4-6 June 2024 – PFAS Paris Conference

Per- and polyfluoroalkyl substances in biosolids: geographical distribution and data from Quebec, Canada

Sébastien Sauvé, Ph. D
Full Professor
Department of Chemistry
Université de Montréal

sebastien.sauve@umontreal.ca

Toyin Saliu
PhD in my laboratory

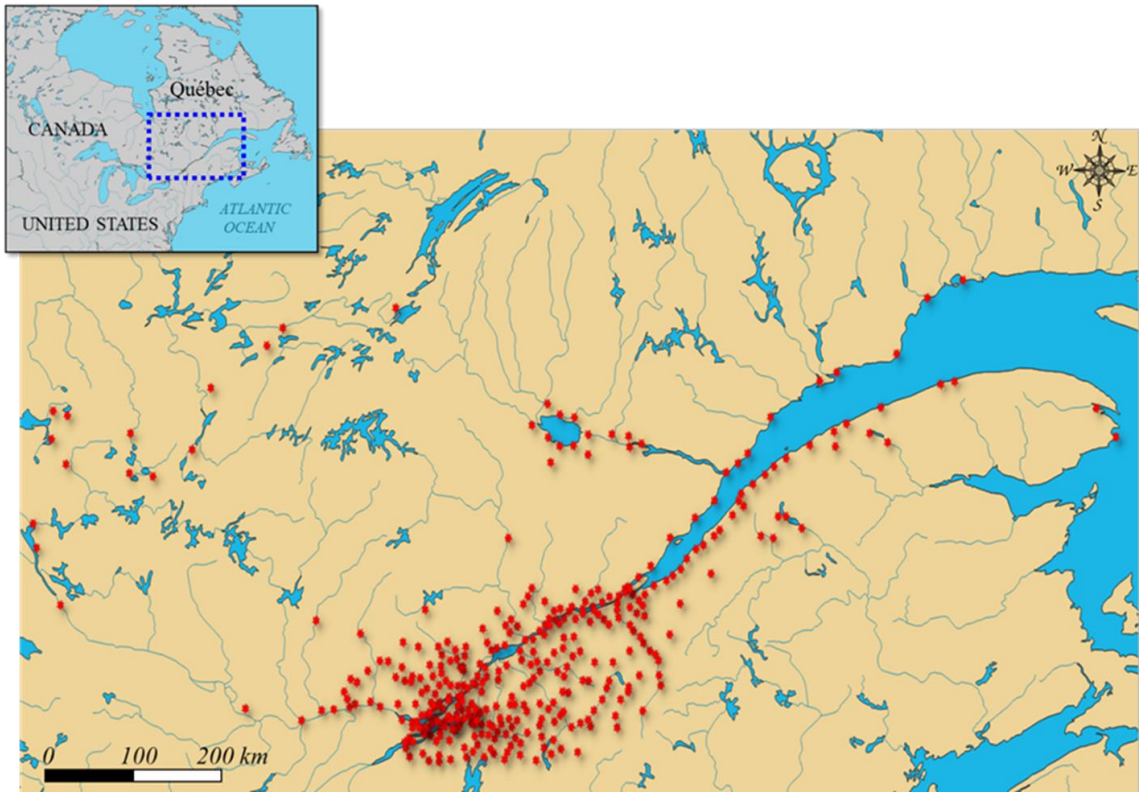
Université de Montréal

ACADÉMIE d'AGRICULTURE de FRANCE
AGRICULTURE ■ ALIMENTATION ■ ENVIRONNEMENT

Current Regulations for PFAS in Drinking Water

- European Union : ∑20 PFAS < 100 ng/L (effective January 2026)
- Canada: ∑~25 PFAS < 30 ng/L (should be approved soon)
- USA:
  - PFOS or PFOA < 4 ng/L
  - PFNA, PFHxS & GenX < 10 ng/L
  - Summation Index for PFNA, PFHxS, GenX &PFBS
- « Health Values » in Denmark, Netherlands and some parts of Belgium:
  - ∑PFAO + PFOS + PFNS + PFHxS < 4 / 2 ng/L

Map of 376 sites sampled in Quebec (Canada - 2018-2020)



Munoz et al. 2023. Water Research, 233: 119750.

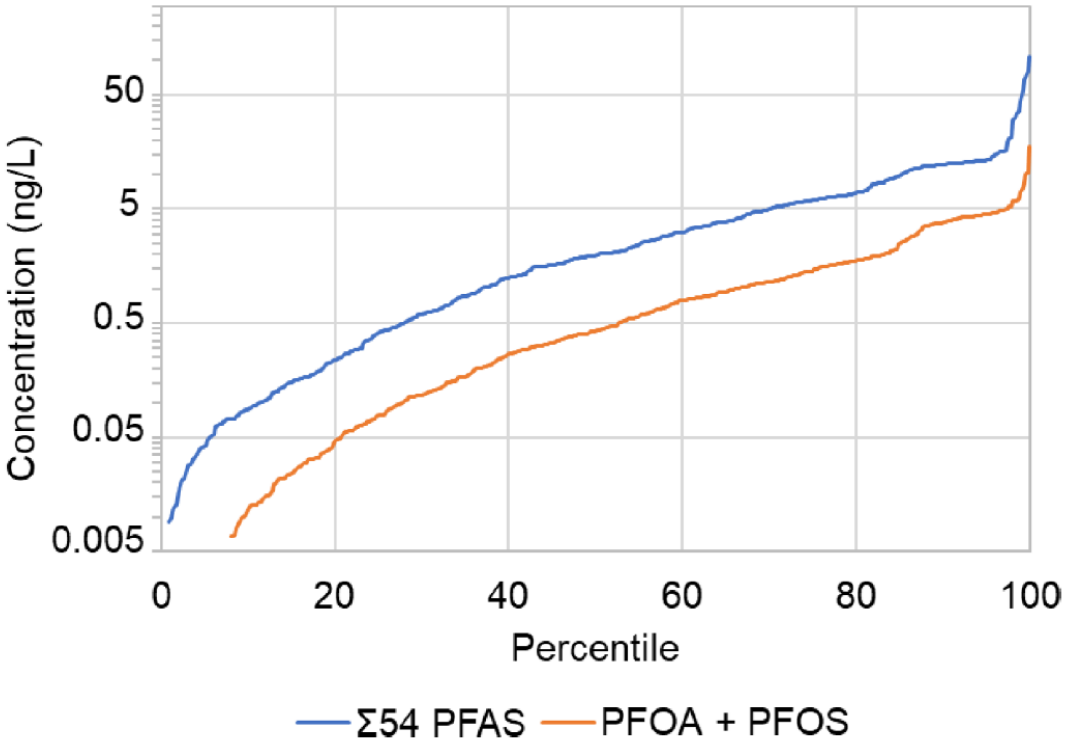
Within the Quebec Dataset (n= 463 samples)

