Study of the fate of chemical elements in the Rhine ecosystem: upstream and downstream of the Fessenheim nuclear power plant (NPP)

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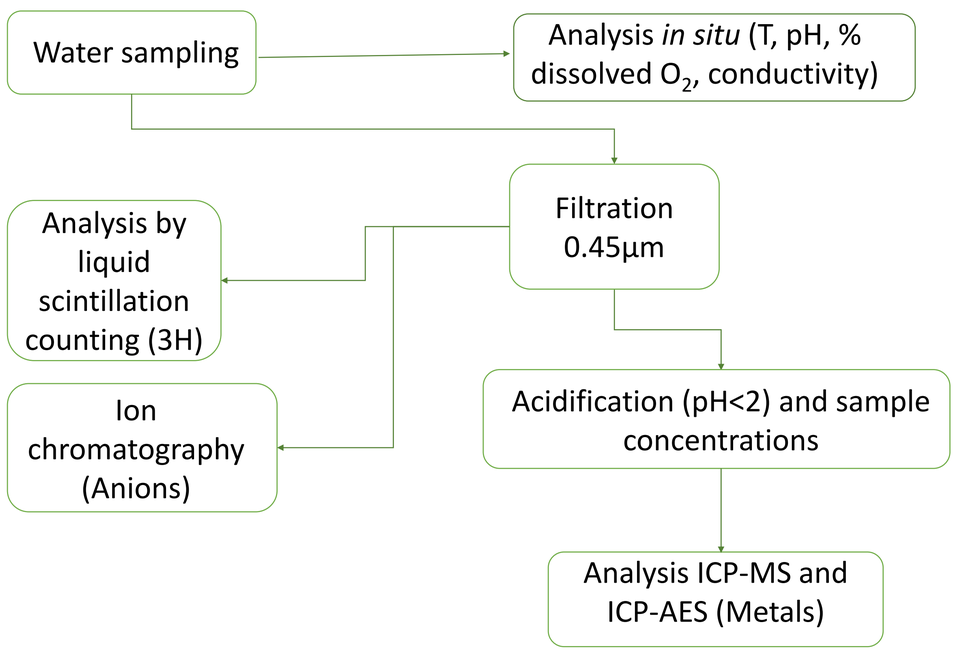
Context and objectives

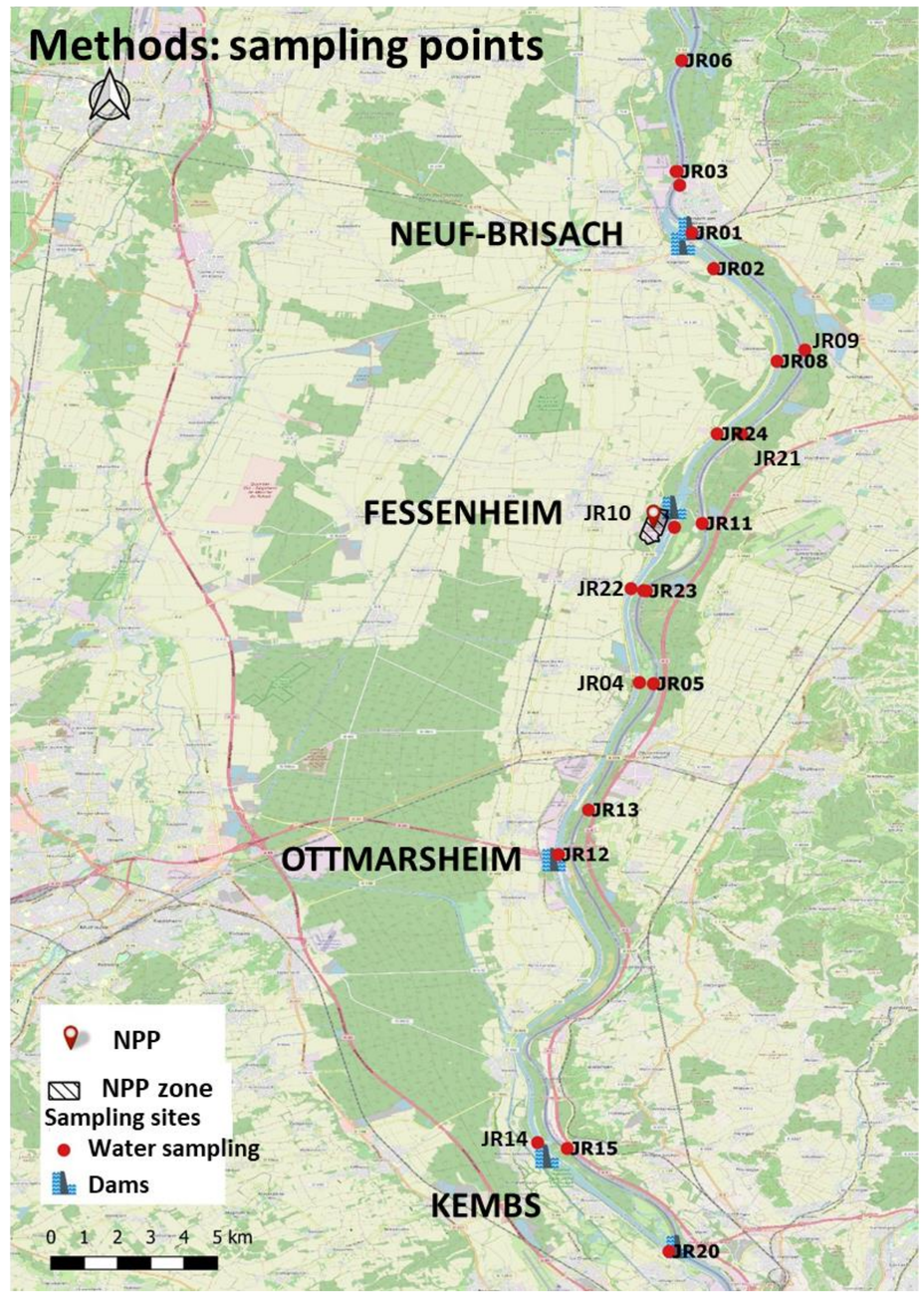
In February and June 2020, the Fessenheim NPP respectively knows the shutdown of its first and second reactors. The question that arises is whether the closure of the NPP is significant in terms of aquatic pollution and whether it is possible to establish a T0 state of aquatic pollution from the NPP closure in Rhine River and in the channel (Grand Canal d'Alsace –GCA-).

