HydroEco´2011

Modelling surface water / groundwater interactions in streams connected to exploited alluvial aquifers by means of hydrochemical data.

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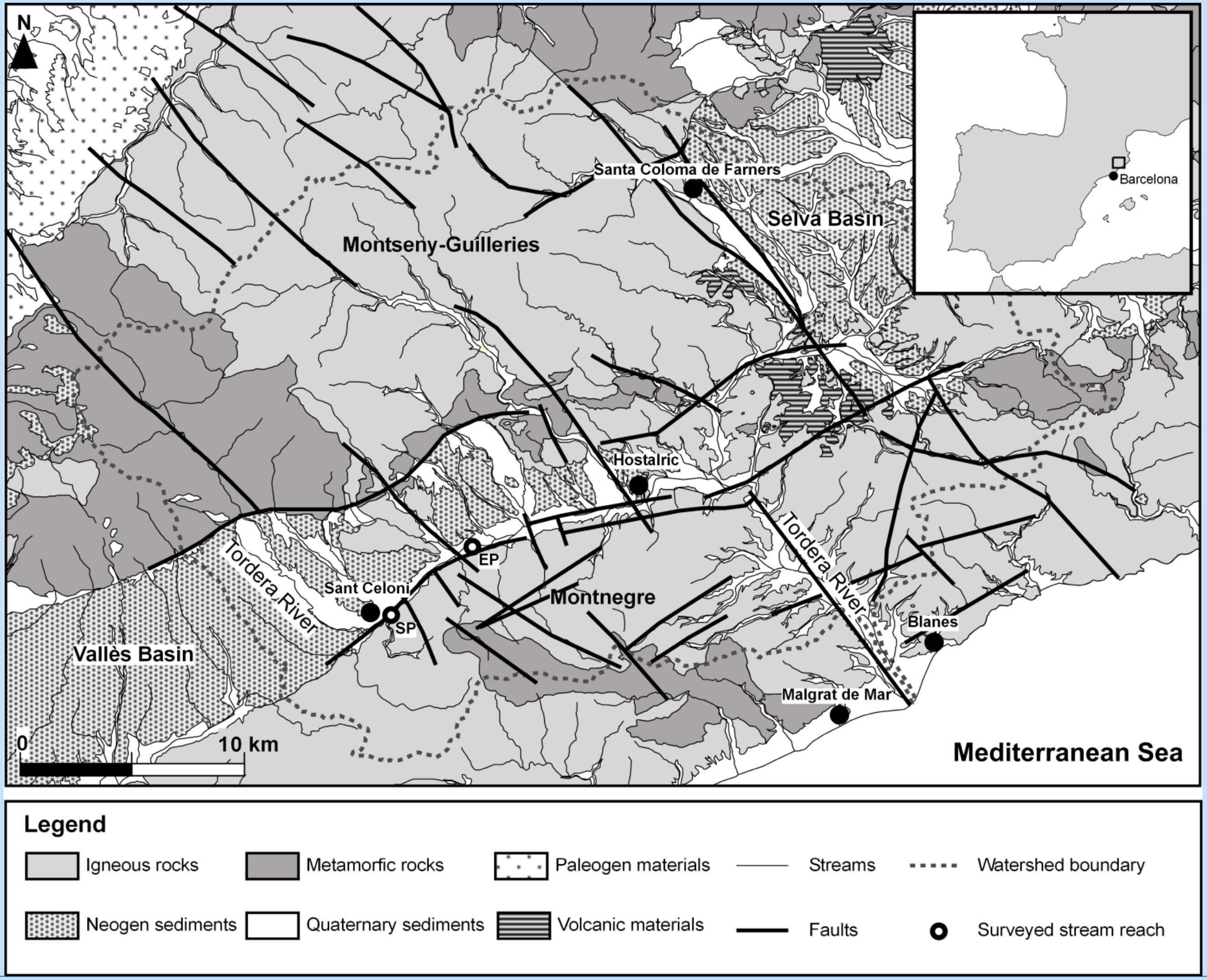
Introduction