Only one site 1 is above the 100 ng/L (EU limit) (+ two newly identified sites)

98% of samples are lower than the 30 ng/L proposed by Health Canada

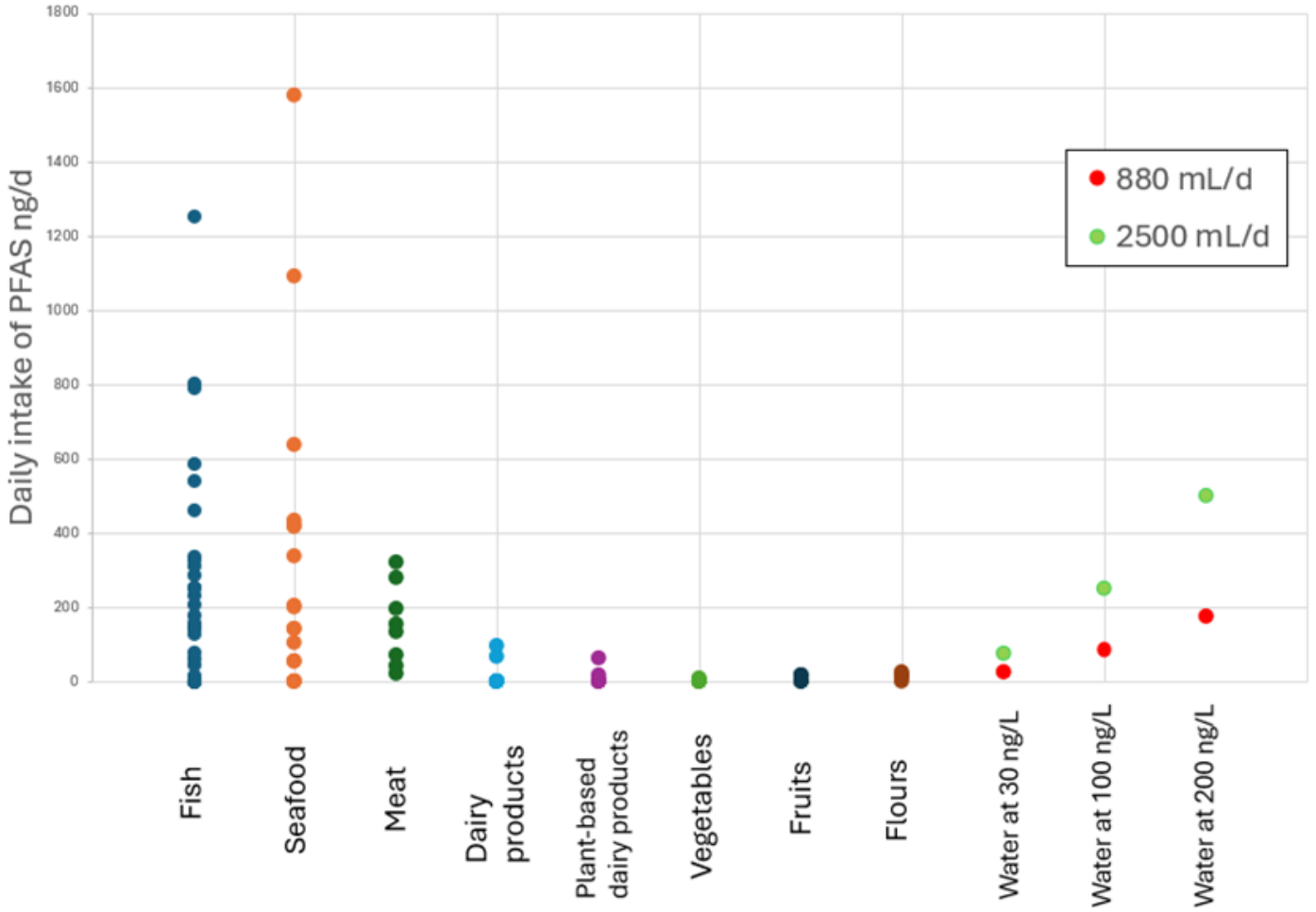
95th percentile for the ∑54 PFAS is 13 ng/L

Median is 2.0 ng/L



Munoz et al. 2023. Water Research, 233: 119750.

