ABSTRACT n° 2103

Seepage water. A new resource?

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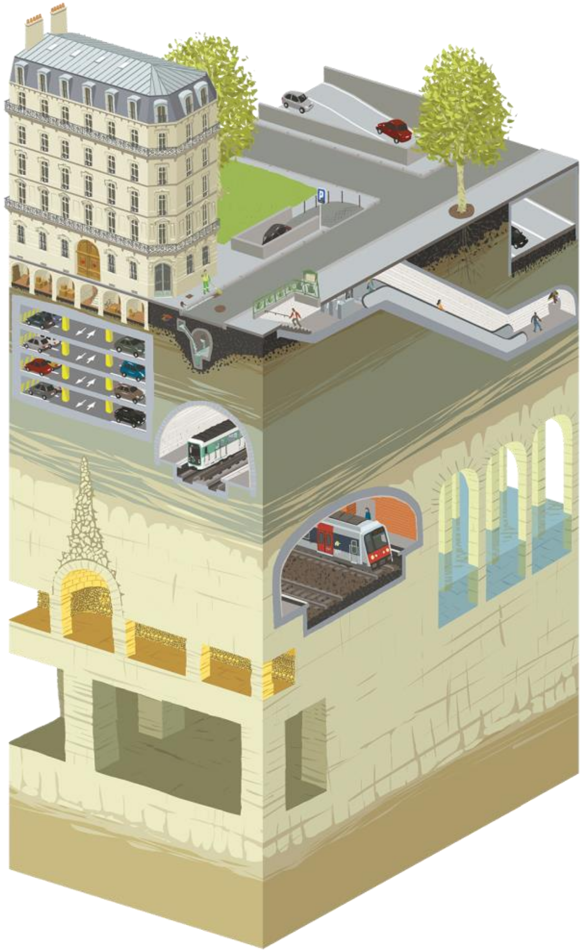
1 Background

Paris underground

The presence of **rivers**, combined with precipitation and permeable underground has as consequence that numerous underground infrastructures like **subway**, **train**, **parking** or basements of modern building are submerged in ground water and have to deal with seepage water (infiltration)



http://desplanchesillustrees.blogspot.fr/2013/02/paris_25.html

Discharge or reuse ?

Paris is pumping about 20 000 m^3/d to keep its underground infrastructure dry. This water is discard principally into the combined sewers of the city and charged for collection and treatment.

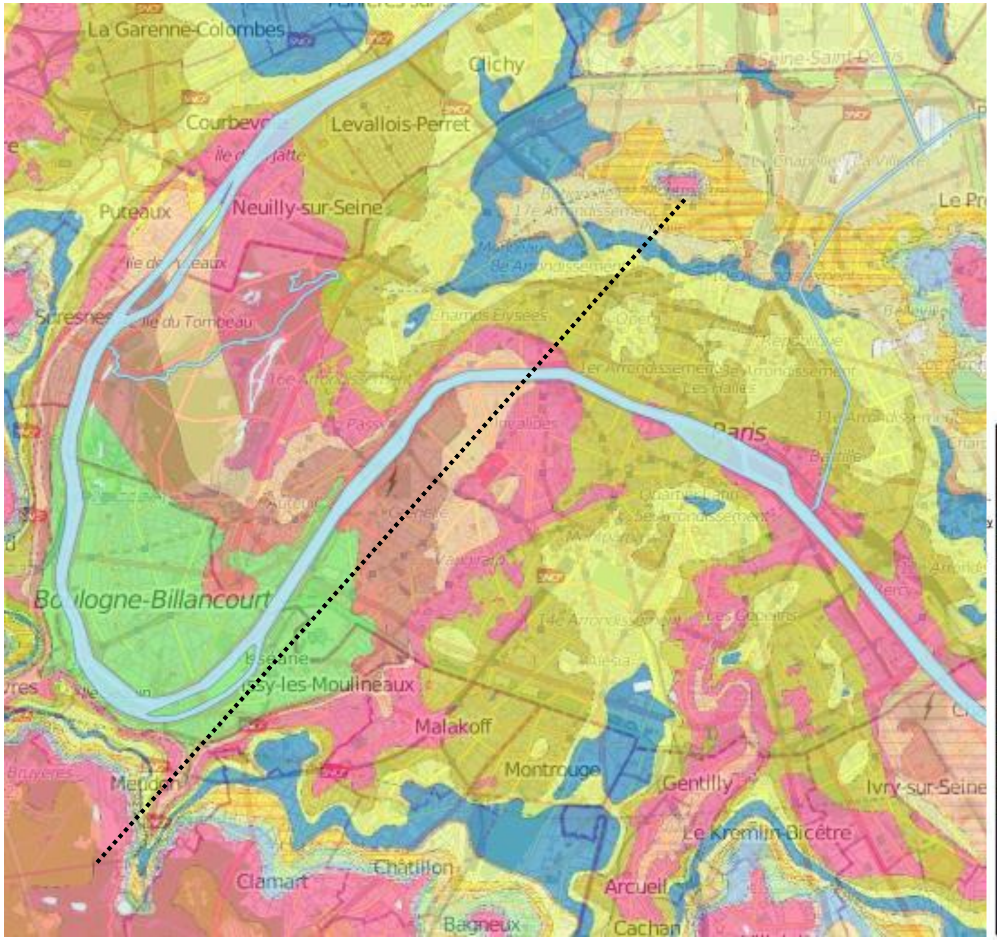
Sewers discharge => treatment taxes -> municipality of Paris

