Evaluating PFAS-Related Human Health and Environmental Risks before and after the implementation of the LIFE SOuRCE Solution

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The LIFE SOuRCE project

LIFE SOuRCE is a European project focusing on the demonstration and evaluation of sustainable on-site remediation technologies for PFAS-contaminated groundwater. Four different techniques are combined and evaluated as treatment trains. One of the project objectives is to demonstrate the benefits of the implementation of the LIFE SOuRCE solution on human health and the environment.

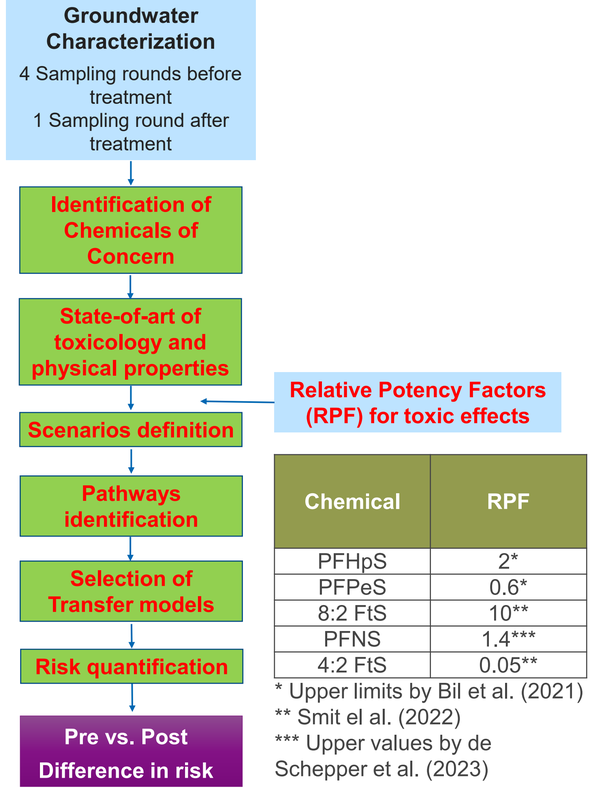
Methodology

This study aims to evaluate the human health and environmental risks associated with PFAS in groundwater before and after the implementation of the EU project LIFE SOuRCE solutions. The assessment focuses on PFAS exposure risks to human health and environmental impacts on a river ecosystem. Two sites with different risk profiles were analysed.

For Human Health Risk Assessment (HHRA), two exposure scenarios were evaluated at the Spanish site:

- **Scenario 1**: Industrial workers exposed to PFAS-contaminated water during cleaning tasks, evaluating accidental ingestion and dermal contact.
- **Scenario 2**: Farmers using groundwater for crop irrigation (2a) and consumers potentially ingesting PFAS through these crops (2b). Lettuce was selected as the test crop. Exposure pathways considered include ingestion and dermal contact for farmers, and ingestion for consumers (adults and children) through PFAS transferred to crops.

For Environmental Risk Assessment (ERA), PFAS risk to the Swedish river ecosystem and fish populations was assessed, establishing a baseline Toxicity Unit (TU) risk prior and after the implementation of the LIFE SOuRCE solution.



Chemical	RPF
PFHpS	2*
PFPeS	0.6*
8:2 FtS	10**
PFNS	1.4***
4:2 FtS	0.05**

* Upper limits by Bil et al. (2021)
** Smit el al. (2022)
*** Upper values by de Schepper et al. (2023)

Figure 1. Methodology scheme for HHRA.