- Alluvial aquifers have traditionally been exploited to meet the demand for water. Human development has resulted in groundwater being withdrawn from these aquifers and the subsequent capture of nearby stream water.
- As a result, stored groundwater reserves diminish, in-stream flow declines, ecological dynamics are jeopardized, and riparian biodiversity is lost.
- Hydrological resources management must be addressed to insure supplies and protect riparian areas from environmental deterioration.
- Complementary alternative water resources may help to reduce human pressures on the stream-connected alluvial aquifers and on the streams themselves. Regional groundwater flow systems could provide an alternative option for water supply.

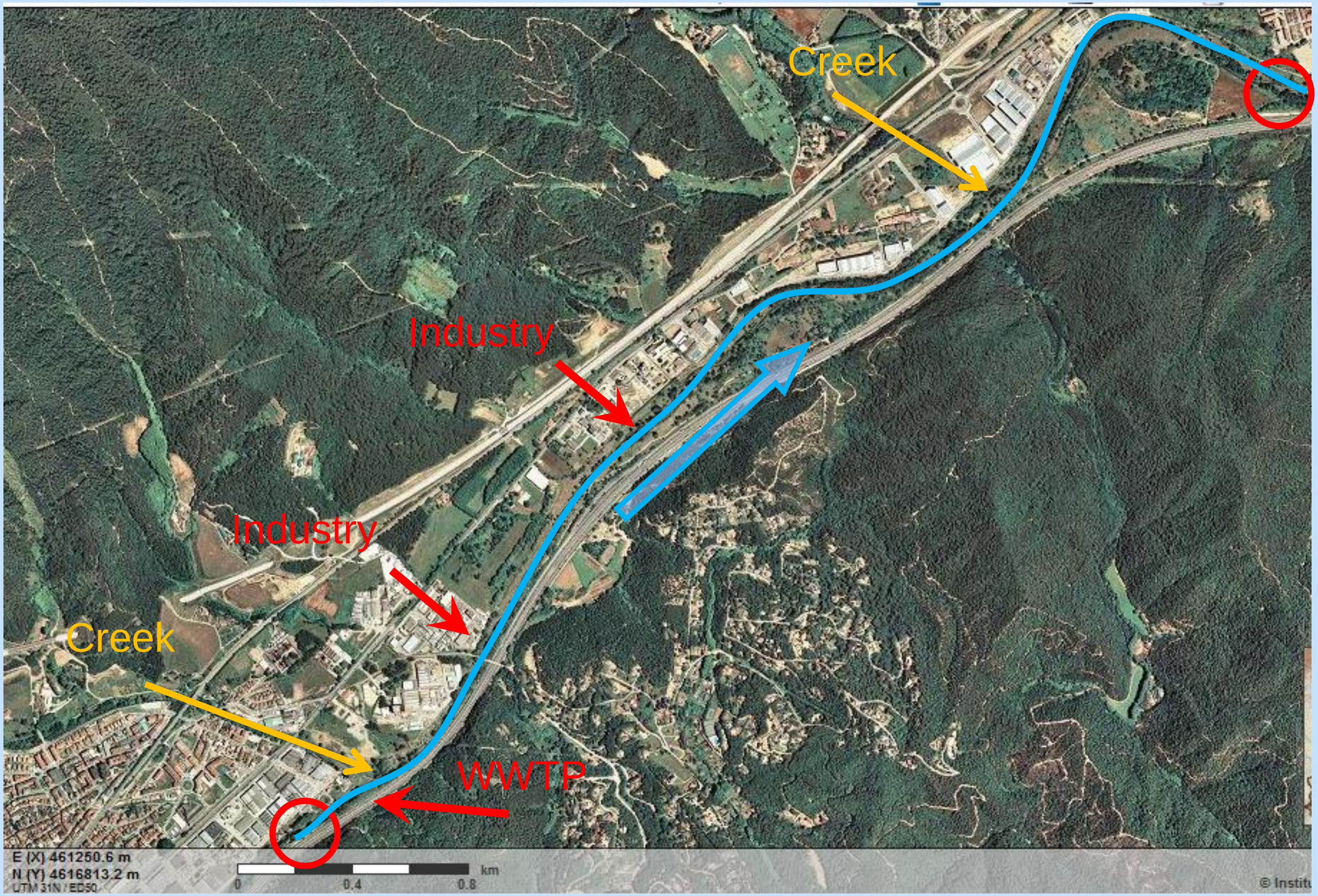
Objectives

- Use discharge and hydrochemical data to investigate the origin of water resources in an intensively exploited stream-connected alluvial aquifer, and to identify new strategies to ease local human impacts on this natural resource.