Methods : experimental protocol

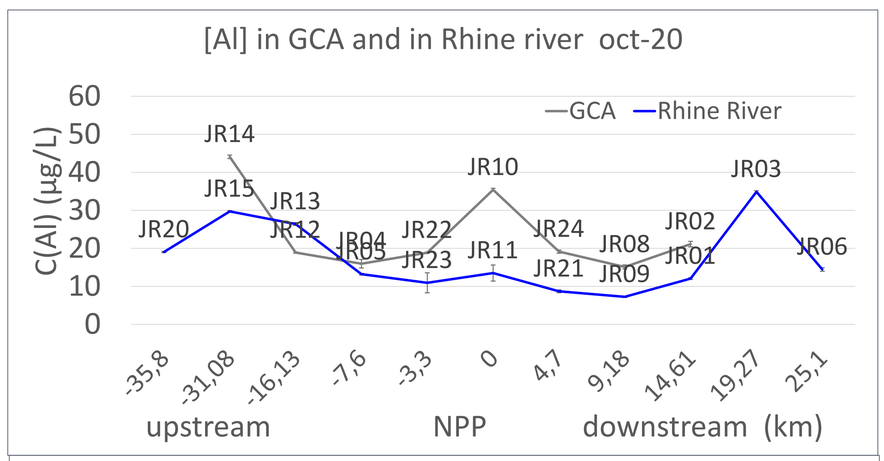


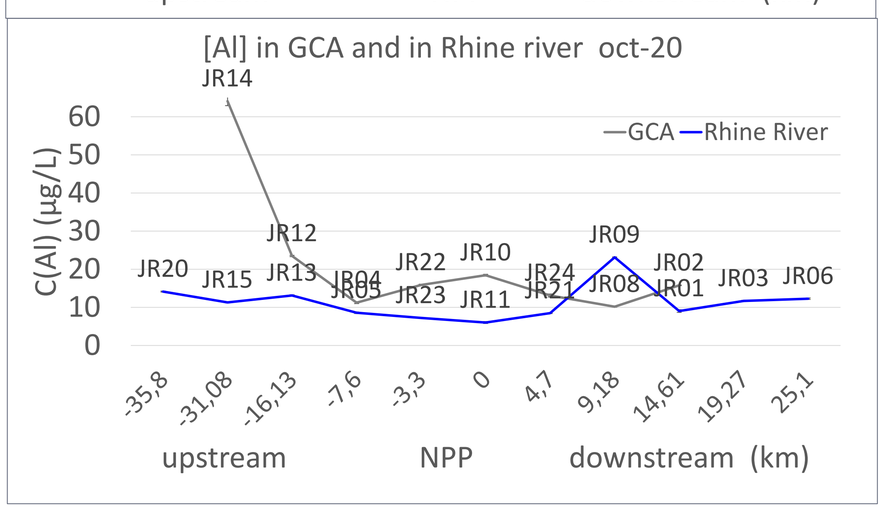
Have been analyzed :
B, Al, Cr, Fe, Co, Ni, Cu, Zn
+ lanthanides
+ $_{92}U$
+ ^{3}H

