

# Organically bound tritium in freshwater ecosystems : long term trends in the environment of french nuclear power stations

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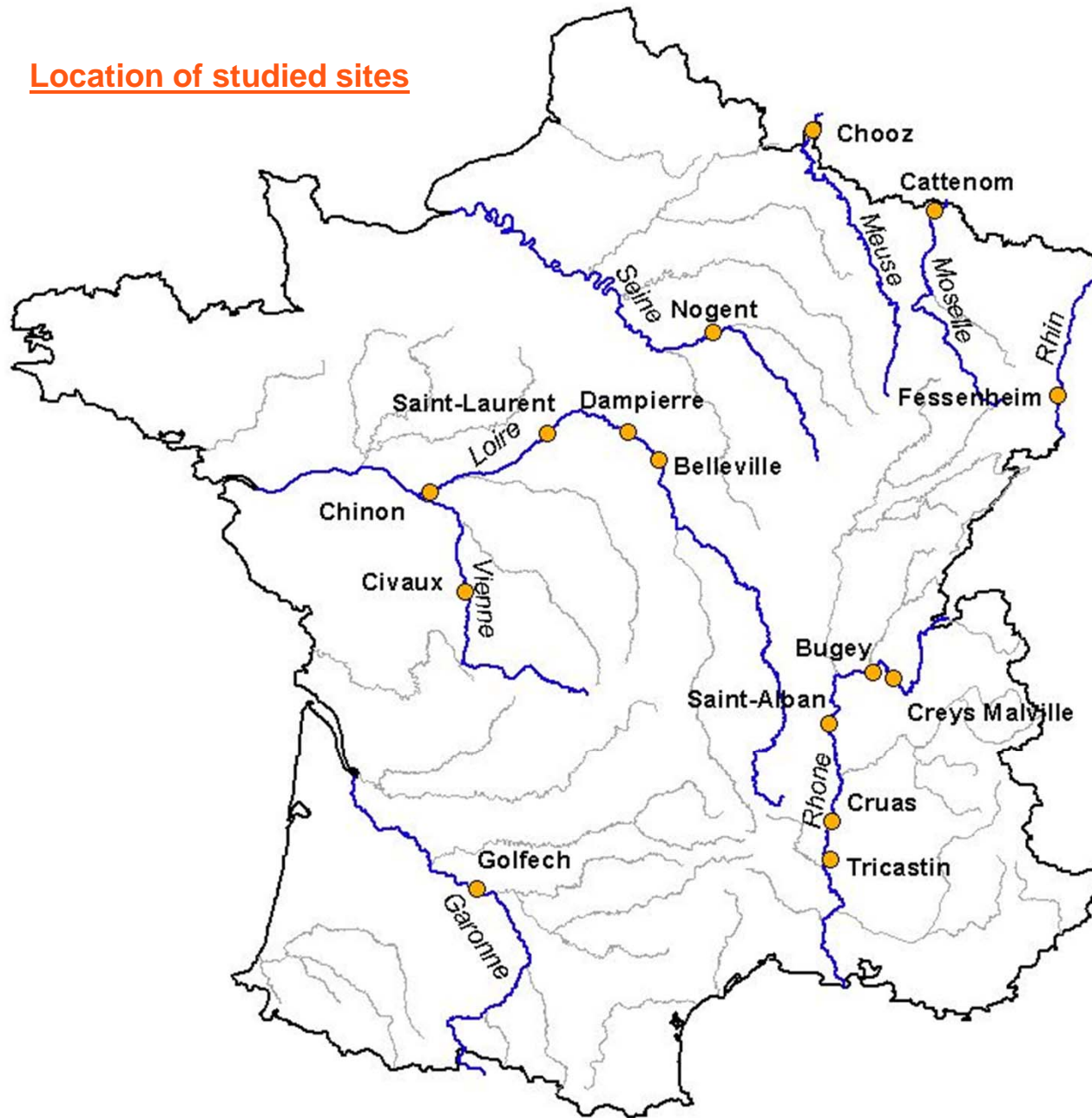
## Radioecological survey in the environment of nuclear power plants