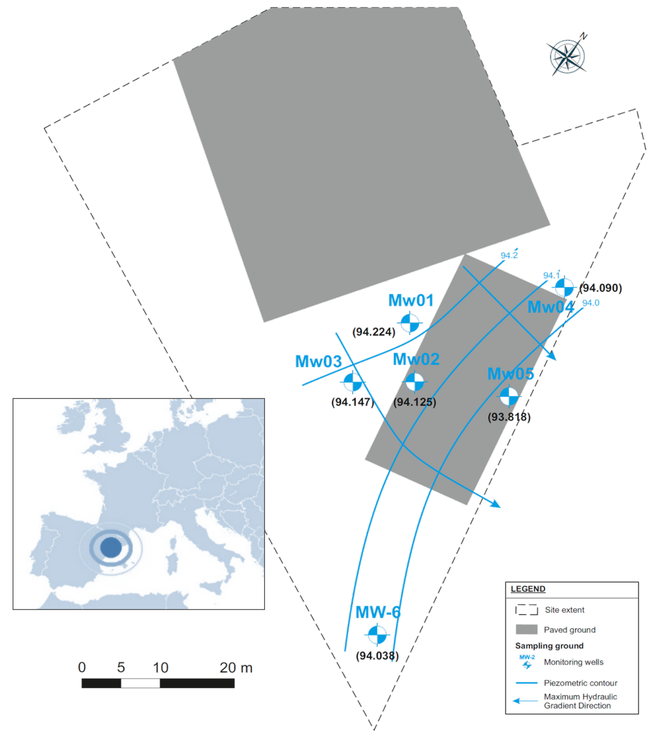


Figure 2. Spanish site.

Results

RISC5 software has been used to obtain risk results. Regarding HHRA, after the treatment, overall toxic risk is reduced by 76% in scenarios 1 (worker) and 2a (farmer), and by 74% in scenario 2b (vegetable consumption). Regarding carcinogenic effects, risk reduction rates were 77% for all scenarios, being PFOA the main contributor to risk. For ERA, the data evaluation is still in progress.

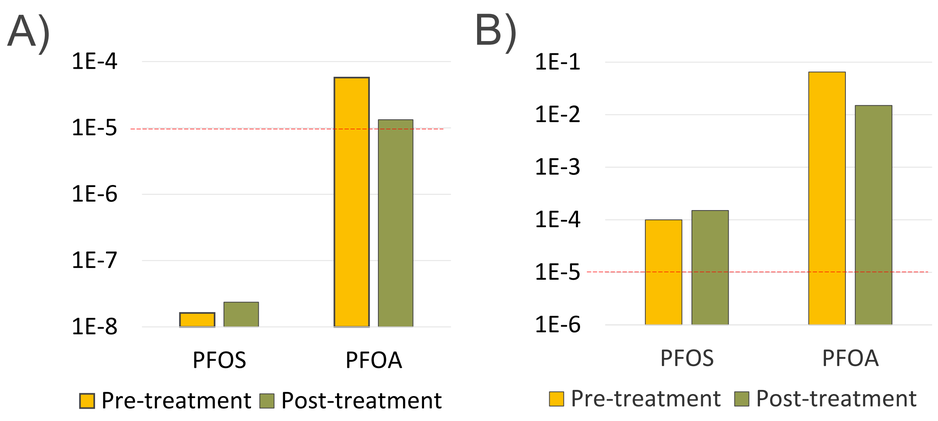


Figure 3. Carcinogenic risk for A) Scenario 1: On-site worker and B) Scenario 2b: Vegetable ingestion (child).

