

Hydrology & Hydrogeology
of the Karst.



9th Conference on Limestone Hydrogeology in Besançon

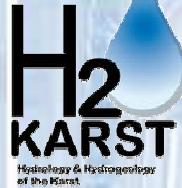
9ième Colloque d'Hydrogéologie en Pays Calcaire à Besançon

Session 4

Metrology and data transmission
“Artificial neural network for karst
aquifer sustainable management”

Marc Lambert

Manager of Syndicat des Eaux du Vivier



The Syndicat des Eaux du Vivier « SEV » in a few figures

- 5 municipalities including the city of Niort
- about 100.000 people depending on the Vivier karstic spring
- 650 km water networks, 36000 compteurs, 5 main water resources
- 60 agents, in public management
- Hospitals, industry with SEVESO sites, schools...)

What are the mains problems?

- Agricultural area with intensive production
- Competition with water supply
- Limited and fragile underground resources, with 2 observed karstic collapses in Vivier spring
- Quality problems due to nitrates and pesticides

Our main purposes about quantity

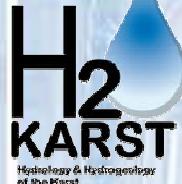
- Securize water supply on our area
- Understand and anticipate needs (peaks, periodicity)
- Understand and modelize water resources (rain effect, cycles, pumping effects...)
- Criterion:

« water resources always > peak needs »

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Geological context

Sew de l'Univers



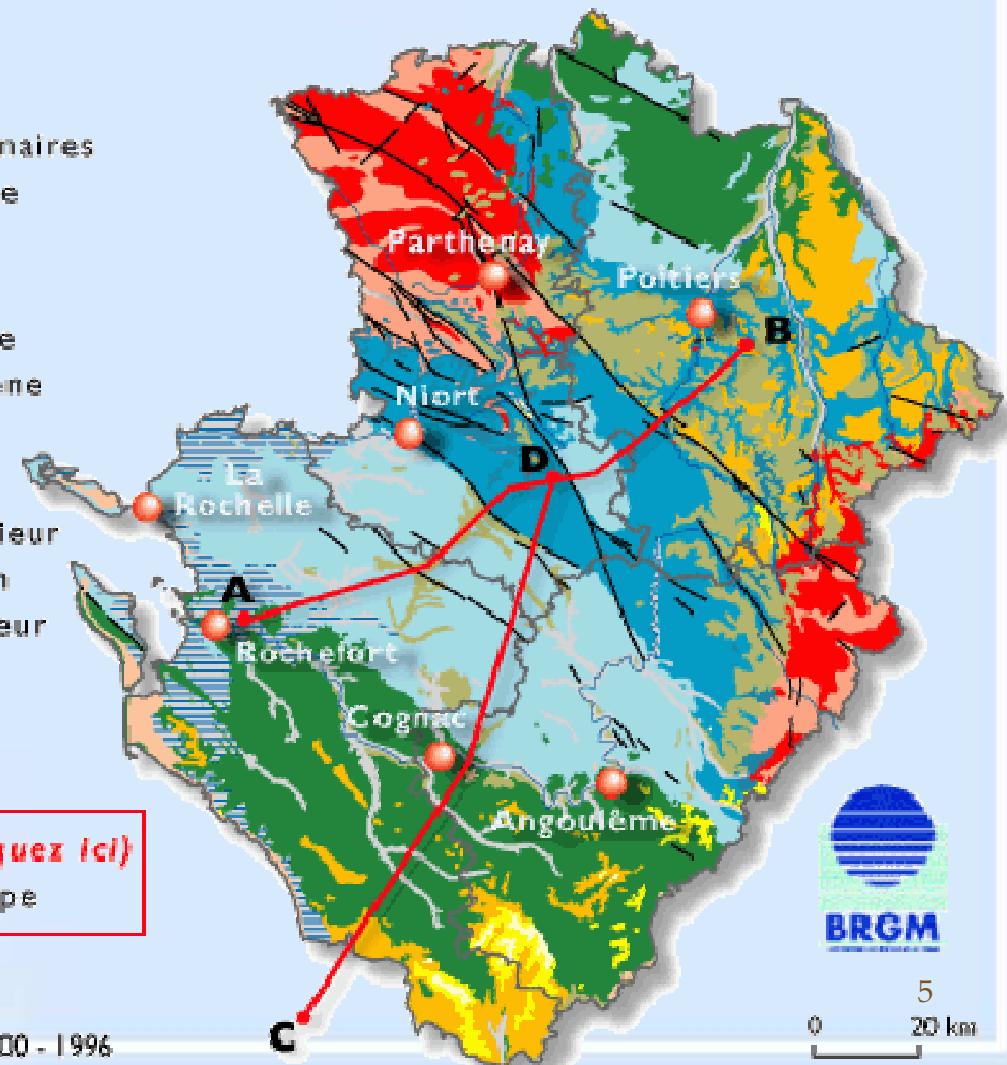
CARTE GEOLOGIQUE

Quaternaire	Alluvions quaternaires
	Holocène dunaire
	Bri fluvio-marin
---	Pléistocène
	Pliocène-Miocène
	Oligocène-Miocène
	Eocène
-----	Crétacé
	Jurassique supérieur
	Jurassique moyen
-----	Jurassique inférieur
	Socle schisteux
	Socle granitique
-----	Faillle

Coupe géologique (Cliquez ici)