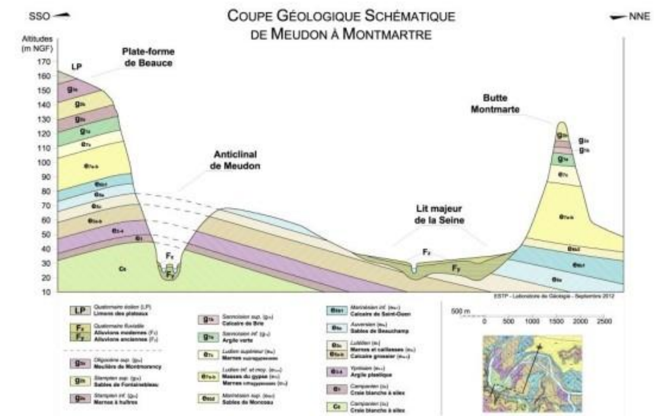
Rivers Seine discharge => environmental taxes -> Water agencies

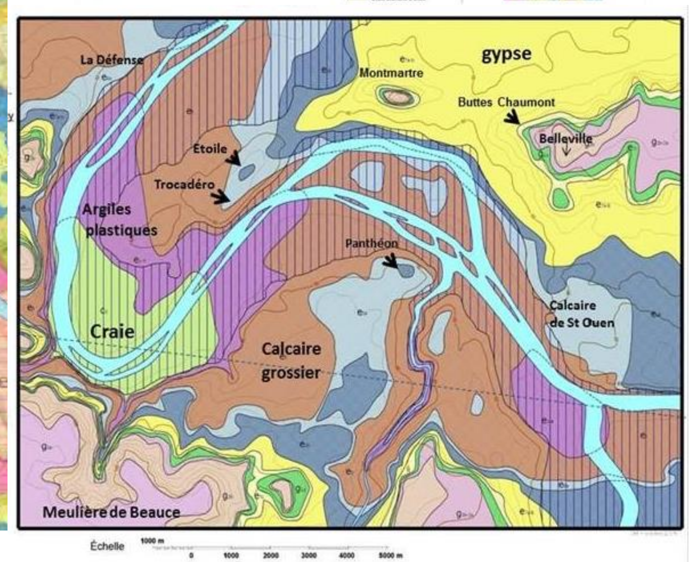
Paris is also using a huge amount of river water (200 000 m^3/d) for urban uses like sewer flushing, street cleaning and watering.

The seepage water could potentially be used for these city needs preserving natural water resources.

Hydrogeology







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2 Approach

Data collection

- Waste water collection and treatment : volumes and basic quality data "Municipality of Paris"

- Public parking service delegation: volumes and basic quality data Saemens, Vinci, Indigo …

- Sampling campaigns within public parkings

Seepage water.
Resource?
=>
Quantity
Quality
Use

Sampling and analysis

- Collection at the underground inlet
- Analysis of
  - Physico-chemistry (on site)
  - Majors elements,
  - Heavy metal (selection)
  - Basic microbiology
  - Organic carbon
  - 3D fluorescence