PFAS in Food



Preliminary Data (Le Moing et al. 2024 – Labo Sauvé)

Soils

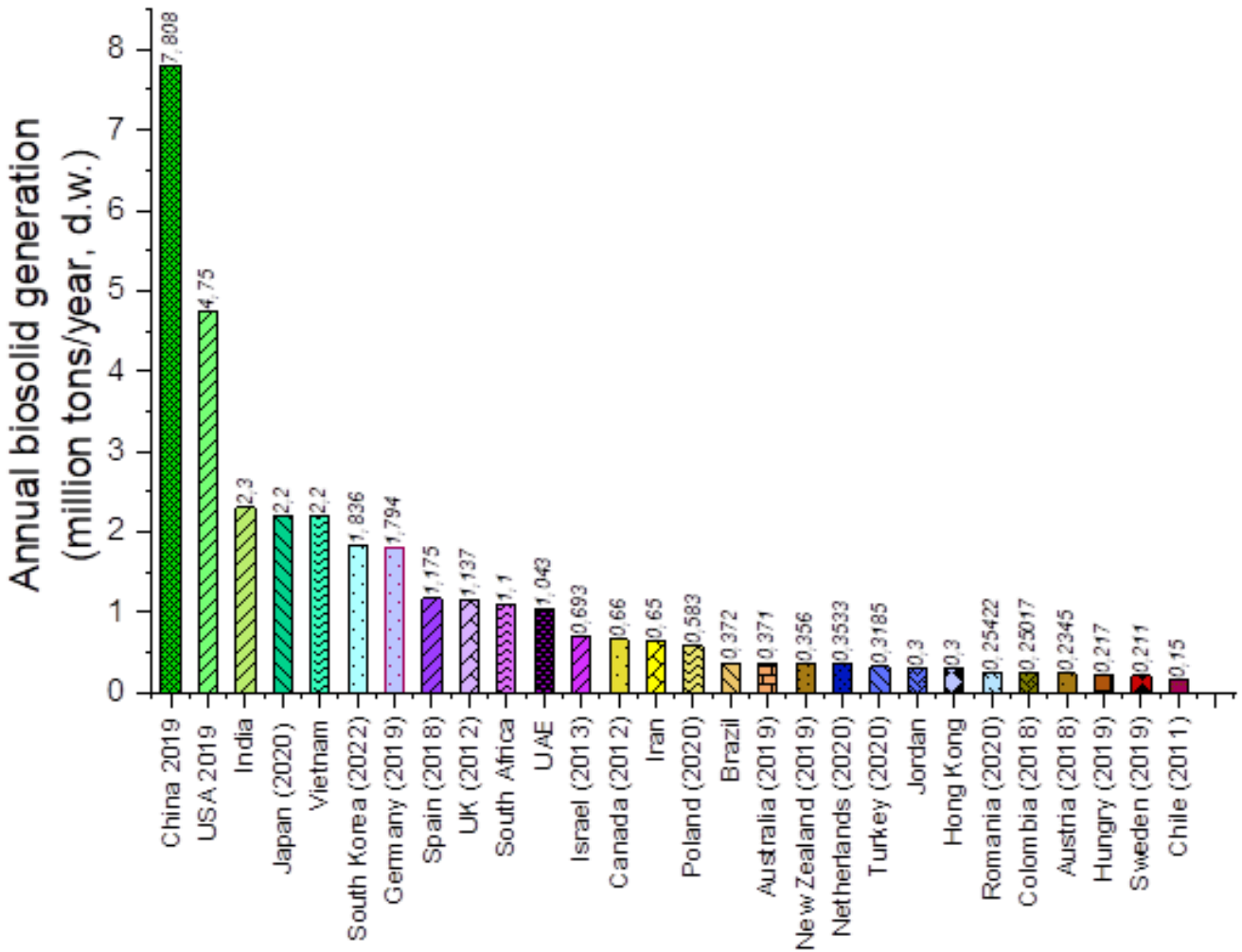
Routes for PFAS additions to soils:

- No PFAS should naturally be present in soils – measured PFAS are totally anthropogenic (background presumed ~0.2 µg/kg)
- Atmospheric inputs
- Chemical fertilisers and soil conditioners
- Pesticides (many contain PFAS)
- Animal manure
- Biosolids, digestates, composts, sewage sludge etc.
- Irrigation water
- Accidental or industrial deposition (e.g. AFFF)