A → B Tracé de coupe

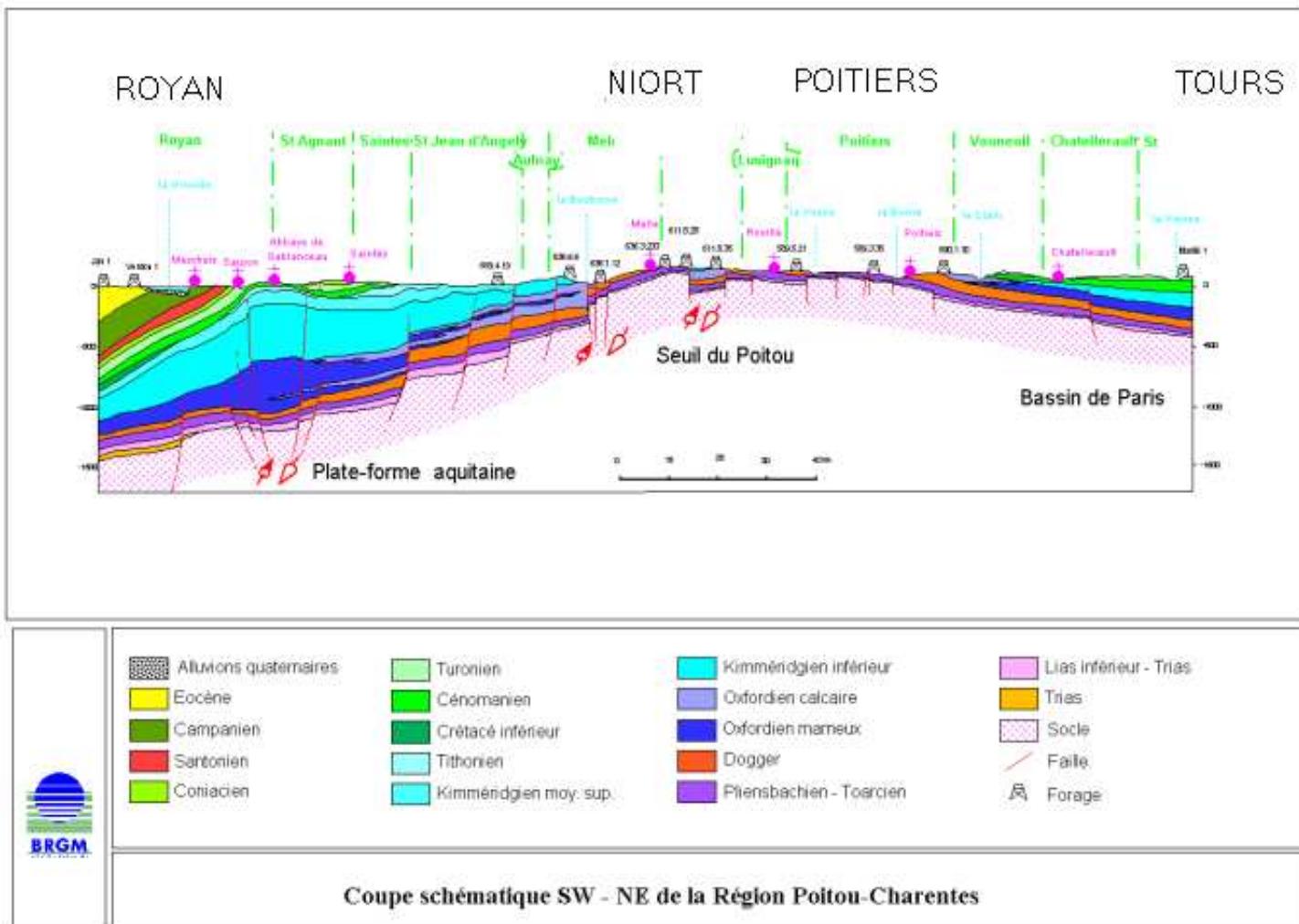
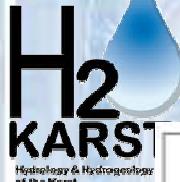
Source : © INSEE - © BRGM
- Extrait de la carte géologique
de la France à l'échelle du 1/1 000 000 - 1996



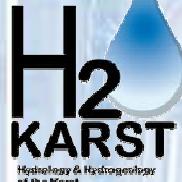
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Geological context (AB cut)