Geological setting

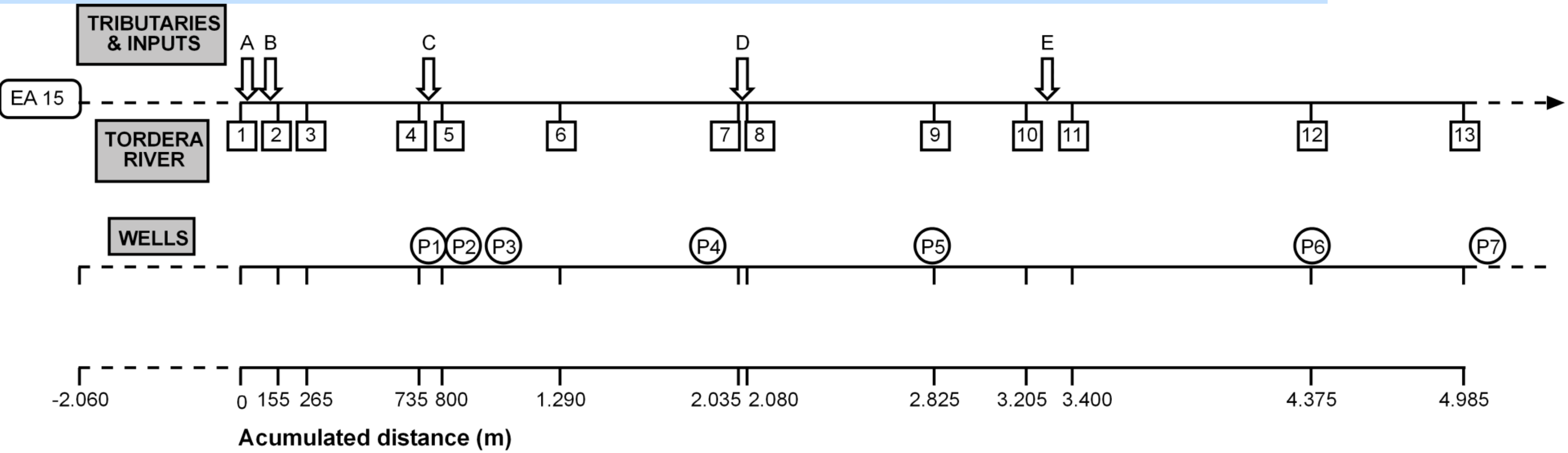


Study area

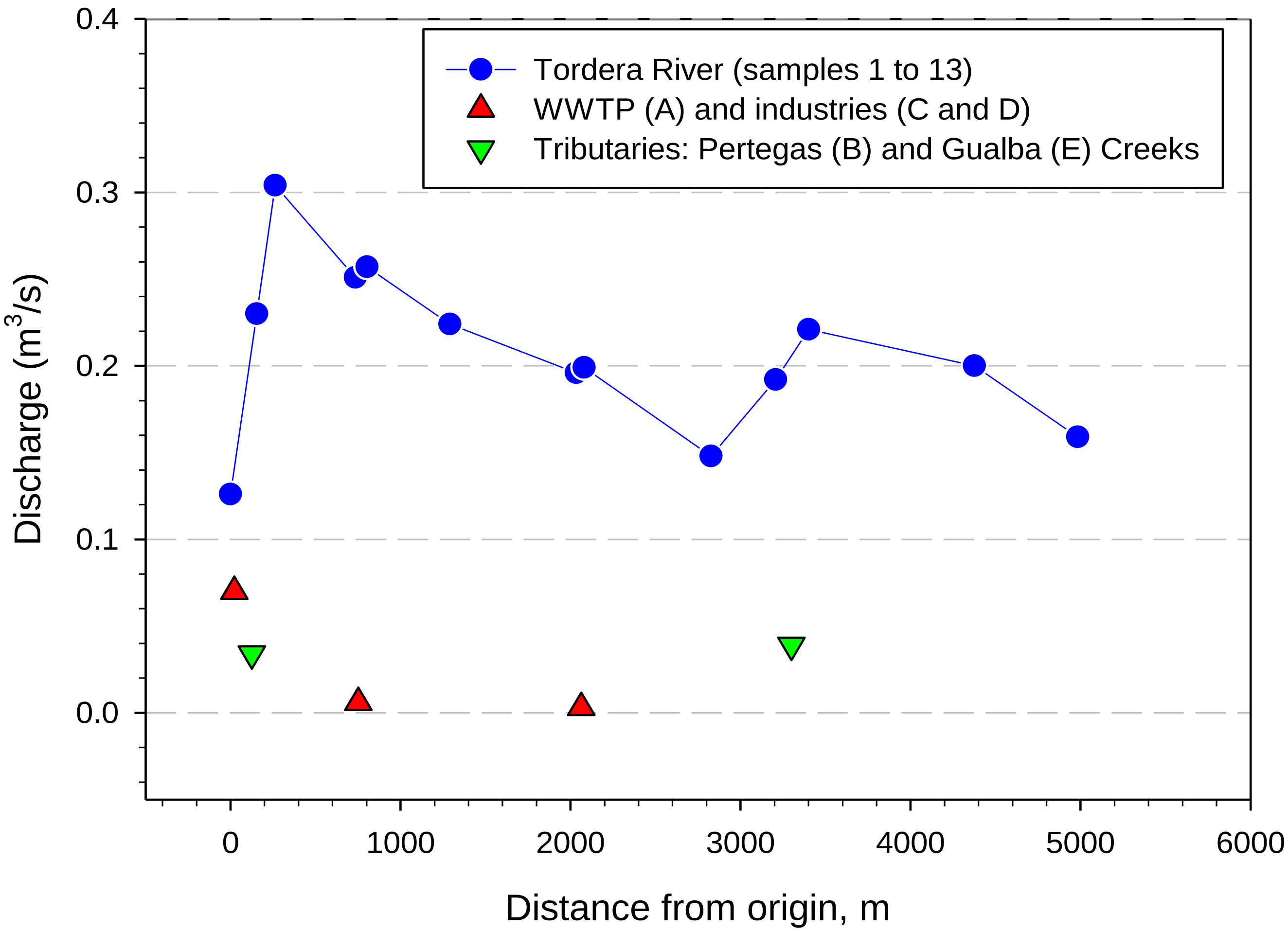

Creek
Industry
Industry
Creek
WWTP
E (X) 461250.6 m
N (Y) 4616813.2 m
UTM 31N / ED50
0
0.4
0.8
km
© Institu