Biosolids

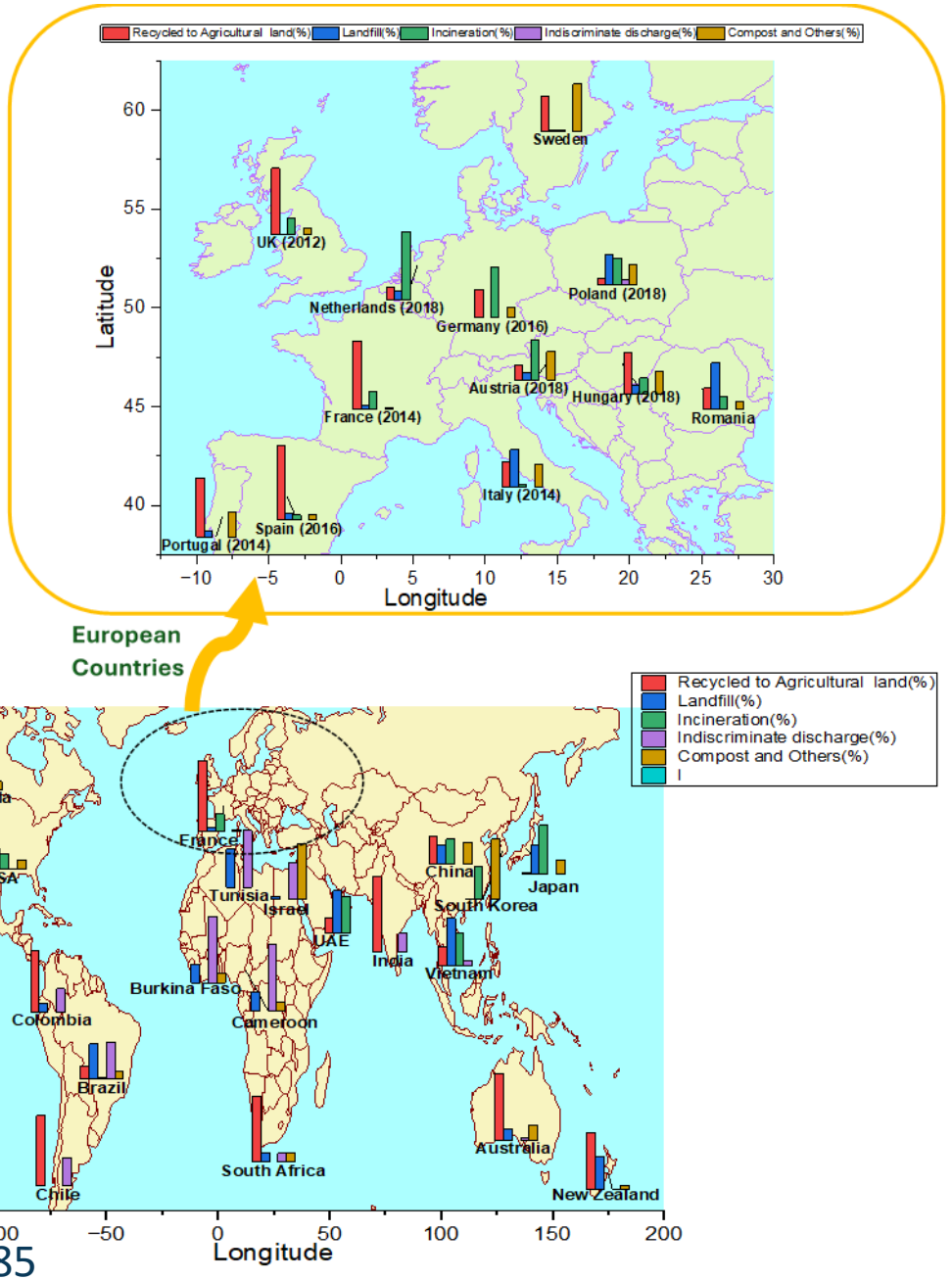
- Agricultural use of biosolids should be the best environmental use of biosolids. Biosolids can recycle nitrogen, phosphorus and can help build up soil organic matter. Also reduces the usage of chemical fertilisers (with associated commercial and geopolitical issues). Incineration and landfill should only be a last resort option.

Production of Biosolids



Saliu & Sauvé (2024) Frontiers in Environ. Chem.
https://doi.org/10.3389/fenvc.2024.1383185

Biosolids



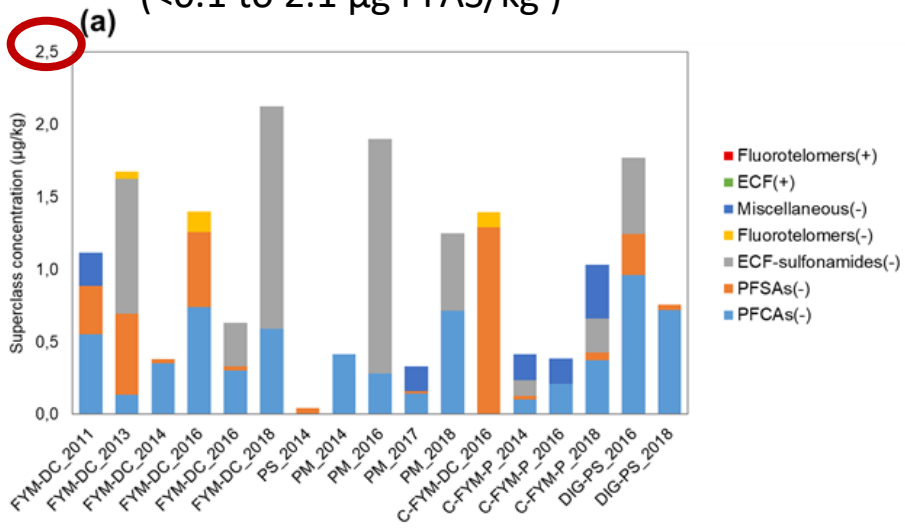
Saliu & Sauvé (2024) Frontiers in Environ. Chem. https://doi.org/10.3389/fenvc.2024.1383185

Biosolids

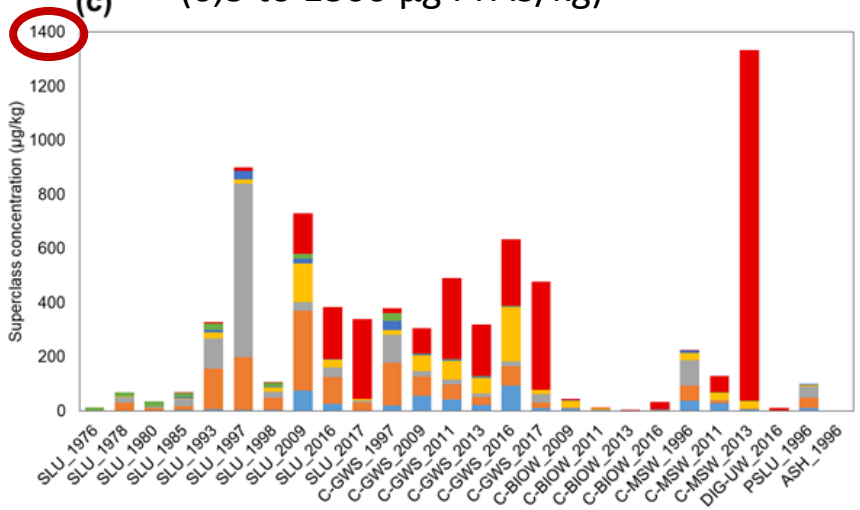
- Given the very slow degradation of PFAS, we must be very careful to prevent the buildup of soil concentrations of PFAS above the levels conducive to an excessive transfer to plants that would cause leaching to underground water.
- Given that our food is already qui contaminated with PFAS, there is very little room to allow an increase in soil concentrations that might increase the concentrations of PFAs in farm products.