Sew de l'Yvette



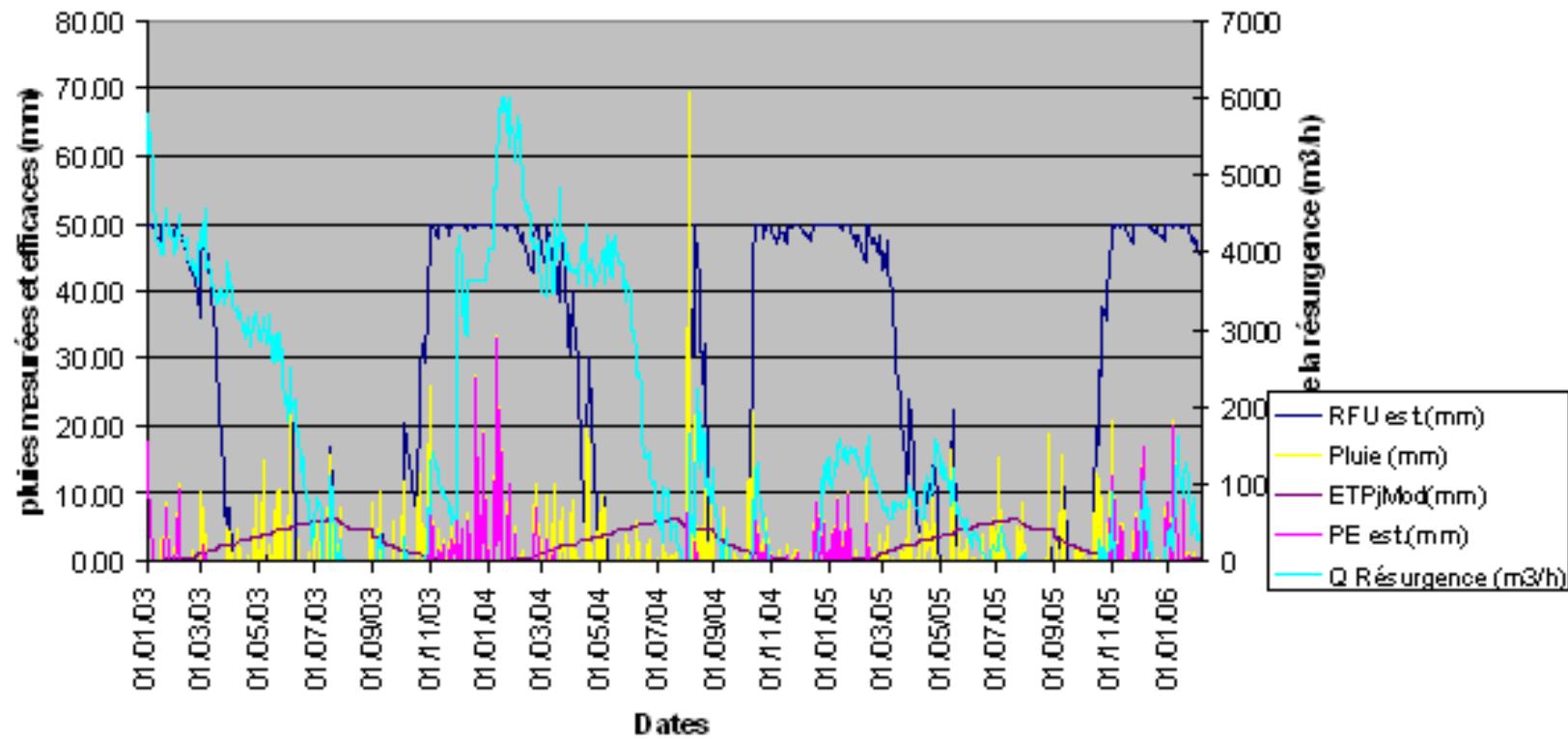
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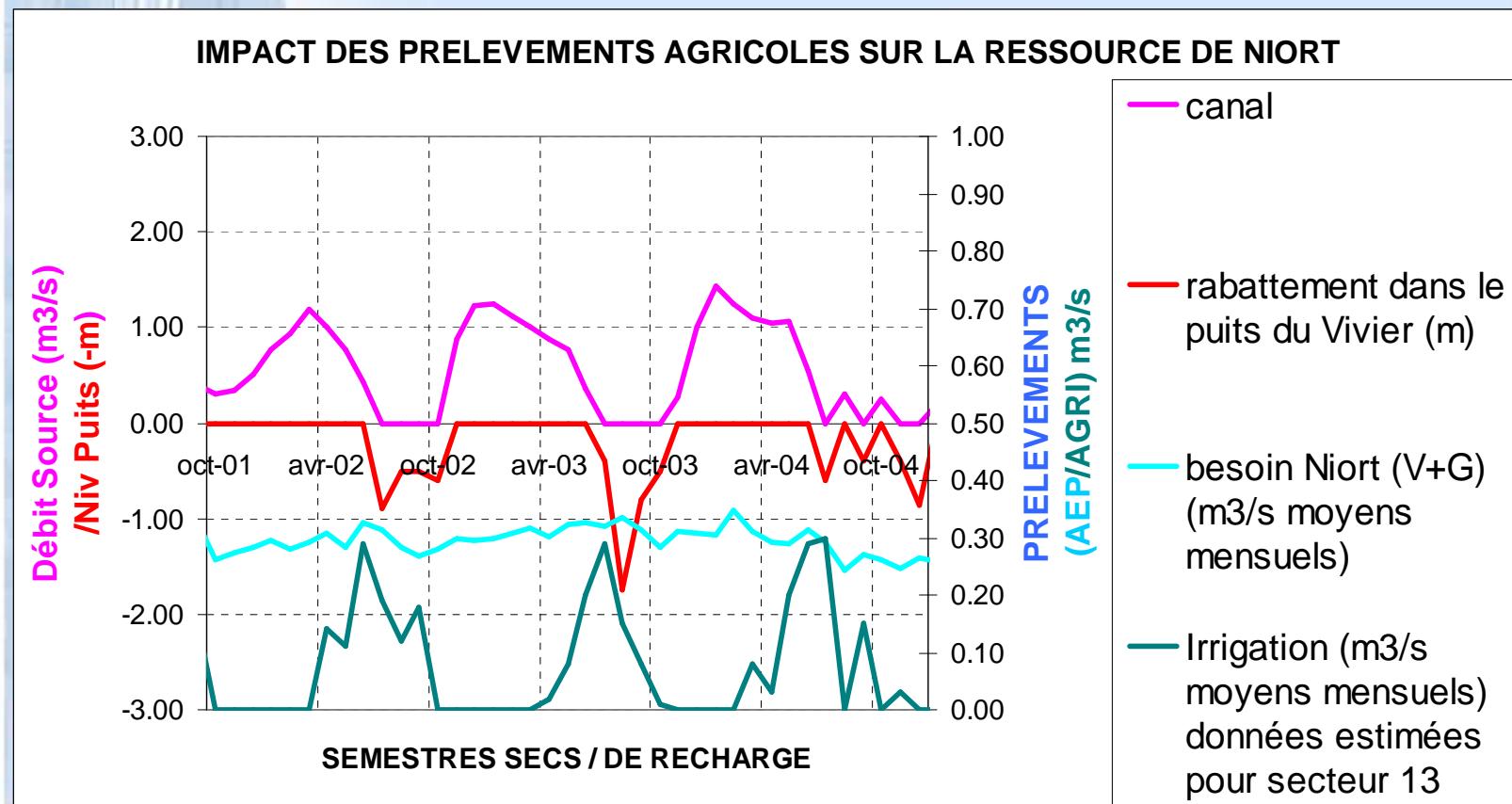
Sew de Vivier

Vivier karst observed behaviour

RESURGENCE DU VIVIER EN FONCTION DES PLUIES MESUREES ET DES PLUIES EFFICACES ESTIMEES ET DE LA SATURATION DES SOLS



Effects of pumpings for irrigation and water supply



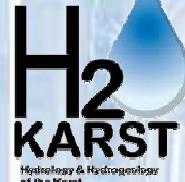


Methodology followed

- 1 : Data collecting, selecting...and mining
(ACP, geostatistics, wavelets...)
- 2 : Modelling with different techniques
(lumped modelling of rainfall - runoff
and rainfall aquifer level, inverse
modelling using fourier analysis, neural
networks...)
- 3: Forecasting with rainfall simulation
- 4: Managing resources...ie how to keep