Methods and sampling locations

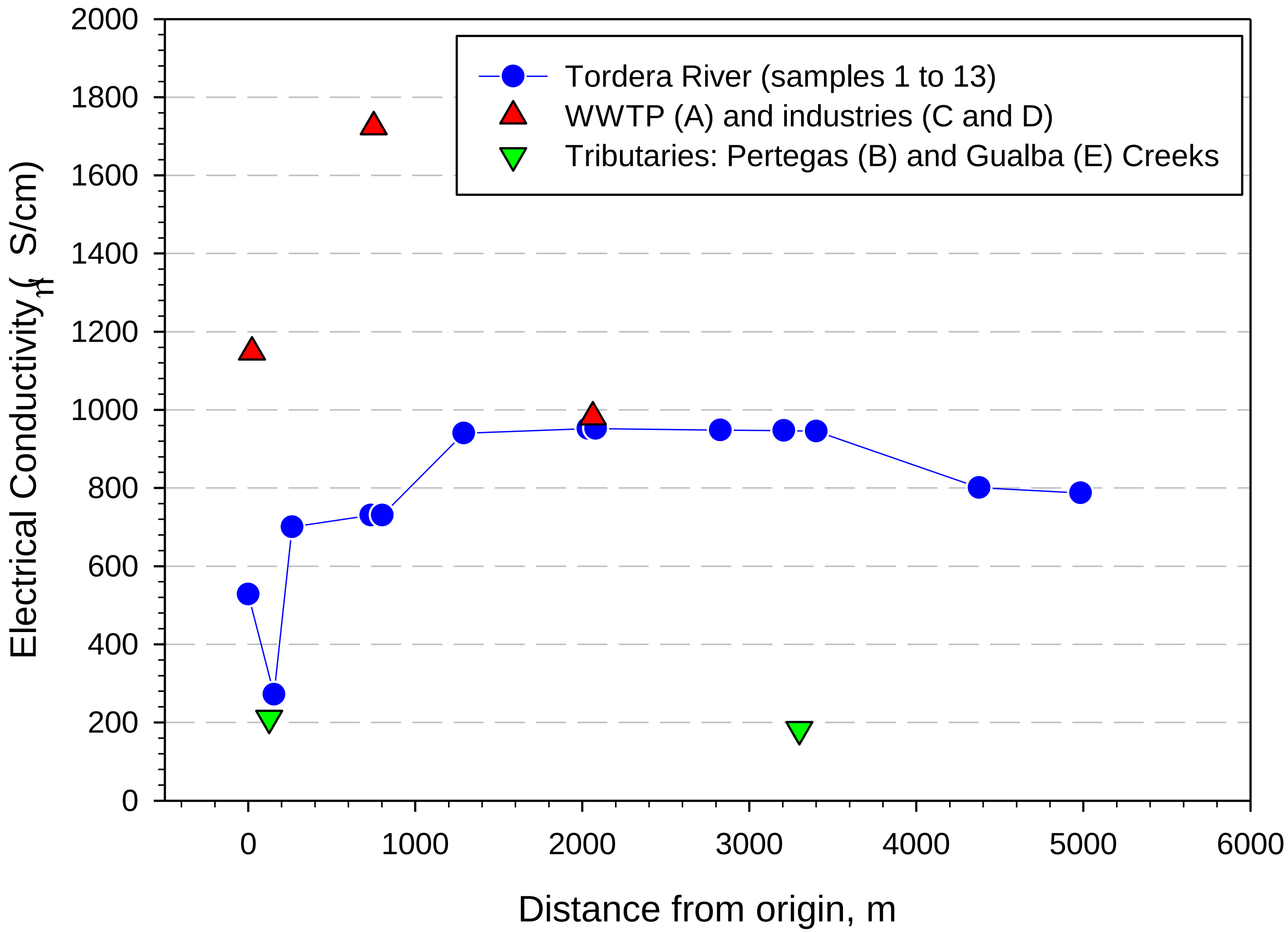
- Local discharge measurements.
- Surface water chemistry
- Groundwater head and chemistry