- 20 nuclear power plant sites with liquid and gaseous discharges of tritium
  - along Atlantic coast
  - along Gironde estuary
  - along rivers : Rhone, Rhine, Loire, Vienne, Seine, Garonne, Moselle, Meuse
- tritium measurements (HTO and OBT)
  - in aquatic and terrestrial environment
  - Started in 1977
  - 2 sites per year since 1992



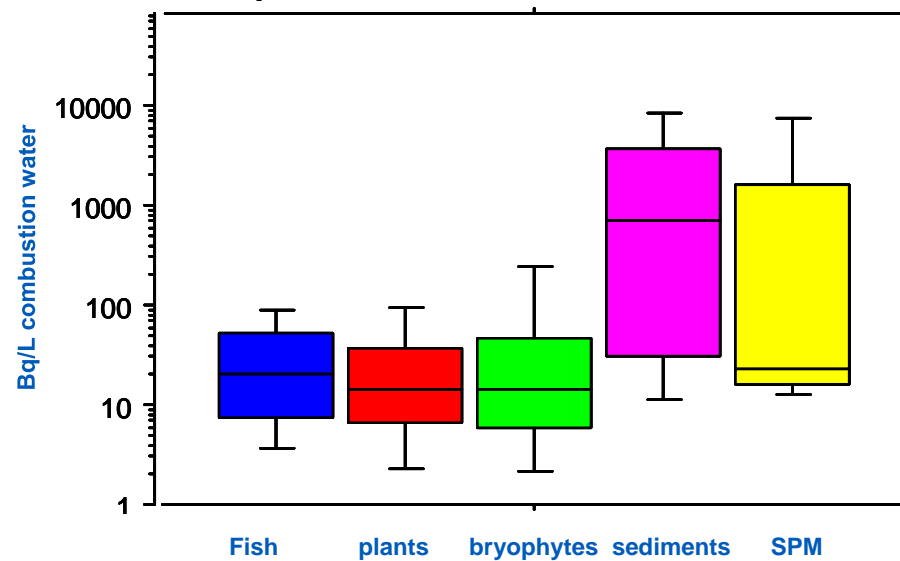
Large data base that can be used to study evolution of background concentrations and influence of NPP discharges