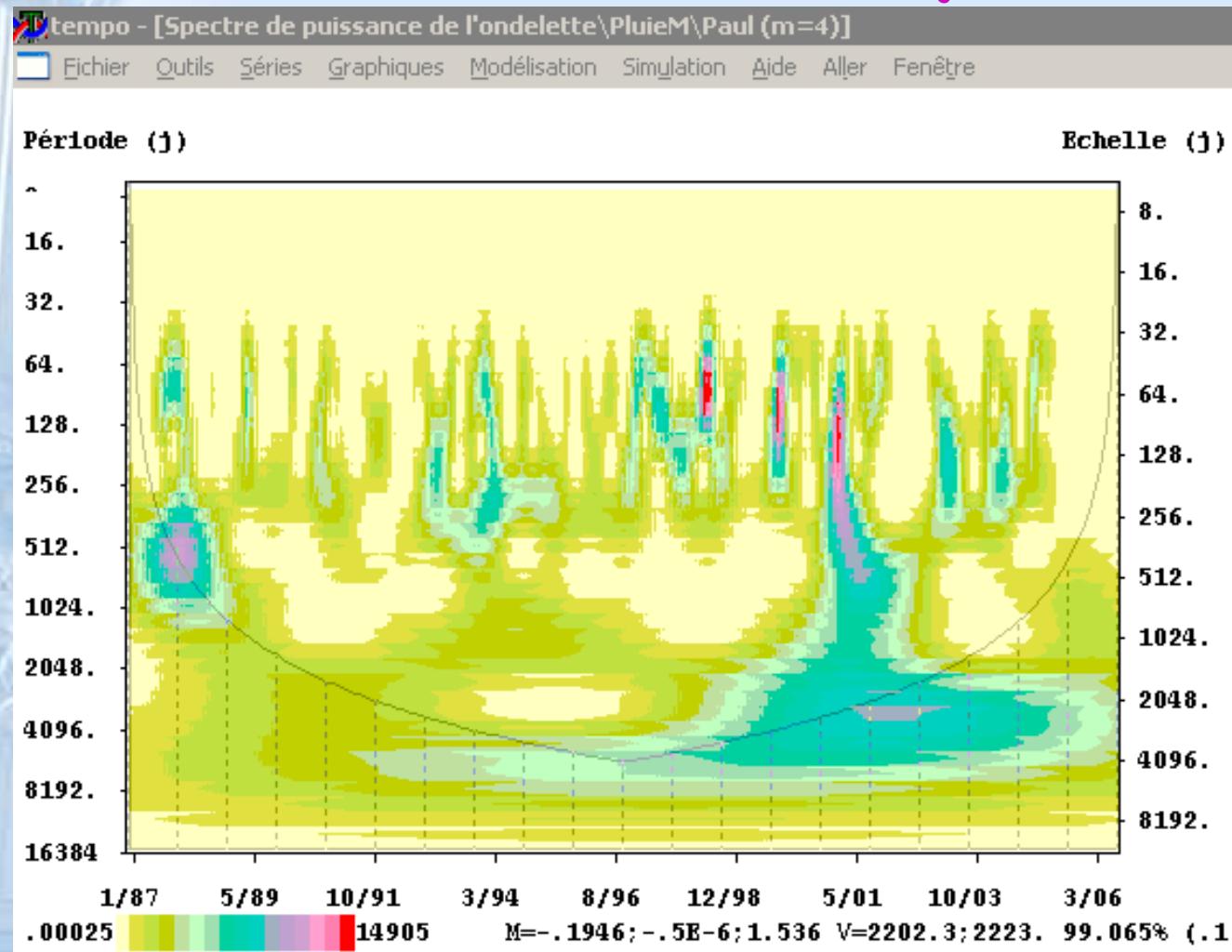
« water resources always > peak
needs »