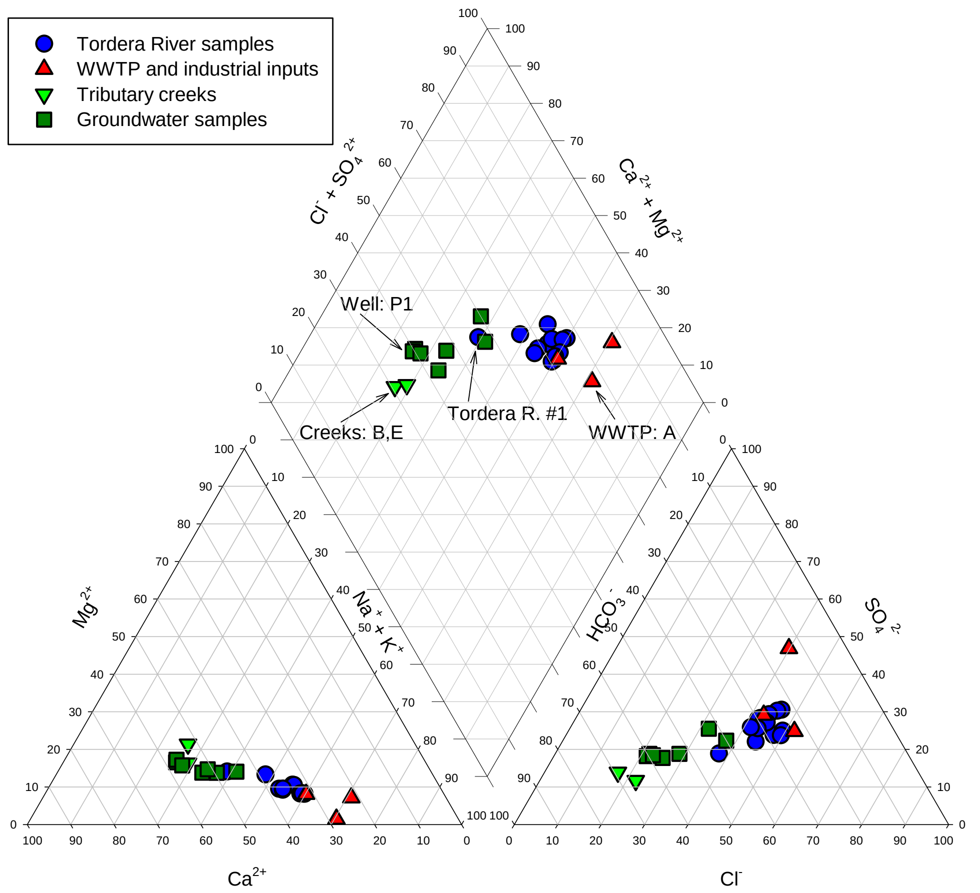
Stream discharge data



Conductivity data



Hydrochemical data



End-Member Mixing Analysis

$$
\begin{cases}
\sum_{j=1}^{n} C_j^{i=1} x_j = C^{i=1} \\
\sum_{j=1}^{n} C_j^{i=2} x_j = C^{i=2} \\
\vdots \\
\sum_{j=1}^{n} C_j^{i=m} x_j = C^{i=m} \\
\sum_{j=1}^{n} x_j = 1
\end{cases}
$$