## Location of studied sites

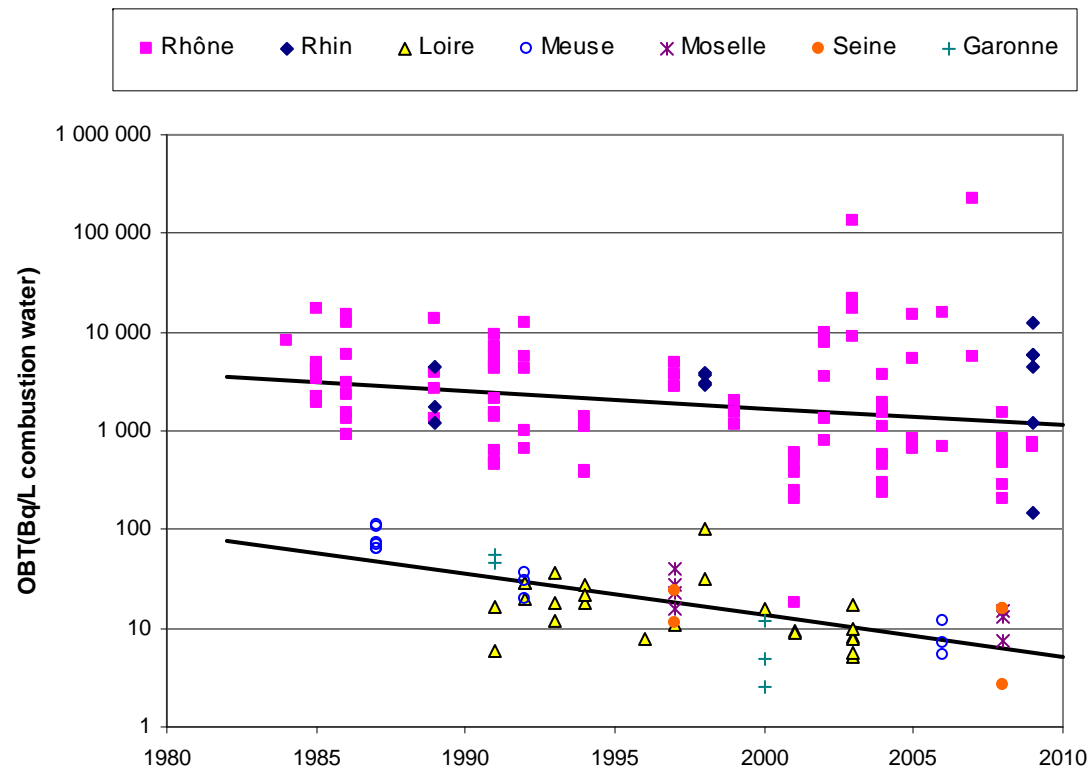


600 OBT  
measurements in fish,  
aquatic plants and  
sediments in  
freshwater  
ecosystems

# OBT in freshwater ecosystems around nuclear power plants (all samples from 1977 to 2009)



# OBT in sediments around nuclear power plants (all sampling sites)

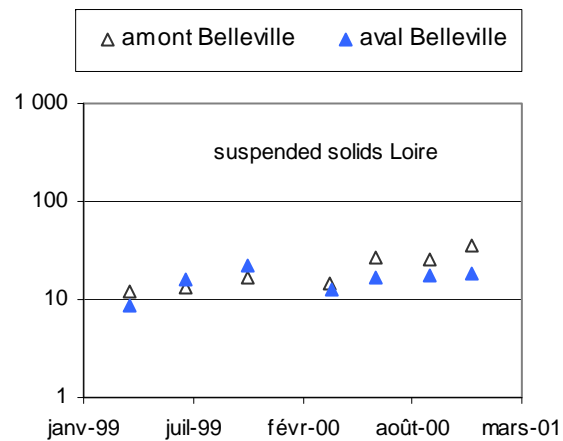


OBT activities are decreasing in relation with decrease in fallout from atmospheric test

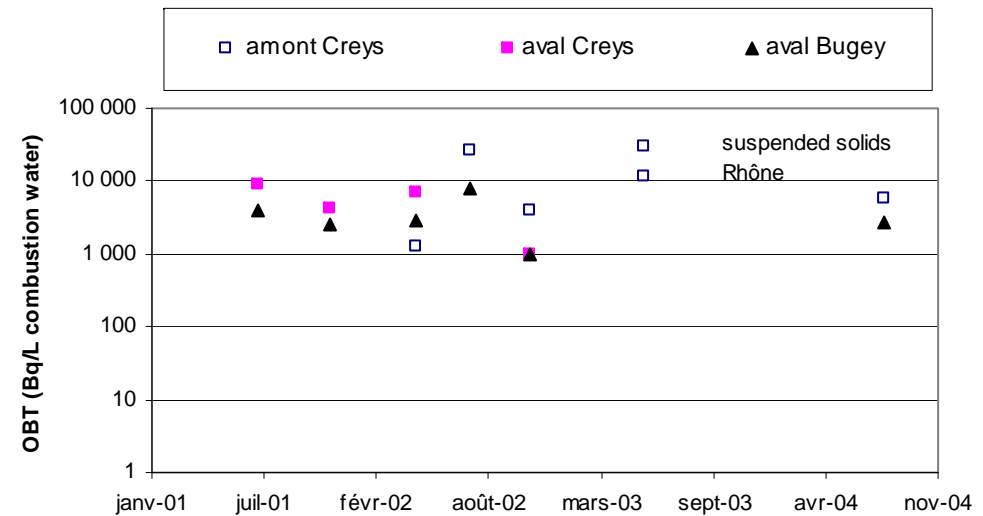
- 2 distinct groups :
- Rhône and Rhine, exponential regression with half-life of 17 years
  - other rivers, exponential regression with half-life of 7 years