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Rainfall data analysis

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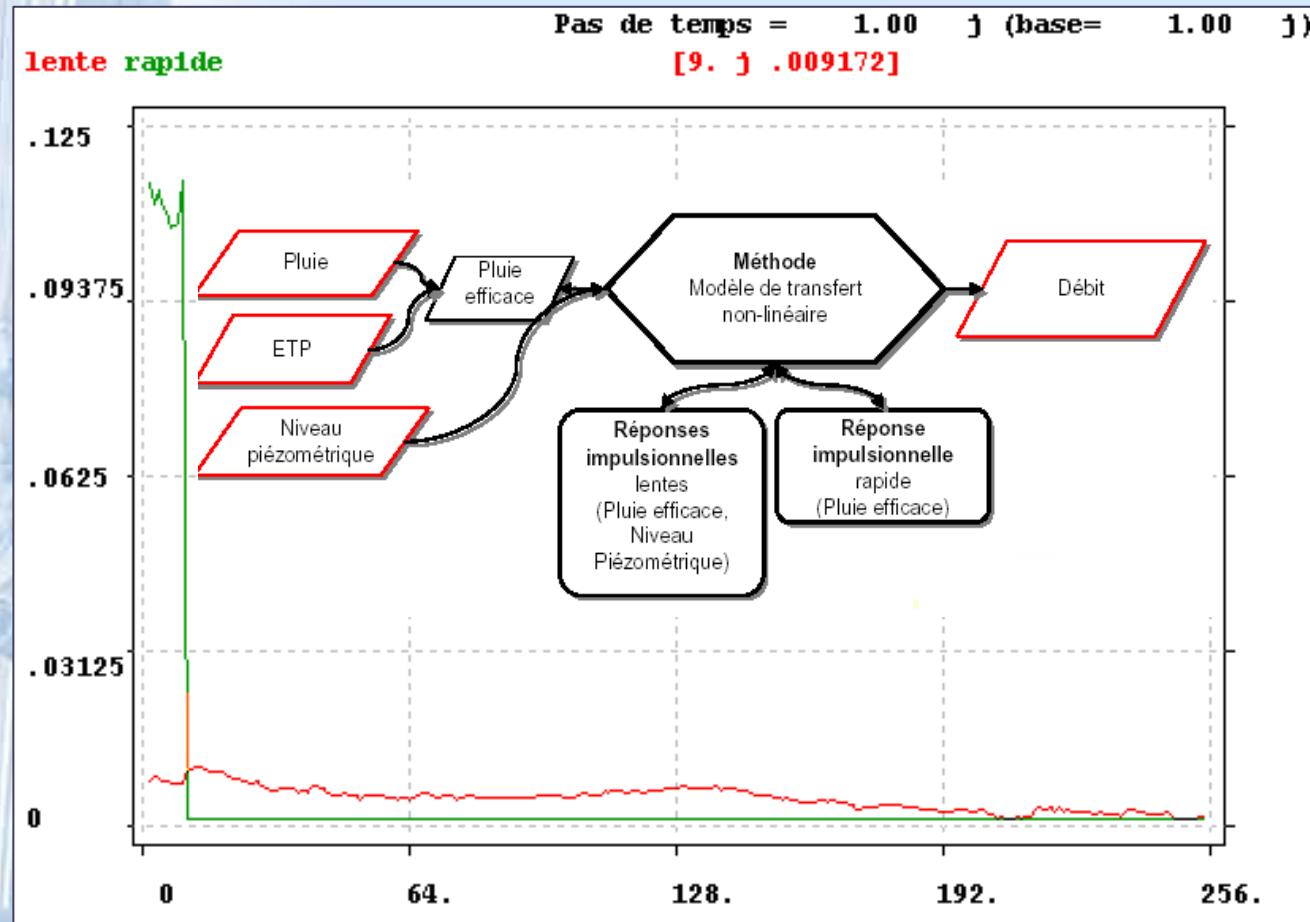


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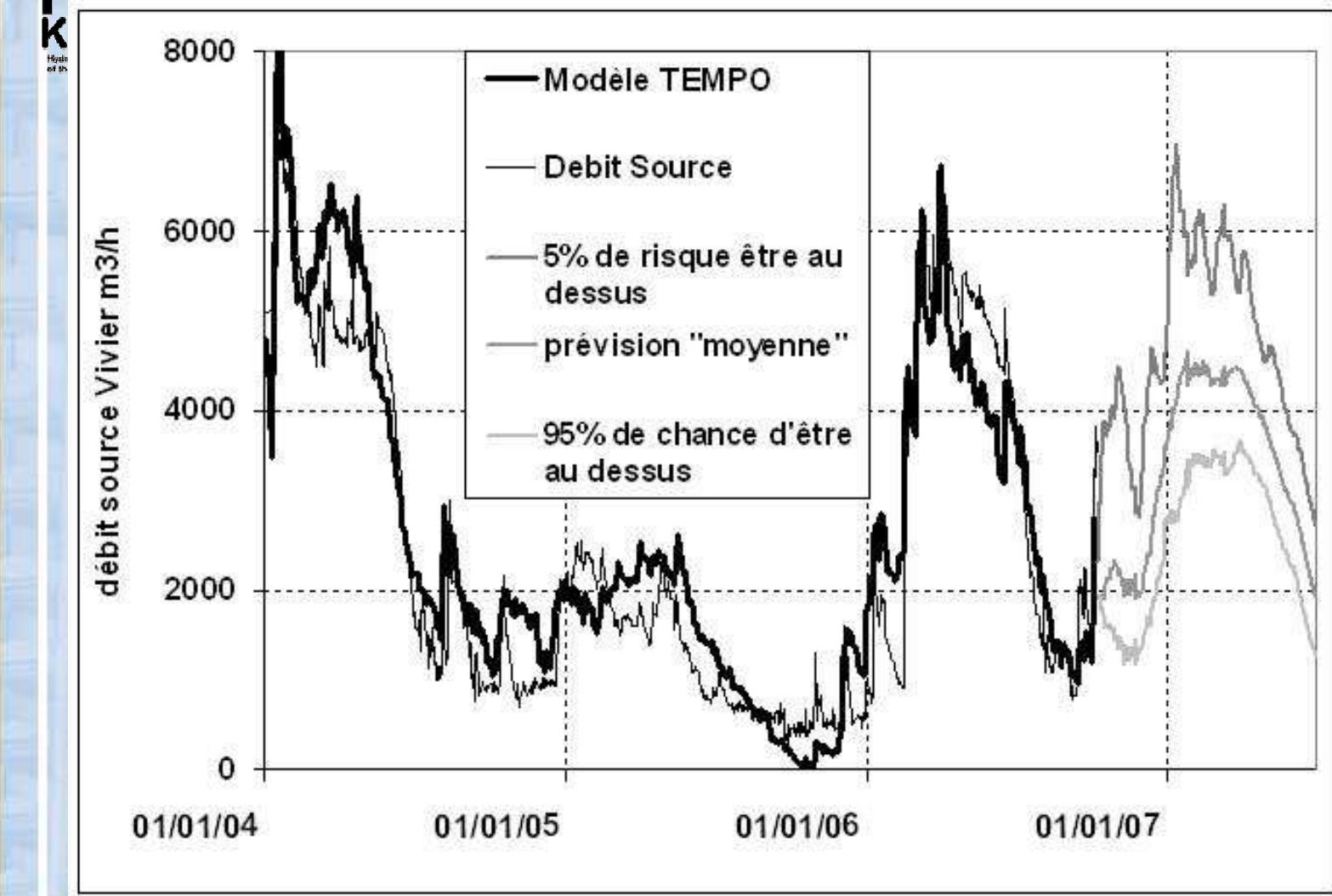