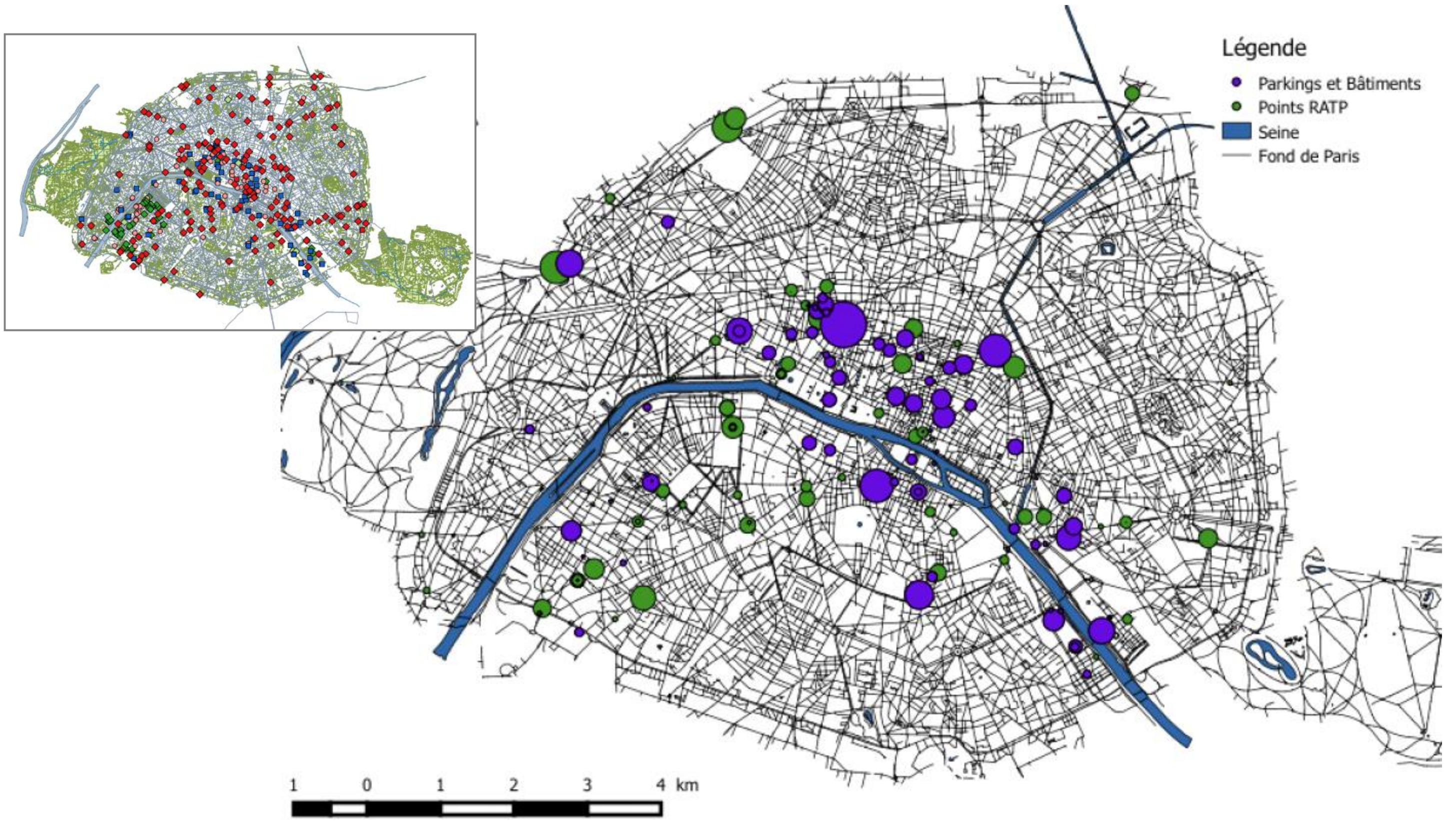
Within Laboratory of the public drinking water company Eau de Paris (**AFNOR/ ISO**) and University laboratory (Stand. Water Methods APHA/ AWWA)

Sampling

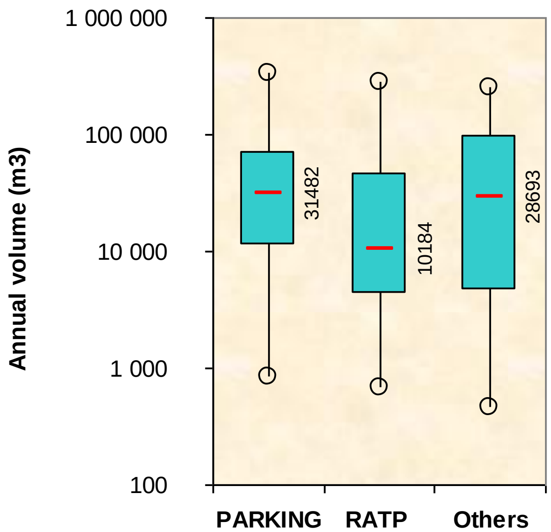

HallesPK_25052016_ms05.JPG @ 12% (RVB/8)
StAnt_17052016_ms02.JPG @ 12% (RVB/8)
StAnt_17052016_ms07.JPG @ 12% (RVB/8)
cnam_31052016_ms04.jpg @ 12% (RVB/8)
12 %
Doc : 57,1 Mo/57,1 Mo