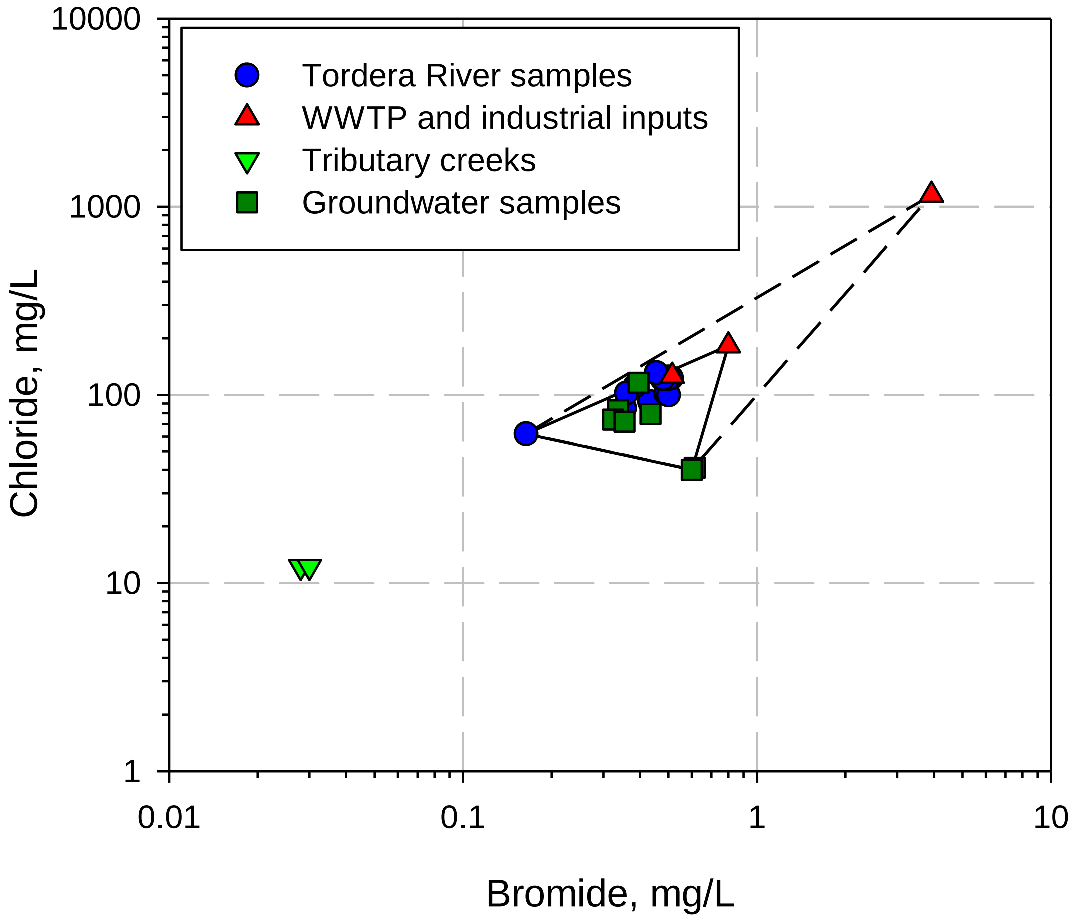
In matrix notation:

A x = C

which solves as,

$$\boldsymbol{x = (A^T A)^{-1} A^T C}$$

End-Member Mixing Analysis



End-Member Mixing Analysis

Tordera River:														
EM:	***Point:***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1) Sample 1: Tordera River	x_1	1.000	0.663	0.523	0.429	0.380	0.611	0.537	0.570	0.561	0.605	0.663	0.729	0.763
2) Sample A: WWTP	x_2	0.000	0.212	0.282	0.366	0.396	0.284	0.300	0.296	0.290	0.279	0.369	0.269	0.188
3) Sample P4: Groundwater	x_3	0.000	0.125	0.195	0.205	0.228	0.080	0.138	0.108	0.124	0.090	-0.053	-0.013	0.032
4) Sample C: Industry	x_4	--	--	--	--	-0.005	0.025	0.025	0.026	0.025	0.026	0.021	0.015	0.016
	Sum:	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Ground water:								
EM:	***Well:***	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**
1) Sample 1: Tordera River	x_1	0.000	0.023	0.727	0.666	0.754	0.806	0.567
2) Sample A: WWTP	x_2	0.000	-0.003	0.295	0.047	0.007	-0.047	0.010
3) Sample P4: Groundwater	x_3	1.000	0.981	-0.038	0.278	0.224	0.212	0.401
4) Sample C: Industry	x_4	0.000	-0.001	0.016	0.009	0.015	0.029	0.022
	Sum:	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Conclusions

- The hydrochemical analysis of river water and that of the groundwater aquifer evidence that a supplementary recharge produced by upward fluxes from the geological basement compensates the water budget.
- End-member mixing analysis shows that this specific contribution is as much as 20% of the total discharge.
- Regional basement groundwater is thus a water supply alternative. The wise exploitation of such resources will ease pressures on the alluvial aquifers and the stream flow.
- Conjunctive use of surface water and groundwater resources can now be considered an opportunity. Companies that are responsible for impacts must be encouraged to participate in hydrological assessment, and compelled to develop further hydrogeological research through private investment.

Thank you!

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