Inverse modelling (TEMPO BRGM)

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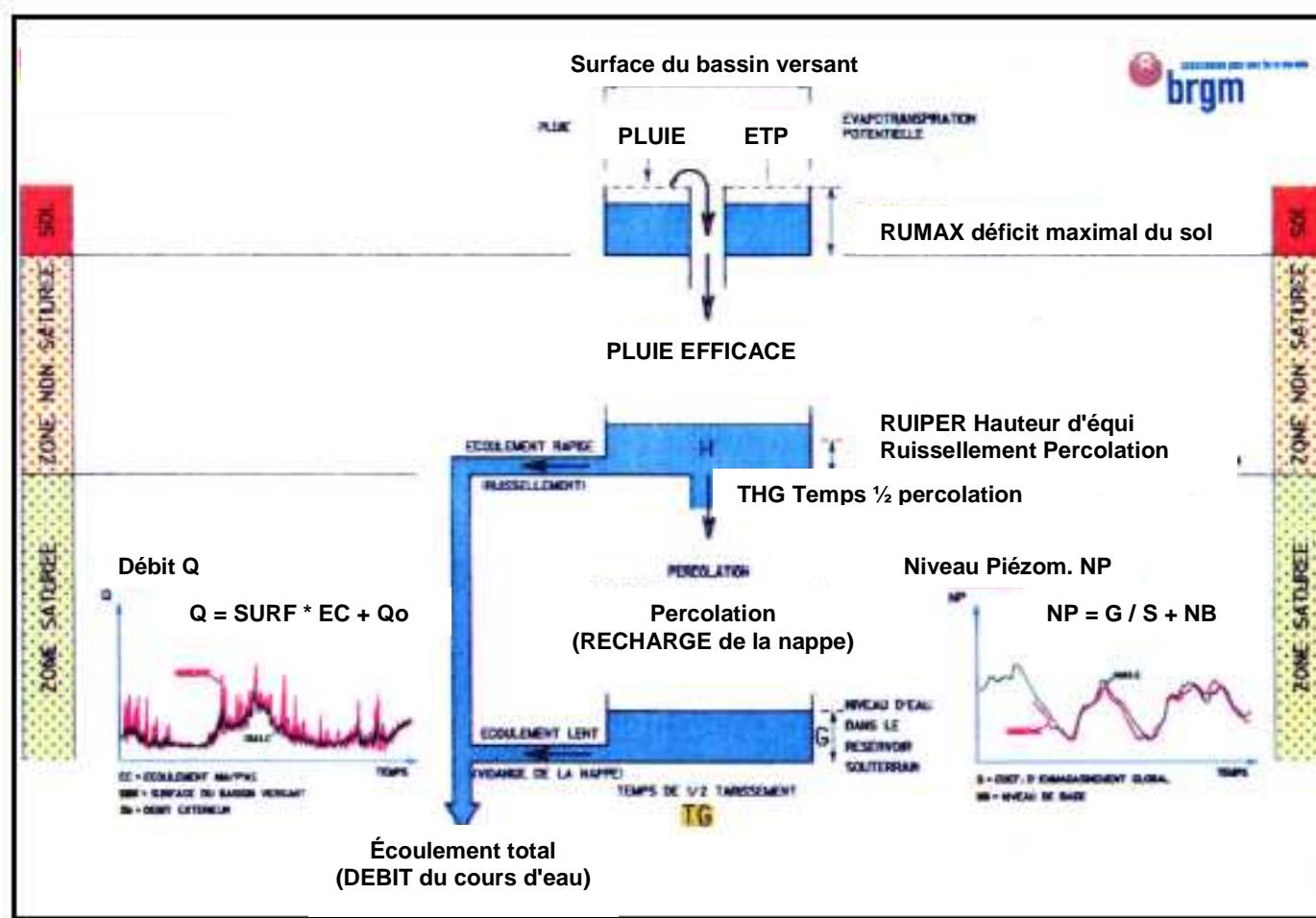


Inverse modelling (TEMPO BRGM) *Sew de Vivier*



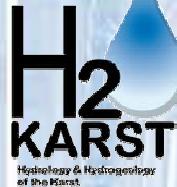
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Hydrological modelling (GARDENIA BRGM)



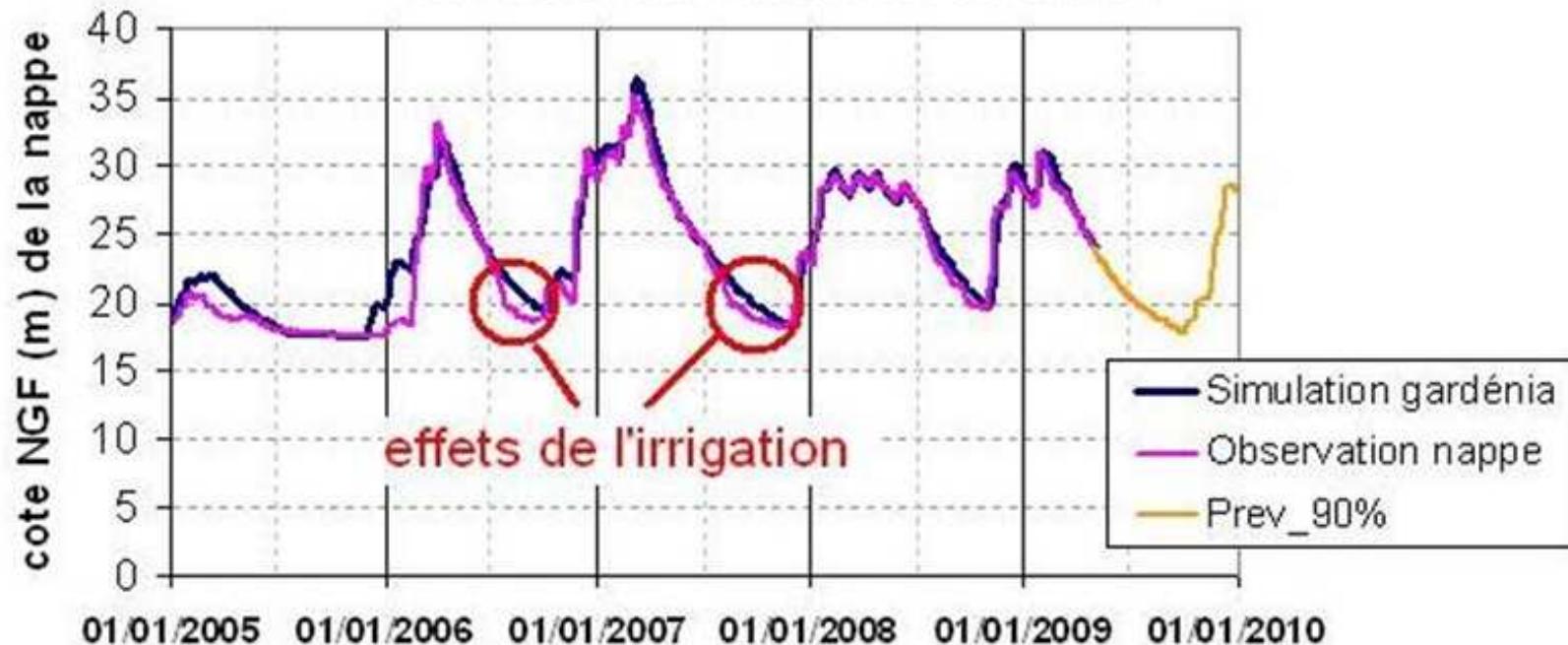
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Hydrological modelling (GARDENIA BRGM)