3 Results and discussion

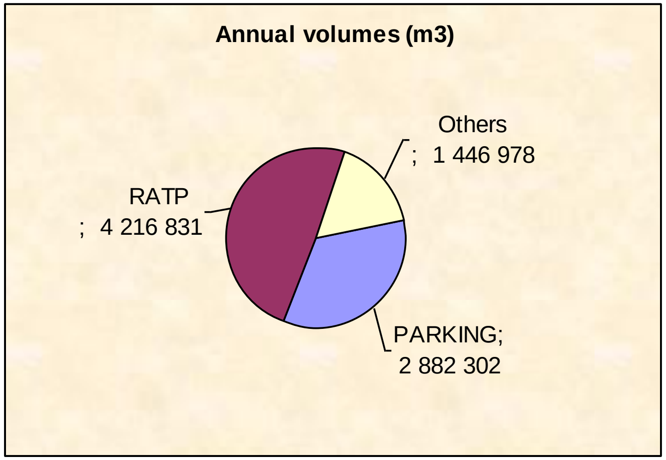
Where and how much is produced



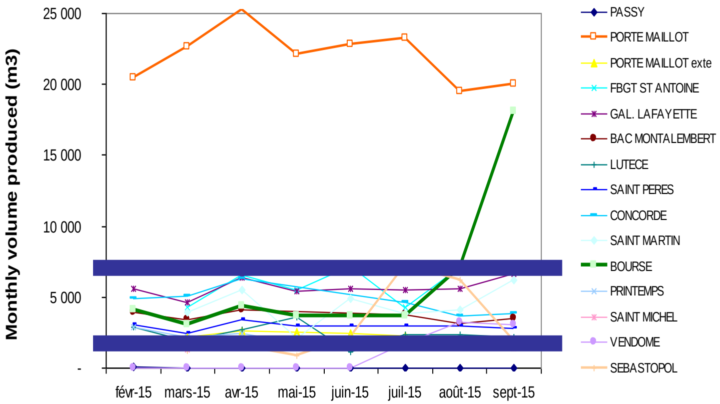
Volumes



1 000 000
100 000
10 000
1 000
100
Annual volume (m3)
31482
10184
28693
PARKING
RATP
Others

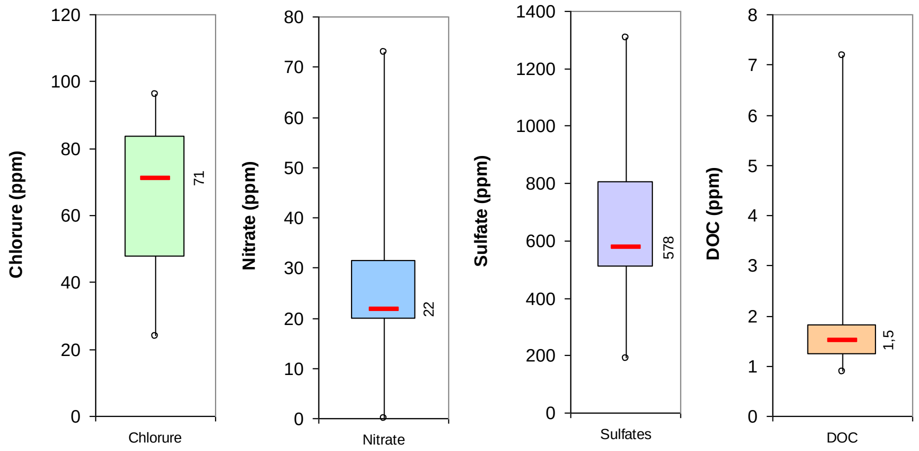


Annual volumes (m3)
Others
; 1 446 978
RATP
; 4 216 831
PARKING;
2 882 302



Monthly volume produced (m3)
25 000
20 000
15 000
10 000
5 000
-
févr-15
mars-15
avr-15
mai-15
juin-15
juil-15
août-15
sept-15
PASSY
PORTE MAILLOT
PORTE MAILLOT exte
FBGT ST ANTOINE
GAL. LAFAYETTE
BAC MONTALEMBERT
LUTECE
SAINT PERES
CONCORDE
SAINT MARTIN
BOURSE
PRINTEMPS
SAINT MICHEL
VENDOME
SEBASTOPOL