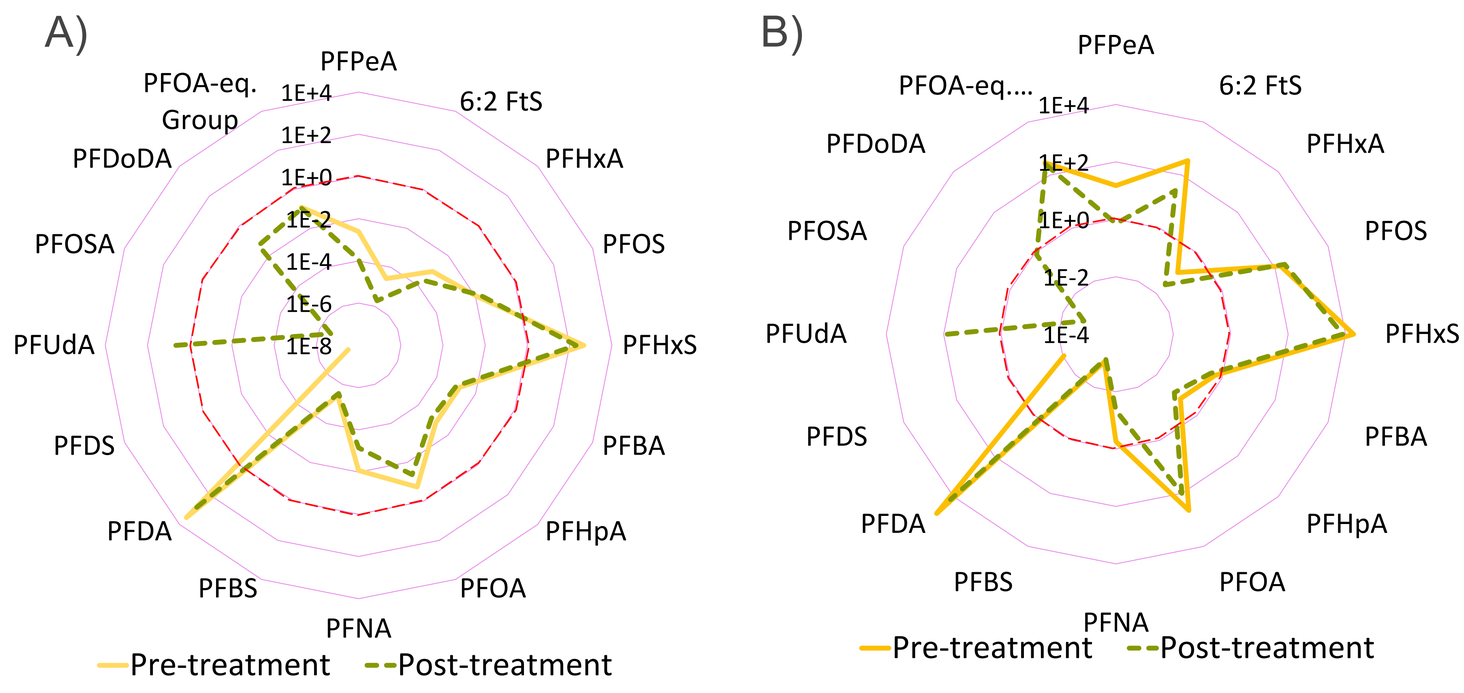


Figure 4. Toxic risk for A) Scenario 1: On-site worker and B) Scenario 2b: Vegetable ingestion (child) .

		Toxic Risk			Carcinogenic Risk		
	Scenario	HQ	Main input		CR	Main input	
PRE-TREATMENT	1 - Worker	3901	PFDA	88%	5.75E-05	PFOA	96%
	2a - Farmer	521	PFDA	88%	9.87E-06	PFOA	100%
	2b - Vegetable ingestion	88256	PFDA	77%	6.51E-02	PFOA	100%
POST-TREATMENT	1 - Worker	918	PFDA	78%	1.33E-05	PFOA	100%
	2a - Farmer	123	PFDA	77%	2.30E-06	PFOA	99%
	2b - Vegetable ingestion	22683	PFDA	62%	1.52E-02	PFOA	99%

Figure 5. HHRA results obtained for the assessed scenarios before and after the implementation of the LIFE SOuRCE solution.

Conclusions

1. LIFE SOuRCE solution implementation shows strong reduction rates in overall human health risk, ranging from 74% to 77% decrease.
2. Toxic risk is not acceptable in any of the three considered scenarios (Hazard quotient (HQ)> 1), being PFDA the main contributor (62 to 88% of total HQ).
3. Carcinogenic risk levels are beyond threshold (Carcinogenic risk (CR)> 10^{-5}) except for scenario 2a, where carcinogenic risk is acceptable.
4. The use of Relative Potency Factors has proven effective as a first approximation of toxic risk in cases where toxicological parameters have not yet been widely accepted.
5. The ERA of the Swedish site will be finalised once concentration data becomes available after the solution implementation, which concluded in early April 2025.

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