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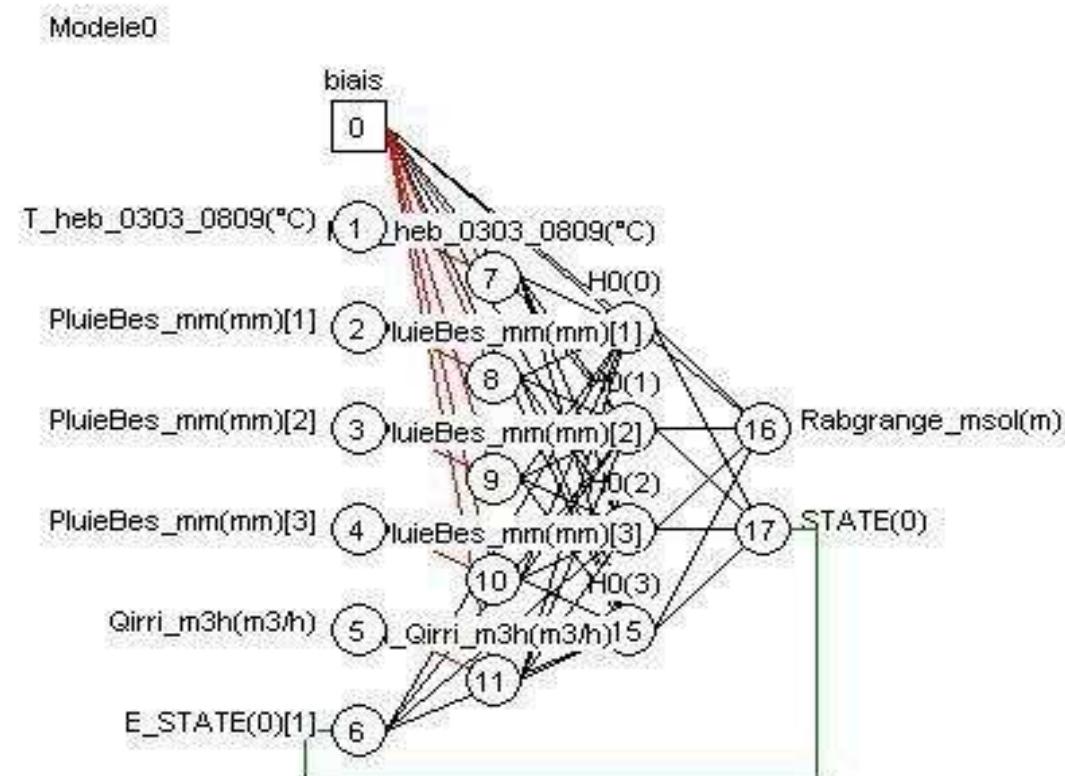
modélisation de la nappe amont avec
GARDENIA - Modèle de boîte



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Artificial neural network modelling *Sew de Jérivier*

(Neuro one Netral)