No significant difference between station upstream and downstream NPP

# OBT in particulate matter upstream all NPP – comparison with downstream



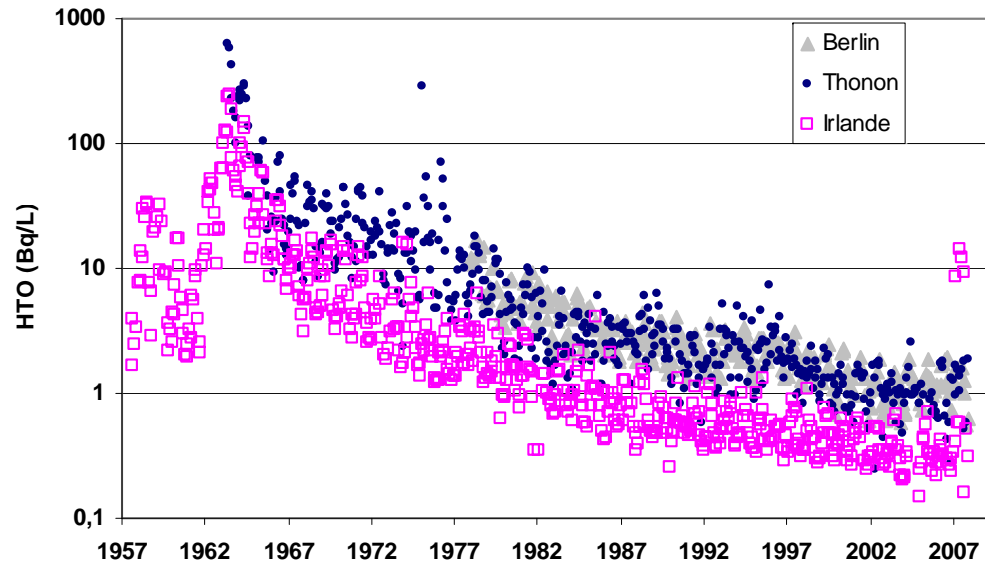
No difference between upstream and downstream



OBT upstream significantly higher than downstream

Origin of tritium undetermined (could be linked to radioluminescent device industry )

# Comparison with evolution of HTO in precipitations



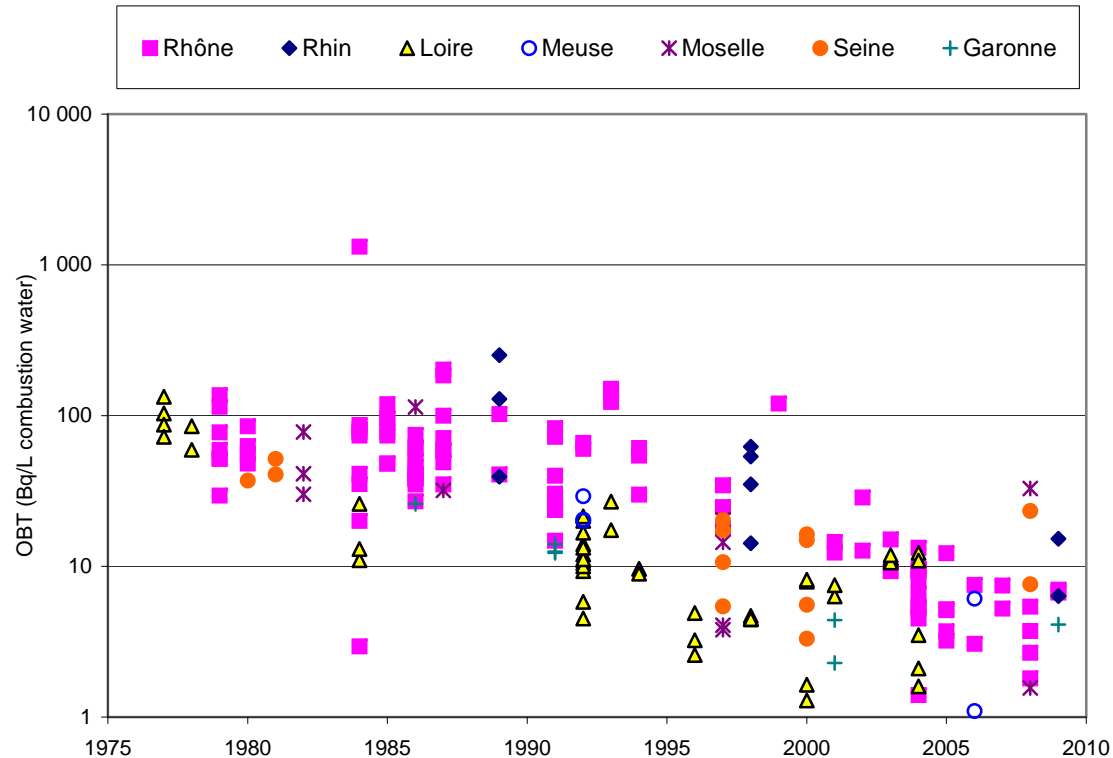
Exponential decrease with a half-life of 6years