Quality



Parameter		Seepage	RENP (2014)	diff
Temperature	°C	17,0	17,8	-4%
pH		7,4	>7,3	
Conductivity	µS/cm	1880,7	715,0	163%
S.S.	mg/l	3,0	4,4	-32%
Hardness	°f	94,5	35,4	167%
TAC	°f	25,4	25,7	-1%
COD	mg/l	1,8	3,3	-46%
Bore	µg/l	116,2	20,0	481%
Calcium	mg/l	312,1	113,0	176%
Magnesium	mg/l	46,7	17,3	170%
Iron	mg/l	55,3	0,3	20760%
Chloride	mg/l	66,8	26	157%
Nitrate	mg/l	26,1	18,9	38%
N-NH4	mg/l	0,3	<0,10	
Sodium	mg/l	42,8	12,0	257%
Sulfates	mg/l	686,5	62,2	1004%
PO4	mg/l	0,037	0,05	-25%
E.Coli	MPN	0 - 100	54	

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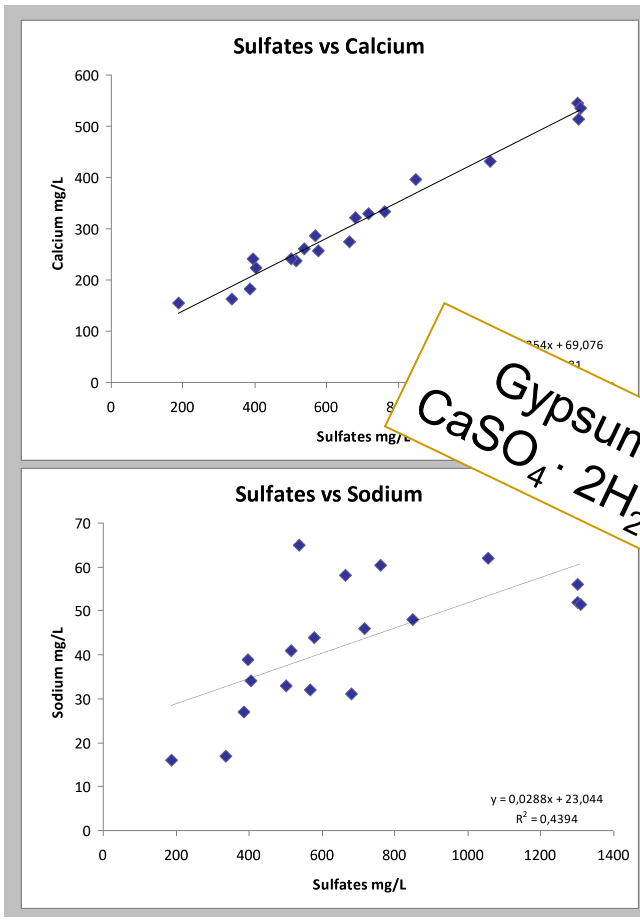
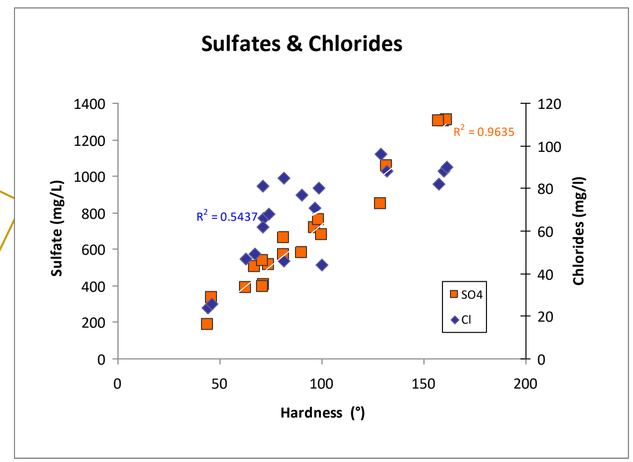
Gypsum **influence**