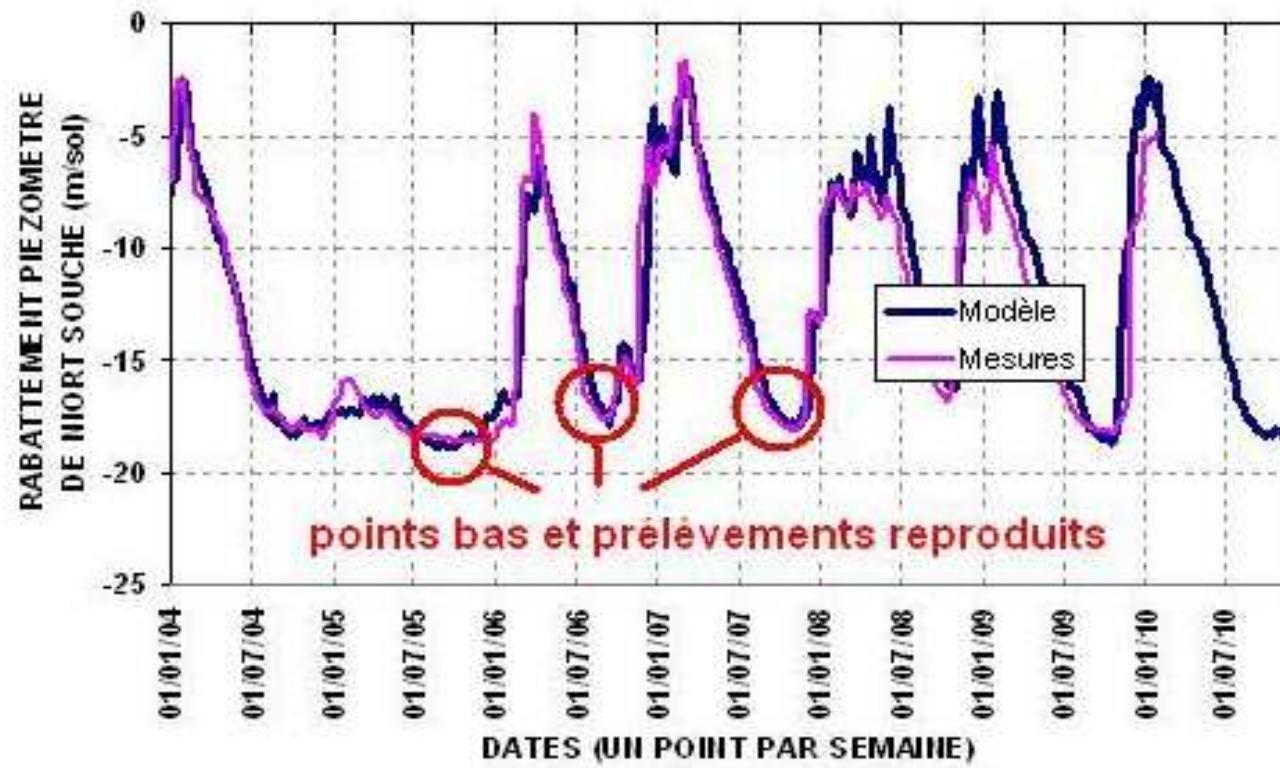


Sortie: Rabqrangne = piézo hebdo moyenne modélisée
 Entrées: T_heb_...: température moyenne hebdomadaire
 PluiBes...: pluies des semaines 1,2 et 3 d'avant,
 Qirri...: prélèvements agricoles hebdomadaires estimés
 biais, E_STATE... : paramètres internes liés au calcul neuronal effectué

Artificial neural network modelling

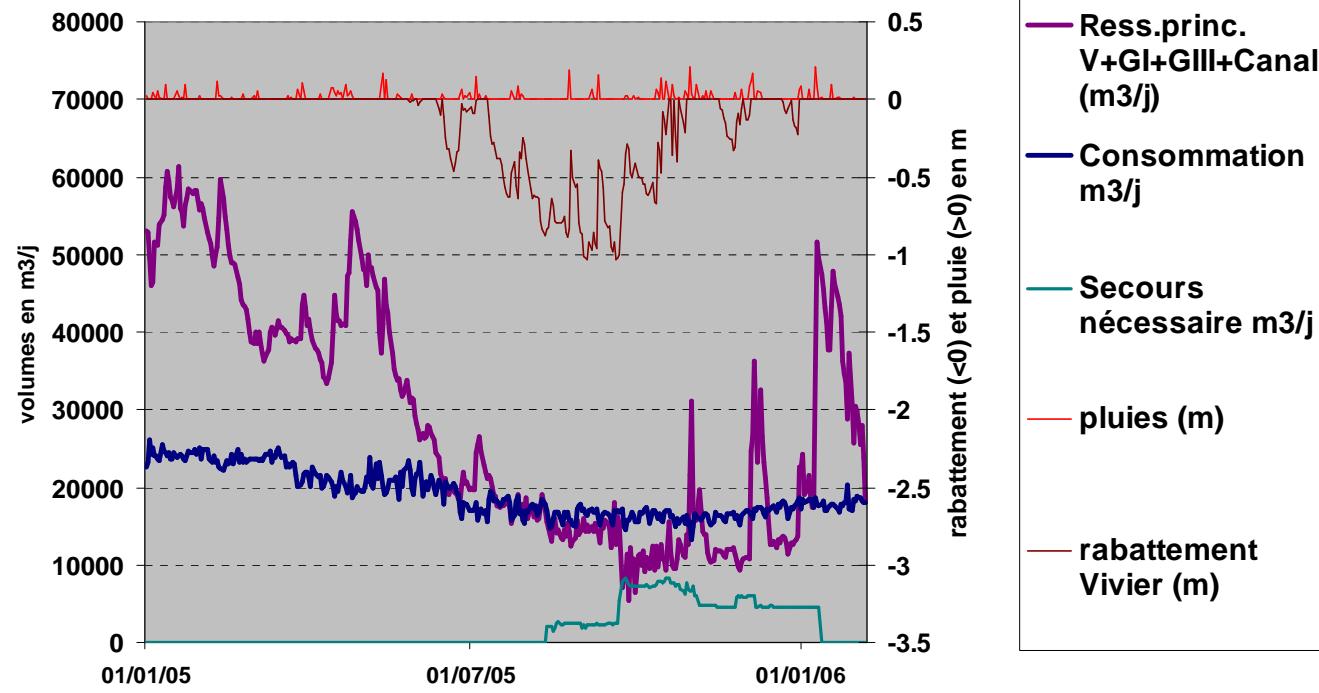
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MODELE TYPE RESEAU DE NEURONES DYNAMIQUES
SIMULATION DE LA NAPPE EN FONCTION DES PLUIES, DES
PRELEVEMENTS ET DES TEMPERATURES HEBDOMADAIRES



Example of use of this model: Crisis anticipation and management

CROISEMENT ENTRE RESSOURCES DISPONIBLES ET BESOINS - ETIAGE 2005



Conclusion: advantages of ANN tools

- After choosing a good model, easy analytical formulation under Excel...
- « Intelligent » black box, but to use under constraints (learning sets must include extrem years)
- Easy to use for simulations (pumpings for irrigation or water supply, climate...)
- Easy to use for sensitivity analysis