Distribution of PFAS in various soil fertiliser products in France (µg/kg dry weight)

Agricultural Products
(<0.1 to 2.1 µg PFAS/kg)



Municipal Composts and biosolids
(0,3 to 1300 µg PFAS/kg)

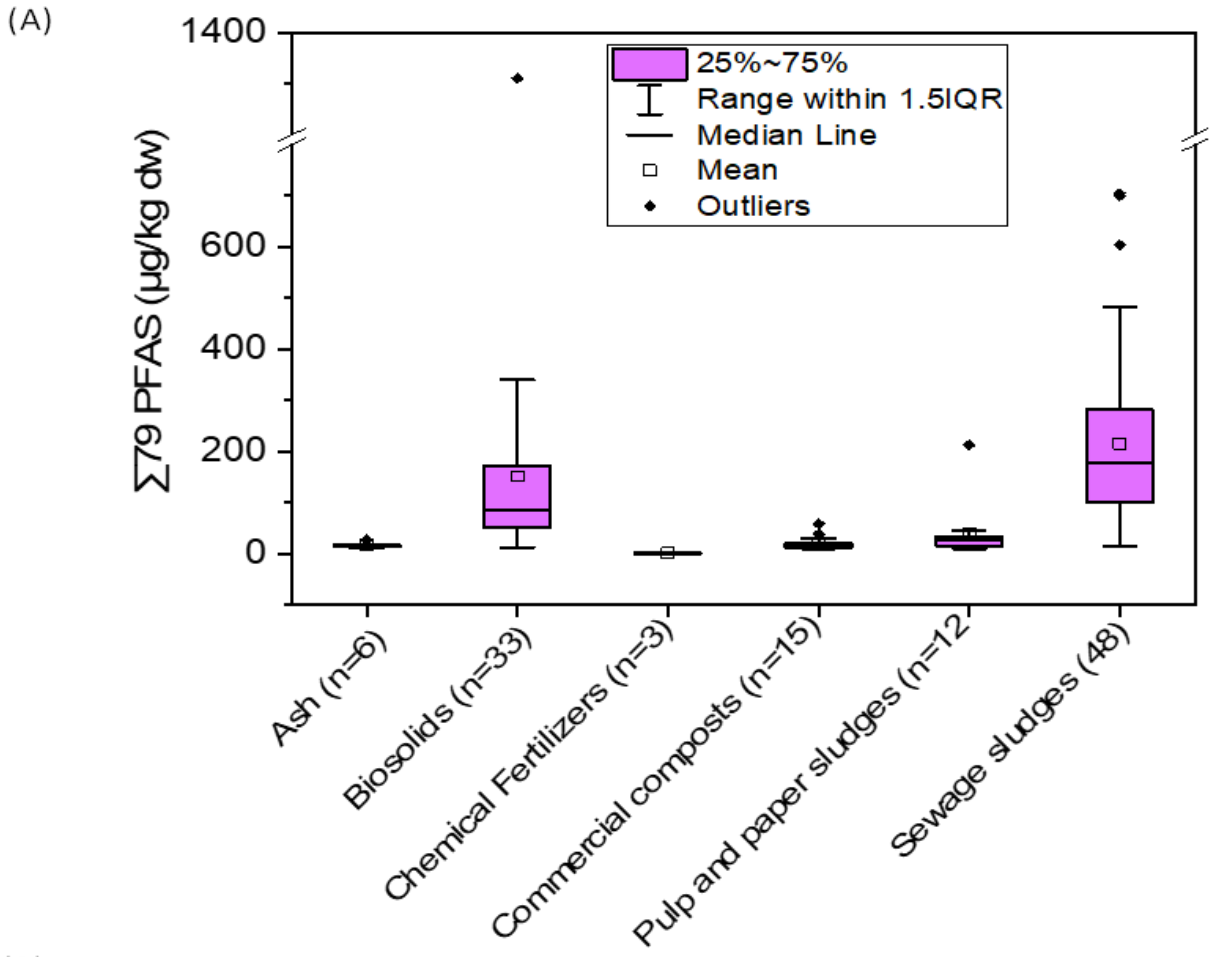


Some urban products were very contaminated, but some were quite clean (products collected from 1976 to 2018).

This data motivated the work with more recent products within Quebec (Canada).

