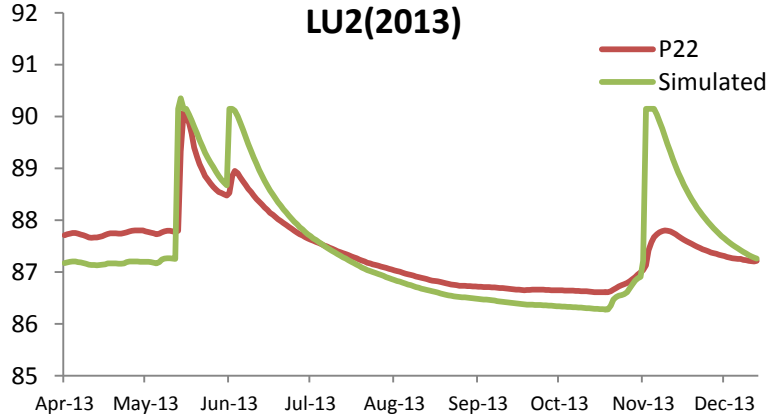
Results—Groundwater level

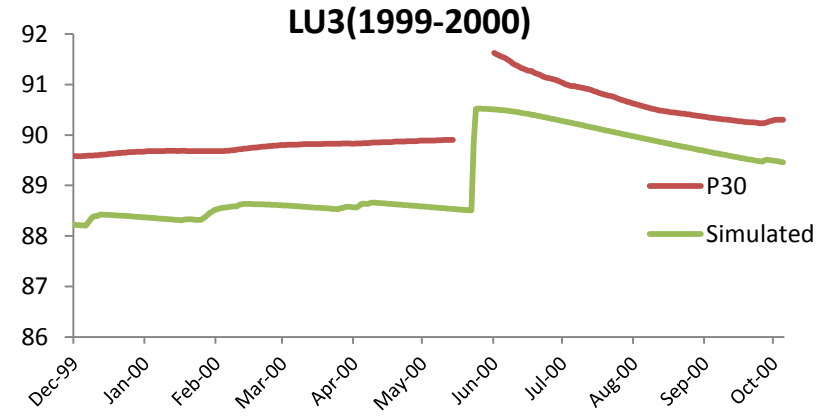
Groundwater level

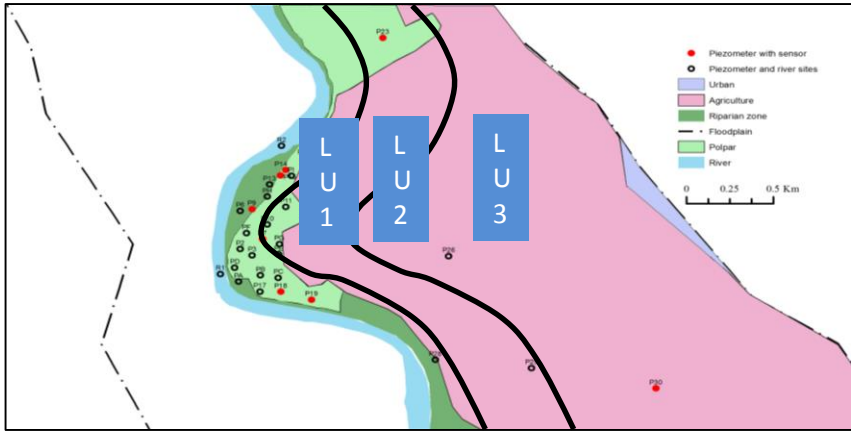






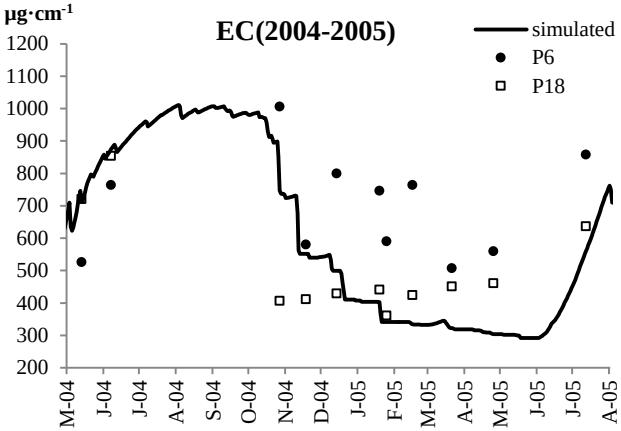


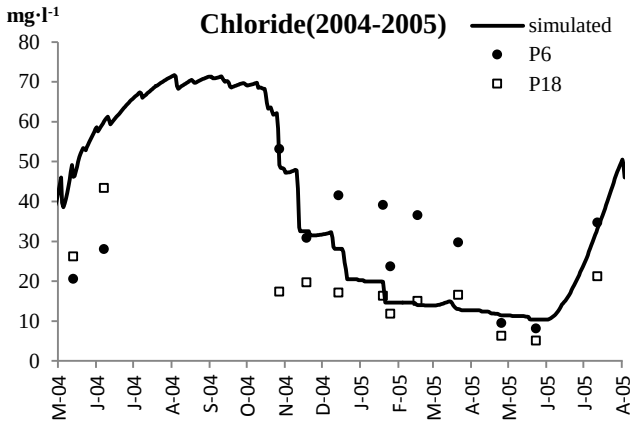


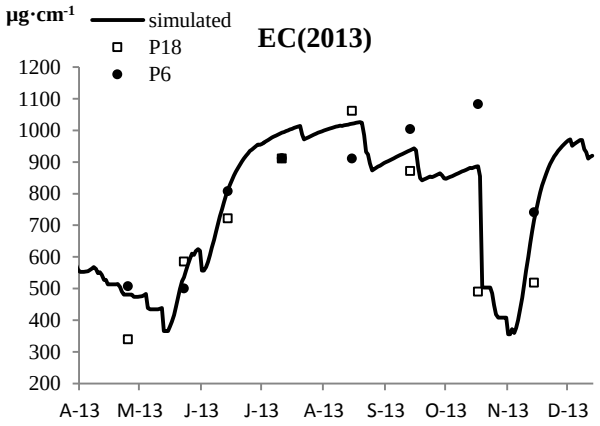


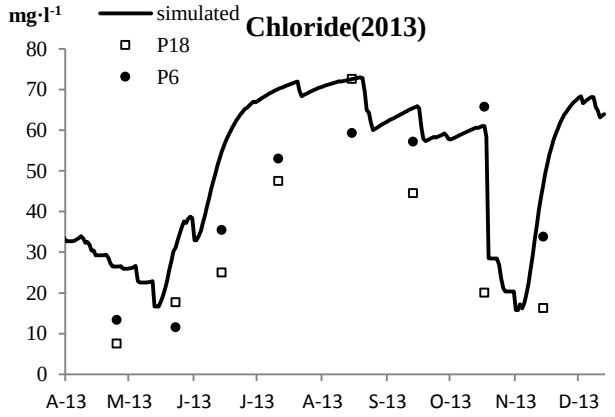
Results—SW-GW exchange

LU1

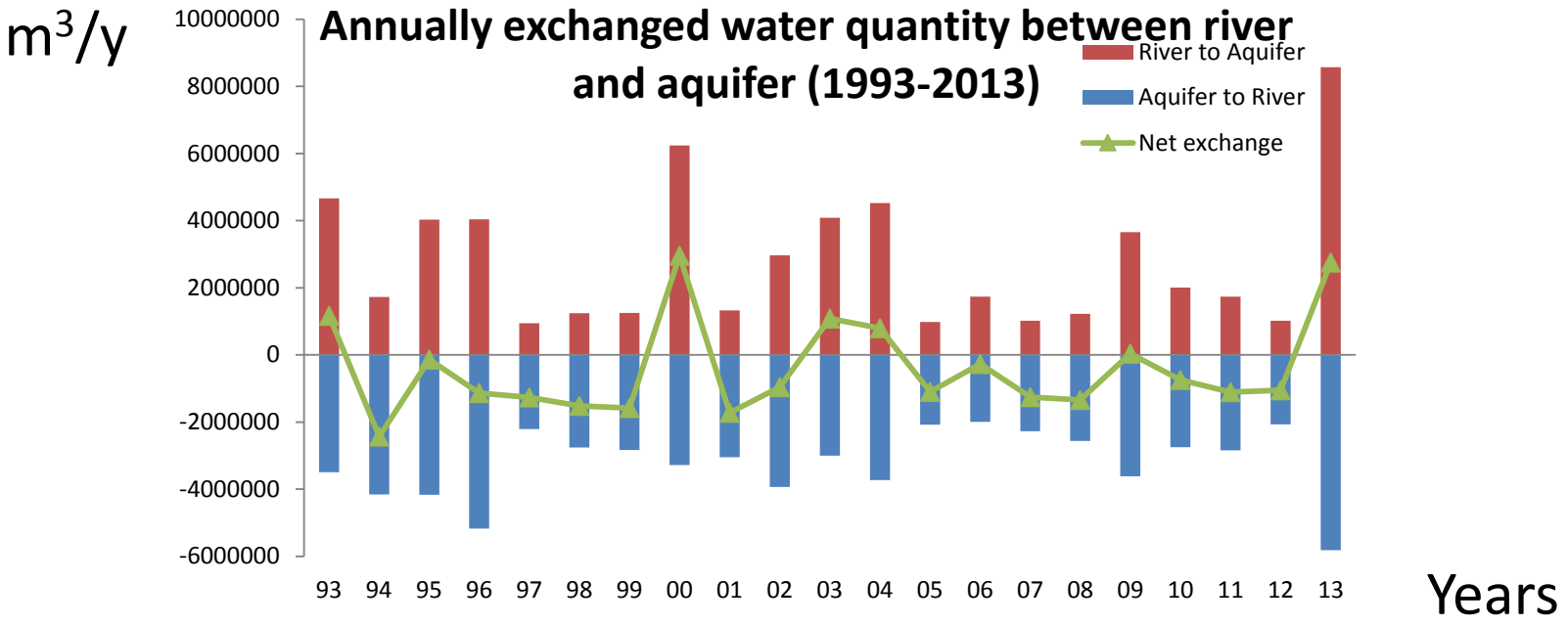








Results—SW-GW exchange



HRU	SOIL	LUSE	PRECmm	SURQGENmm	GWQmm	ETmm	RCHRGmm
3	R131	AGRL	671.05	111.69	109.81	450.21	111
2	R131	PAST	671.05	64.34	163.86	516.65	98
1	R131	FRSD	671.05	63.03	580.17	498.38	116

River water ⇄ Aquifer

Conclusion and Outlook

CONCLUSIONS

- Modified SWAT model can satisfactorily simulate near bank zone groundwater levels
- Model can accurately reflect the actual water exchange between surface and subsurface systems of alluvial plain of Garonne River

ONGOING AND FUTUR WORK

- Improve hydrological module and test with more subbasins and HRUS
- Complete nutriment module with LU structure and implement biogeochemical processes
- Integrate with ArcGIS interface and apply in the large basin scale