Only some results are discussed in this presentation



Results and discussion





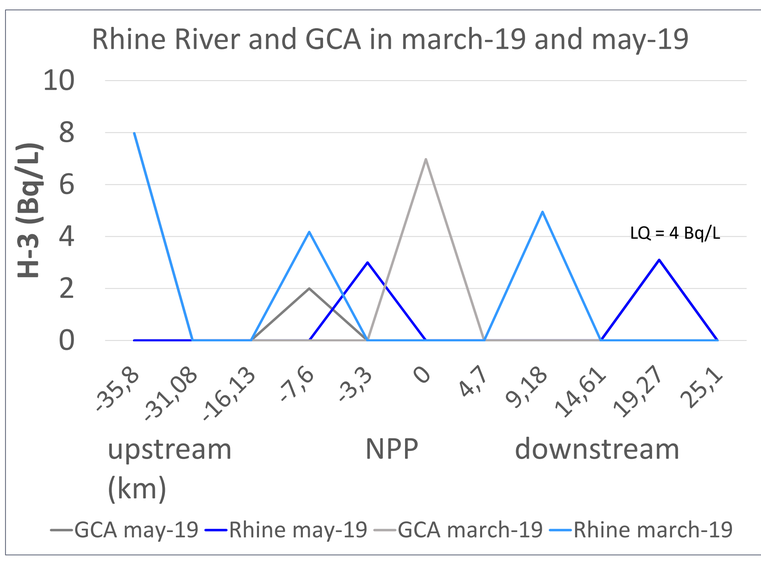
- In water table [Al]= 30 µg/L
- 2018 releases of 2800 µg/L of Al by the NPP in GCA (Grand Canal d'Alsace)
- 2020 [Al]>30 µg/L in GCA (JR14 and JR10) and in Rhine river (JR03)
- 2021 [Al]> 30 µg/L in GCA (JR14)

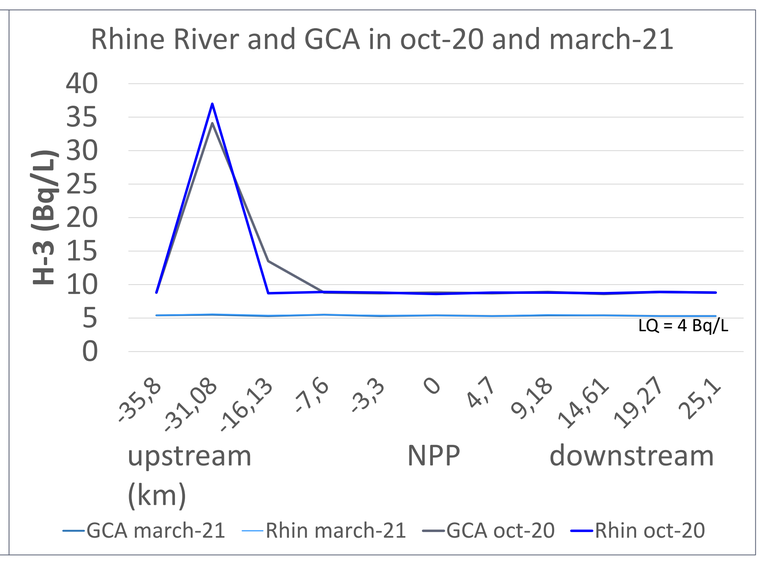
Al, Zn, Cu are found in the releases collected in the NPP tanks; come from circuits, equipment or packaging products.
In the Rhine River, aluminum pollution can come from alumina (good thermal insulator) or calcium aluminate (building material)

The Enrichment Factor (EF) was calculated at the plant discharge point (JR10).
A contamination is detected if EF>1

$$EF = \frac{C(Y)_{sample(JRX)}/C(Al)_{sample(JRX)}}{C(Y)_{Rhine(mean)}/C(Al)_{Rhine(mean)}}$$

At JR10 (NPP)	EF(Cr)	EF(Cu)	EF(Fe)	EF(Ni)	EF(Zn)
jan-18	141,51	74,26	1,34	12,73	1,50
feb-18	10,89	5,71	0,16	0,98	0,12
march-18	7,86	4,13	0,10	0,71	0,08
april-18	12,86	6,75	0,15	1,16	0,14
may-18	7,65	4,01	0,09	0,69	0,08
june-18	0,11	0,10	0,09	0,01	0,00
july-18	11,79	6,19	0,12	1,06	0,12
august-18	14,15	7,43	0,13	1,27	0,33
sept-18	14,15	7,43	0,13	1,27	0,15
oct-18	14,15	7,43	0,13	1,27	0,15
nov-18	14,15	7,43	0,03	1,27	0,20
dec-18	0,63	0,33	0,15	0,06	0,02
june-20 (shutdown of the second reactor)	3,26	9,14	0,32	0,78	0,05
oct-20	0,05	0,78	0,09	0,08	0,06
march-21	0,06	1,87	0,26	0,06	0,47





EF calculations

- for Cr, Ni et Cu, showed that the shutdown of the plant reduced their contamination.
- for Fe et Zn, do not show a significant impact of the NPP, whereas EDF announces up to 2180 µg/L of Fe at the discharge point (JR10) in june-18. It is impossible to say that the NPP does not participate in this contamination. There is a significant dilution factor generated by the flow.

Tritium

- The background of tritium currently range between 1 and 4 Bq/L
- In Rhone river tritium activity ranges from 1 to 10 Bq/L and even 20 to 50 Bq/L *(Antonelli, 2007 and 2008)*
- In Rhine river, the Fessenheim NPP had a low contribution to this pollution which could be generated by the use of tritium in medical applications and in the production of luminous objects or during dam flushing operation *(Lepage et al., 2020).*

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