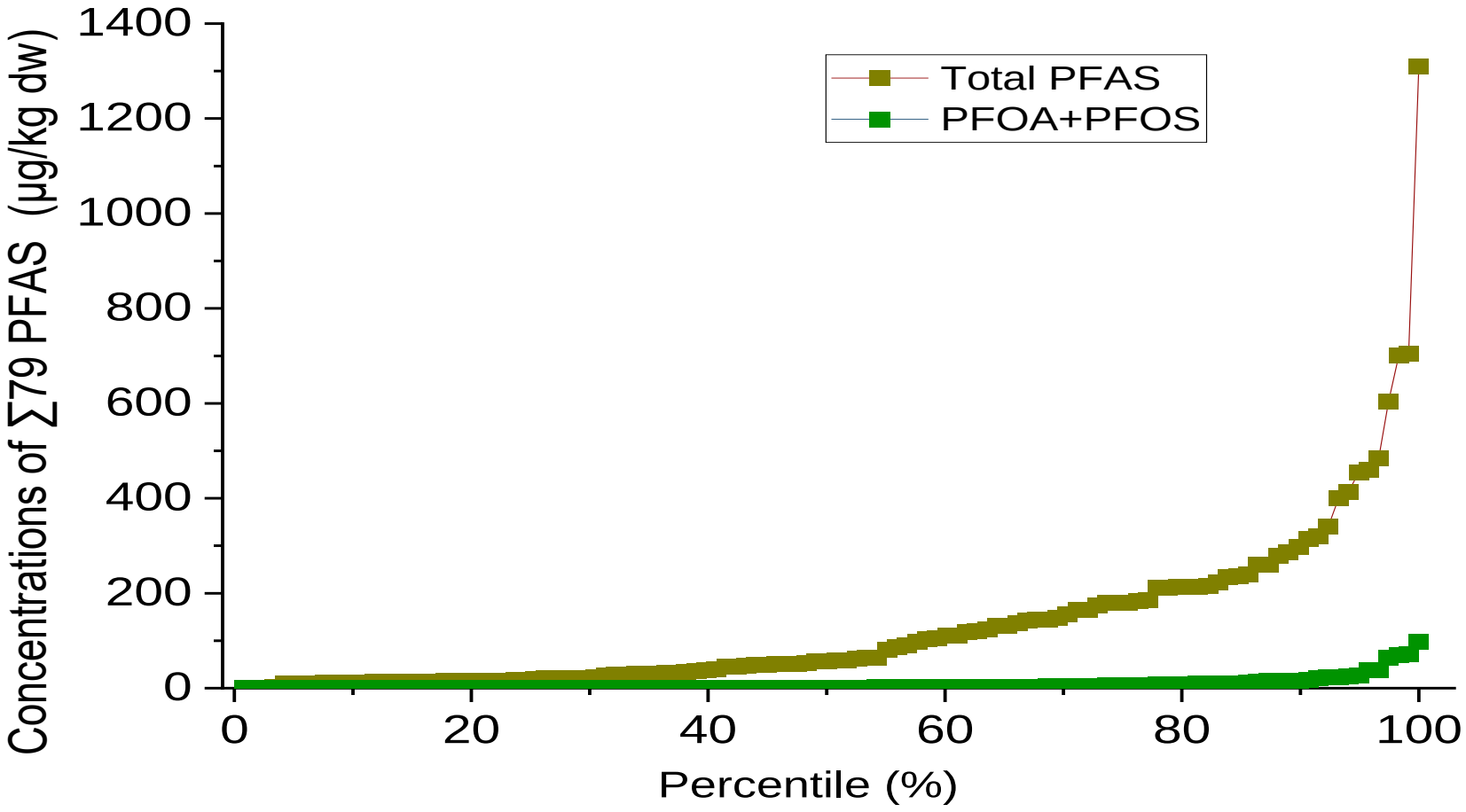
Munoz et al. Environmental Science and Technology (2022) 56:6056-6068

PFAS Concentrations (n=118)

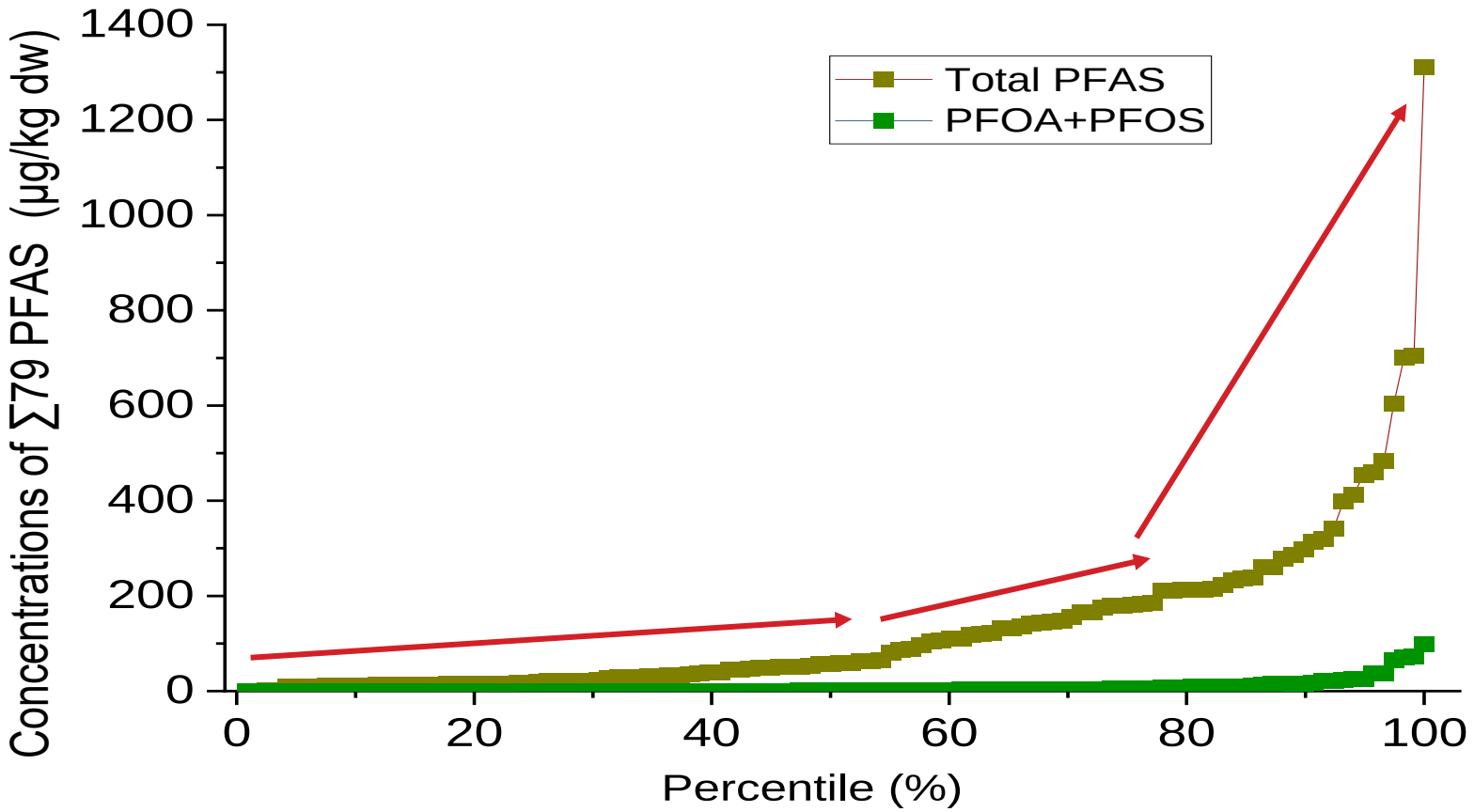


Preliminary data (Saliu et al. 2024 – Labo Sauvé)