Gypsum

$CaSO_4 \cdot 2H_2O$



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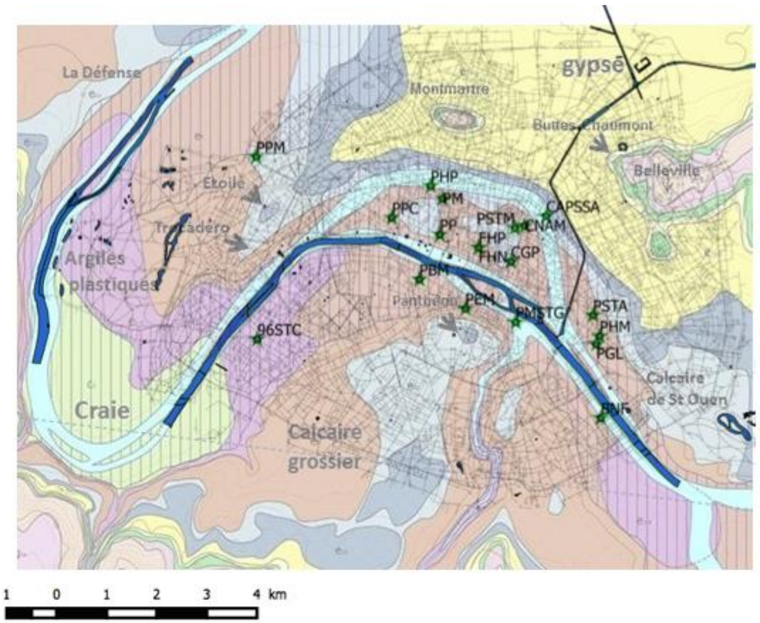
Correlations

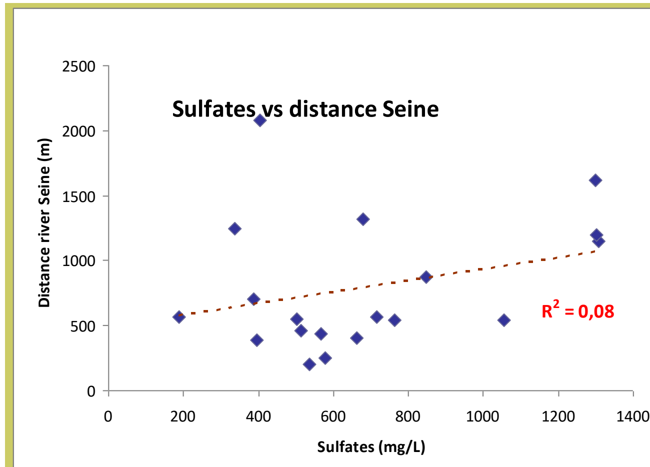
- Principal component analysis

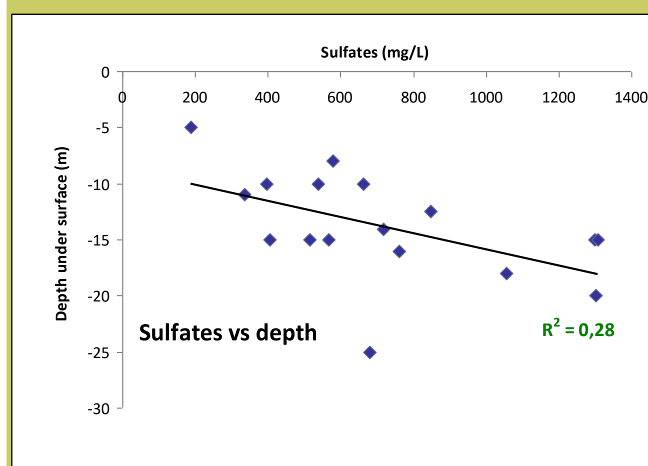
	volume	distance	NGF	Conductivité	Dureté	TAC	COD	Calcium	Strontium	Chlorure	Sodium
volume	1										
distance	0,380	1									
NGF	-0,255	-0,423	1								
Conductivité	0,332	0,356	-0,277	1							
Dureté	0,411	0,330	-0,283	**0,770**	1						
TAC	-0,150	0,008	-0,026	-0,316	0,187	1					
COD	-0,037	-0,251	0,002	-0,135	-0,065	0,300	1				
Calcium	0,415	0,321	-0,339	**0,786**	**0,990**	0,110	-0,049	1			
Strontium	-0,144	-0,236	0,222	0,090	0,335	**0,509**	0,047	0,260	1		
Chlorure	0,256	-0,013	-0,012	**0,528**	**0,738**	0,278	0,097	**0,716**	0,266	1	
Sodium	0,245	-0,197	-0,099	0,466	**0,622**	0,079	0,109	**0,638**	0,232	**0,908**	1
Sulfates	0,460	0,297	-0,316	**0,818**	**0,982**	0,056	-0,098	**0,989**	0,292	**0,724**	**0,663**

En gras, valeurs significatives (hors diagonale) au seuil alpha=0,050 (test bilatéral)