Present level : 1 Bq/L in continental areas

One order of magnitude lower than OBT in sediments of rivers other than Rhone and Rhine  
Taking into account radioactive decay, present level in sediments equivalent to level in precipitation 40 years ago, in agreement with the average residence time of organic matter in soils (Balesdent et al 1997)

OBT in watershed (year n) = HTO in precipitation (year n - 40).  $\exp(-\lambda_r \cdot 40)$

# OBT in fish around NPP (all sampling sites)



OBT activities are decreasing in relation with decrease in fallout from atmospheric test

Exponential regression with half-life of 6 years

influence of NPP significant on rivers other than Rhône and Rhine :

+ 7 Bq/L (average) between upstream and downstream



# Calculation of the increases in river HTO activities resulting from power plant discharges- comparison to observed differences in fish OBT between upstream and downstream stations

Site	Year	fish species	discharge added HTO concentration in river	OBT level (Bq/L combustion water)
			Bq/L	delta upstream-downstream
Dampierre	1992	anguille	7,8	1,5
St-Laurent	1993	anguille	4,3	9,4
Chinon	1994	anguille	3,0	-0,7
Cattenom	1997	anguille	27,9	10,61
Cattenom	1997	chevaine	27,9	16,38
Nogent	1997	brochet	11,5	14,8
Nogent	1997	chevaine	11,5	6,67
Belleville	2000	anguille	6,1	6,86
Belleville	2000	barbeau	6,1	6,25
Nogent	2000	anguille	32,5	12,98
Nogent	2000	chevaine	32,5	9,39
Dampierre	2001	barbeau	5,2	1,18
Golfech	2001	gardon	5,7	2,11
St-Laurent	2003	barbeau	2,2	1,24
Chinon	2003	anguille	3,2	0,5
Belleville	2004	chevaine	8,7	9,2
Chooz	2006	chevaine	17,0	5
Cattenom	2008	brême	41,4	31,17

Average OBT/HTO = 0,62

Good agreement with TRS 472 partition factor



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# Contribution of OBT in sediment to OBT in fish in upstream areas

Calculation based on 2 term sources :

- HTO in precipitation (year n) = HTO in surface waters(year n)
- OBT in sediment (year n)

- In rivers other than Rhone and Rhine, sediment OBT contributes to 13 % of fish OBT
- In Rhone river, sediment OBT contributes to 1/10 000 of fish OBT

# Conclusions

- In river catchments, where atmospheric test fallout is the main source of tritium, observed levels result from the exposure of aquatic organisms to two distinct tritium pools of different age :
  - tritiated water from rainfall (representing present fallout),
  - organic tritium from soils (formed over several decades) which supplies particulate matter to surface waters.
- in the Rhône and Rhine river basins, an additional source of organic tritium of very low bio-availability, probably originating from the luminous paint industry, is responsible for the spiking of sediment organic matter up to 100 to 100 000 Bq/L combustion water.
- influence of NPP tritium discharges is detectable only in rivers, with low background OBT activities, i.e in other basins than the Rhône and Rhine. The observed increase in plant and fish OBT is lower than the discharge added HTO activity in water, which confirms the absence of bioaccumulation for tritium originating from HTO and the absence of highly bio-available tritiated organic molecules in NPP discharges

See Gontier & Siclet, Radioprotection (submitted)