Concentrations of PFAS in biosolids, sewage sludge, digestates, composts, paper sludge (n=118)



Preliminary Data (Saliu et al. 2024 – Labo Sauvé)

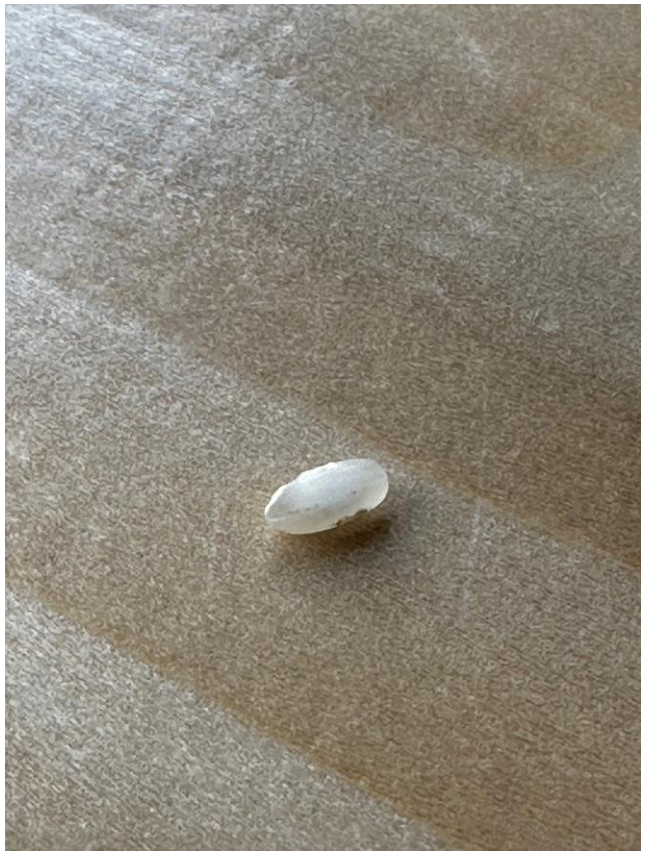


- Progressive increase up to ~75 µg PFAS / kg of soil, presumably from various domestic sources (wrappings, cosmetics, textiles)
- Further steeper increase up to ~120 µg PFAS / kg of soil (~¾ of our samples) – moderate external input
- Exponential increase from about 120 µg PFAS / kg de soil, max of 1260 – presumably form an industrial or commercial contamination

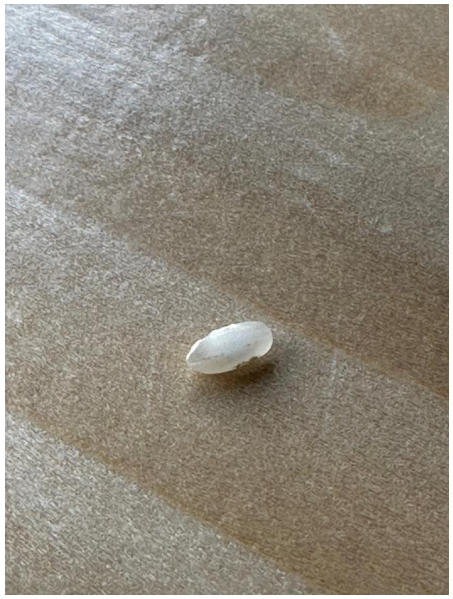
What is 100 µg/kg ?

1 bag of soil of 8kg

How many grains of rice in one bag of soil is 100 µg/kg?



