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# Identification of two concentration components to better understand the concentration-flow relationship(Obs. ORACLE)



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- To study the concentration-flow relationships of a watershed by applying a two-component mixing equation :  $\checkmark$
- Goal
- A concentration associated with the base flow rate ( $C_1$ ), to represent the regular flows,
- A concentration associated with hydrometerological events ( $C_2$ ), o represent the fluxes linked to the rapid transfer of water
- in the soil.

### $C_k = C_{1j} + (C_{2j} - C_{1j}) \frac{Q_{ext(k)}}{Q_{t(k)}}$ **Mixing equation**

Avec:

 $C_{2i}$ 

- : Total concentration for the time step k (mg/L)  $C_k$
- $Q_{ext(k)}$ : External rate flow for the time step k (m<sup>3</sup>/s)
- : Total flow for the time step k (m<sup>3</sup>/s)  $Q_{t(k)}$ 
  - : Base concentration parameter for the time step *j* (mg/L)

150

100

50

[Q](L/s)

: External concentration parameter for the time step *j* (mg/L)



Figure 1: Orgeval catchment with its corresponding subs-catchments (source: Irstea-Antony)

## **2. Resolution of equation** ✓ Computation of base flow and extern flow using the

Base Index Flow (BFI) method [1]



 Resolution of the mixture equation with two unknowns  $C_1$  and  $C_2$ , using the linear regression method Chloride , 2015-09-15 Coef. reg. fit  $C_k = 34.7 + 1.96 * \frac{Q_{ext(k)}}{Q_{4(k)}}$ (a) Hydrograph (b) Ternary graph 40 Hours 22:30:00 11:30:00 30 mg/L) 00:30:00 20 [CI] 10 - regréssion fit line

- Study Zone: Catchment of Avenelles (45,7  $\checkmark$ km<sup>2</sup>)
- High-frequency measurements (approximately every 30 minutes) from June 2015 to August 2016.
- Ten chemical elements studied (Table 1)  $\checkmark$
- Table 1: Summary of the mean values, min and max of the chemical elements studied from the high frequency measurements

itom	Unit	Avenelles Catchment				$\checkmark$ For each chemical element, the daily values of $C_1$
		Mean	Min	Max	100	and $C_2$ were calculated from June 2015 to August
magnesium	mg/L	8,58	2.98	11,46	80 -	80 2016.
potassium	mg/L	3,53	1.57	8,65	60 - ර	- 60
calcium	mg/L	118,55	56.51	168,04		$\checkmark$ For the majority of chemical elements, $C_1$ is very
sodium	mg/L	13,10	2.79	26,53		stable, $C_2$ much more variable.
strontium	mg/L	0,35	0.17	0,57	5-06-12     5-07-31       5-07-31     5-07-31       6-02-14     5-11-07       6-08-31     1	
fluoride	mg/L	0,15	0.03	2,88	100	From these results it is envisaged:
sulfate	S mg/L	19,06	4.06	25,69	80 - · · · · · · · · · · · · · · · · · ·	80
nitrates	Nmg/L	11,85	3.08	18,36	60 - ර	$\checkmark$ To find a single parameter of $C_1$ and $C_2$ that
chloride	mg/L	31,48	3.63	51,05		efficiently encompasses interactions between
phosphate	P mg/L	0,13	0,00	0,22	20 -	flows and concentrations.
rainfall	mm/30min	0,05	0,00	10,10		
flow	m³/s	0,33	0,05	12,20	2016       6       6       6       2	$\checkmark$ To apply this method to medium and low-
<ul> <li>vve pre results</li> </ul>	related to	e only the the chic	ne calcul oride ions	ations and	the whole study period (from 06/12/2015 to 31/08/2010 for chlorides	6) frequency measurements
					Conclusions	Perspectives
				ΤΙ\/Λ	It is possible to identify two components to explain the	$\checkmark$ Sensitivity analysis of parameters $C_1$ and $C_2$ to better
	$\sim$	Scho		> I I V A	variations in the concentration of the ten chemical	understand how they yary
		00110	narsnips and ure	ants by concyted	variations in the concentration of the ten chemical	understand now they vary.
					elements studied.	<ul> <li>Make seasonal study of <math>C_1</math> and <math>C_2</math> parameters.</li> </ul>
			NCY	TEC		$\checkmark$ Link $C_1$ , $C_2$ and flow descriptors.
		CONSEJ TECNOLOGÍ/	JO NACIONAL DE A E INNOVACIÓN	E CIENCIA, I TECNOLÓGICA		
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Figure 2: Calculation of Q<sub>base</sub> (blue) from Q<sub>total</sub> (red) using the BFI method for each month in the Avenelles catchment. Rain in black.

[1] Gustard A., Bullock A., Dixon J. (1992) Low-flow estimation in the United Kingdom. Institute of Hydrology.



### Hours

Figure 3: a) Daily hydrograph showing flows (Q<sub>total</sub> and Q<sub>base</sub>) and observed concentration. b)Example of calculation of  $C_1$  and  $C_2$  for Chloride, from  $C_{obs}$ and Q<sub>ext</sub> and Q<sub>total</sub> using the linear regression method, for the date of 15/09/2015.

Thanks to the high frequency we can calculate values of  $C_1$  and  $C_2$  for each day.