Hydro-geology



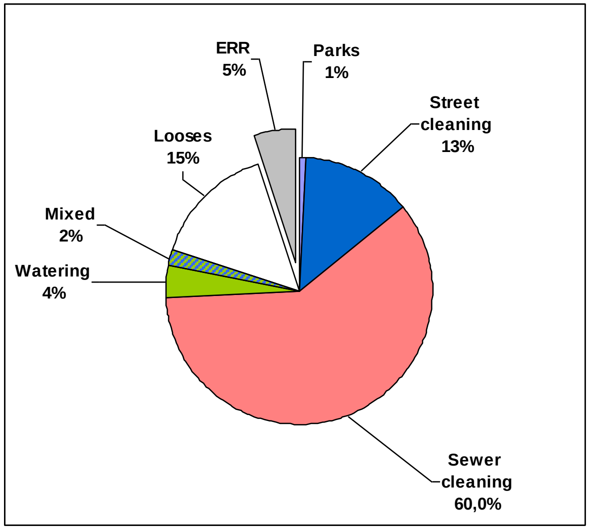


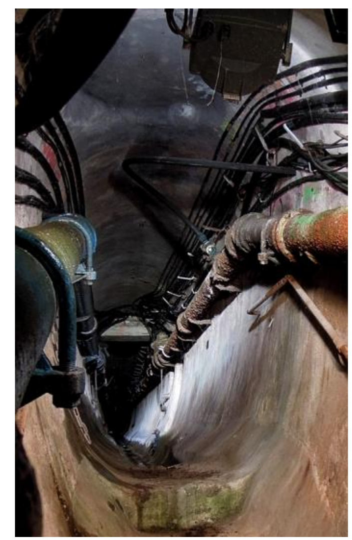


City water usages

V = 200 000 m^3/day

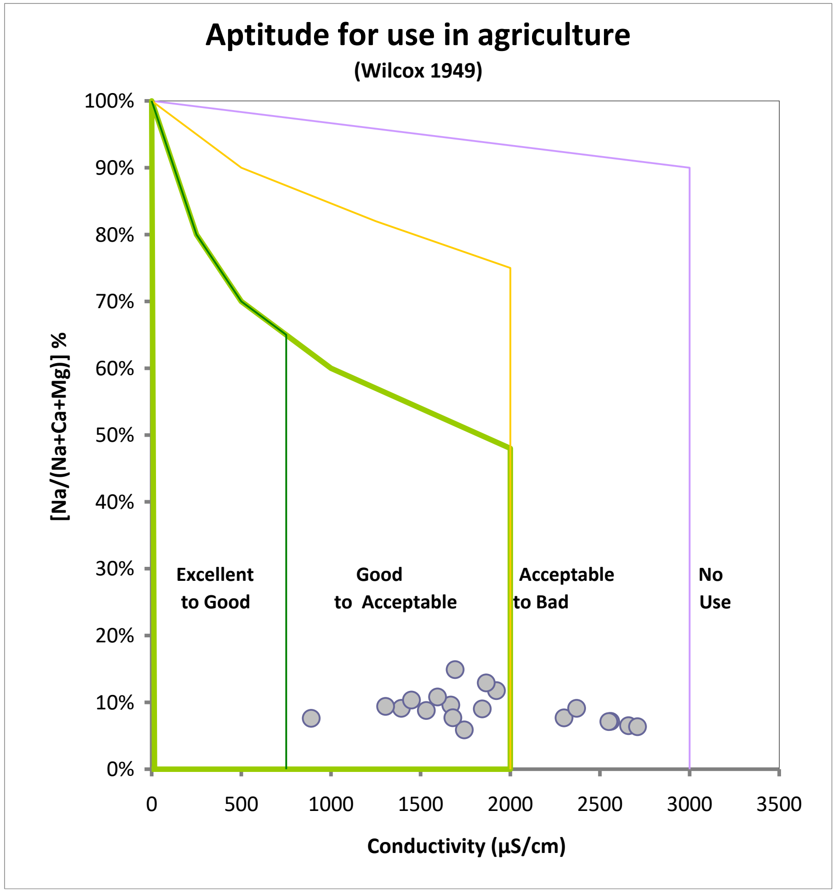
≈ 1 € /m^3





RENP water for : watering

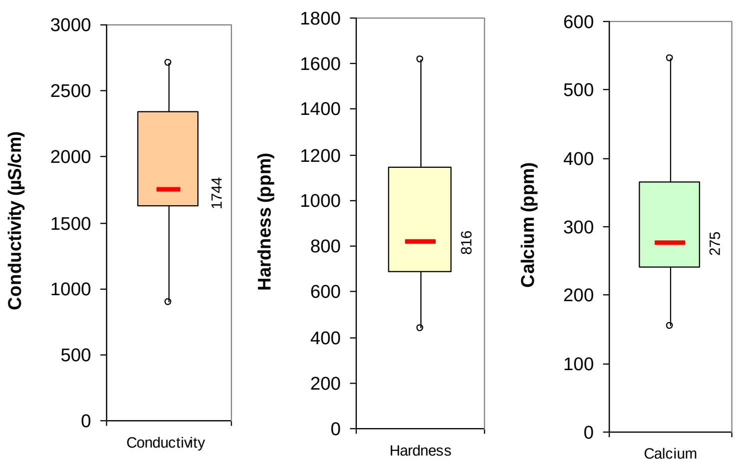
- Bacteria : OK
- Na : OK
- Conductivity : OK - limit
- SO4 : limit