100 µg/kg is equivalent to 1 rice grain dispersed in 38 bags of earth of 8 kg

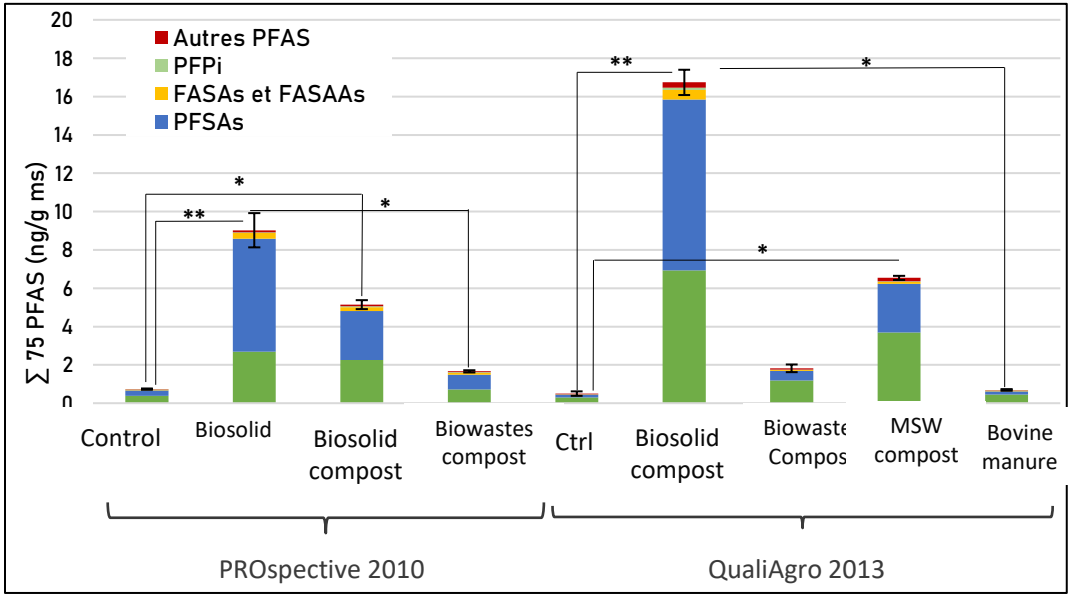


PFAS accumulation in soils having received organic amendements

Quantification of PFAS in amended soils

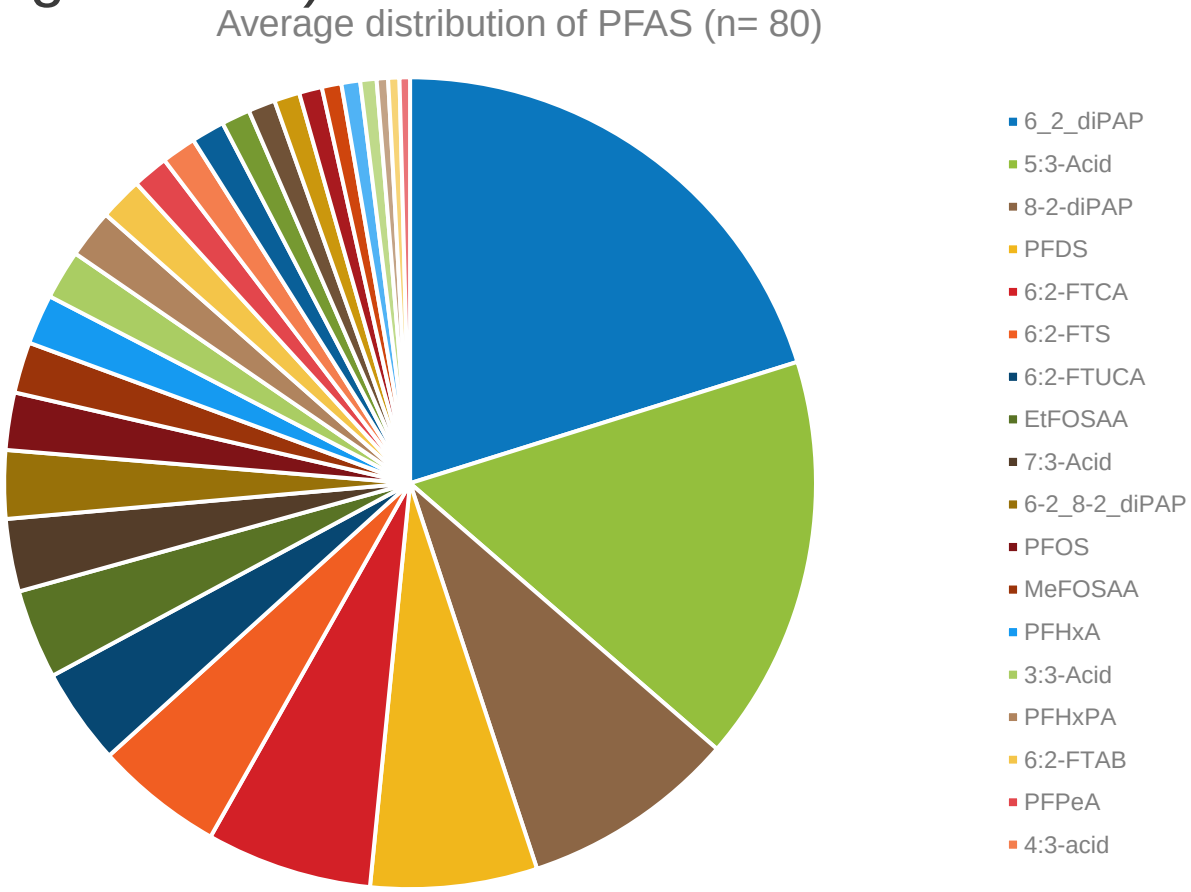
- [PFAS] in amended soils > [PFAS] in control soils
- Soils with biosolids and municipal composts > soils with organic by-products > soils with bovine manure ≈ control soils
- Mainly an accumulation of long chain PFAS

Soils with various amendments



Concentrations of PFAS in amended and control soils; * $p < 0,05$, ** $p < 0,01$

Distribution of PFAS in the Quebec biosolids (80 target PFAS)



Not necessarily the same PFAS appear to contaminate biosolids as those that are observed in contaminated drinking water. Will need to be considered when devising environmental guidelines for PFAS in soils/biosolids

What do we do?

- Urgent to require an analysis for PFAS in biosolids before their application to agricultural land.
- The analysis should integrate at least 20-30 PFAS, well selected and must integrate the family of diPAP – that seem to dominate the profiles of biosolids.
- The threshold for « non-contamined » biosolids is probably around 70 and 120 µg ∑PFAS / kg of soil, but this is based upon a statistical distribution of the data – not on actual risks of plant uptake or underground water leaching.
- Until we have more information for evidence-based risk analysis of plant uptake and leaching – we should use a statistical approach to segregate contaminated biosolids that contain higher levels of PFAS (at circa? >100 ng ∑PFAS/kg) and prevent their disposal onto agricultural soils.

What do we do bis?

- Urgent to regulate non essential use of PFAS that end up in wastewaters and biosolids (food wrappings, cosmetics, textiles, materials, etc).
- Explore options to treat wastewaters, sludge and biosolids to reduce the concentrations of PFAS.
- Absolutely need to study:
    - Soil to plant uptake
    - Transformation of PFAS in soils
    - Leaching to underground water

Questions to answer

- At what soil concentration of PFAS do we get excessive uptake and transfer to plants?
- At what soil concentration do we get significant leaching of PFAS to underground water?

- The question to these question will determine what the acceptable thresholds for PFAS in soils and biosolids should be.

Merci!

sebastien.sauve@umontreal.ca