No limits for unrestricted irrigation with reclaimed water are exceed (Spain, Portugal, France, WHO). Though the Portuguese norm for irrigation recommends 1000 µS/cm and 575 ppm of sulfate

RENP water for : transport / cooling

- Sulfates
- Conductivity
- Hardness



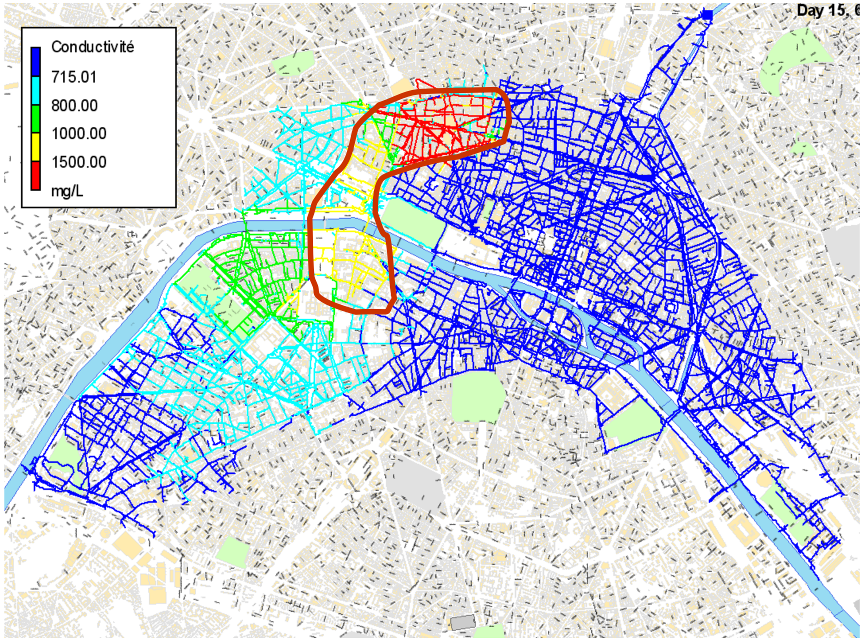
Langelier Saturation Index (LSI)
$= pH - [10.0754 + 2.432636 \times e^{-(T/86.89927)} - 0.2006 \times e^{-(0.004624 \times TDS)} - \log(\text{Ca Hardness}) - \log(\text{Total Alkalinity})]$

LSI	Indication
-2,0<-0,5	Serious corrosion
-0,5<0	Slightly corrosion but non-scale forming
LSI = 0,0	Balanced but pitting corrosion possible
0,0<0,5	Slightly scale forming and corrosive
0,5<2	Scale forming but non corrosive

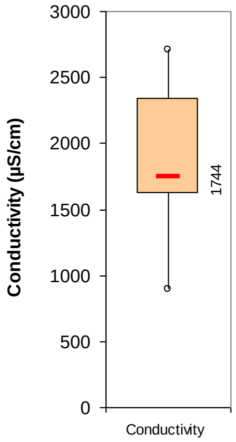
Water is supersaturated with respect to calcium carbonate ($CaCO_3$) and scale forming may occur.

Distribution

- Example of point « Opera »
  - Most important in volume (75 m3/h) and in charge (2700 µS/cm)



Epanet



4 Conclusion

Conclusion

- Seepage water is an **abundant** resources which could contribute up to 10% of the municipal water use for cleaning and irrigation
- A big disparity exists between the point as well for quantity as for the quality
- The hypothesis of relationship between depth of the source and sulfate content is not confirmed
- **BUT** seepage water is « **harder** » to use because it contains 10 times more Sulfate and 3 times more Calcium than the Seine river water.
- It could therefore be used directly only for street and sewage cleaning. Any other use **needs dilution** or even pre- treatment.
- If we admit a dilution rate of 2 to 4, 75% of the sources (< 2500 µS/cm) would be suitable for inclusion in the industrial water supply system.

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Thank you for your attention

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