An integrated approach for the effective management of water pollution risks from emerging contaminants

Perfluorinated compounds
HOlistic ENvironmental
Interinstitutional eXperience

Life Phoenix

Preventing. Ensuring. Promoting

LIFE PHOENIX Project

lifephoenix.eu

COORDINATOR

REGIONE DEL VENETO

PARTNERS

REGIONE DEL VENETO AZIENDA ZERO

arpav Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto

IRSA CNR

Università degli Studi di Padova

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Lesson learnt from three-years monitoring of irrigation waters, agricultural soil and plants

Claudia Ferrario

IRSA CNR

IRSA-CNR Brugherio

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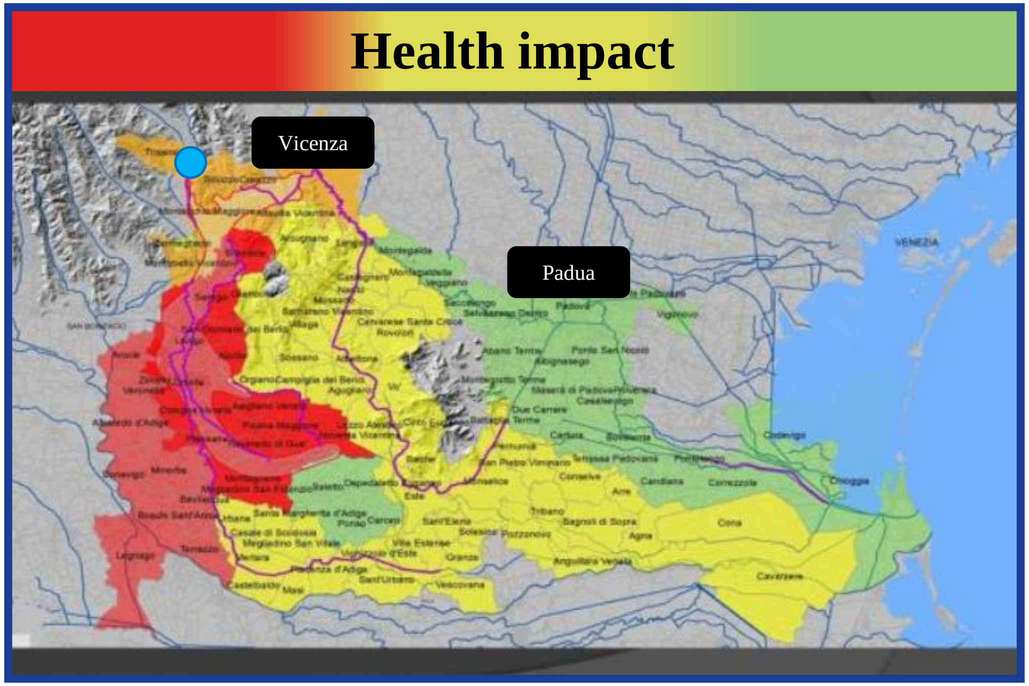
Veneto

Sampling area



Contamination source (fluorochemical industry)

Matching the results of the biomonitoring study to those of drinking waters, Veneto local authority divided the contaminated area in three zones with different health impacts: zone of max exposure (red area), of precaution (yellow area) and not directly impacted (green area)

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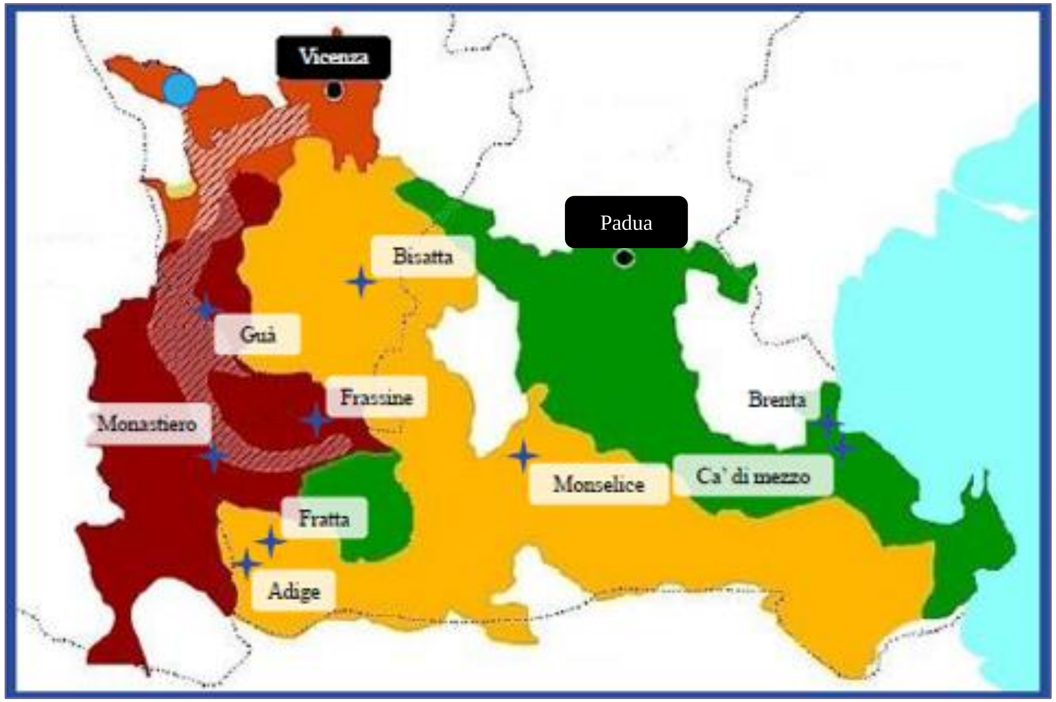
Veneto

Sampling sites



Contamination plume

Contamination source (fluorochemical industry)

Provincial borders

1 reference site
2 in green area
4 in yellow area
3 in red area

→ water body used for irrigation → agricultural soil
vegetal species
terrestrial invertebrates

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Matrices

Abiotic

Biotic

Vegetables

- epigean crop (lettuce)
- hypogeal crop (onion)
- extensive crop (maize)
- spontaneous plant (reed grass)

Animals

- terrestrial earthworms

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Frequency of sampling

Abiotic

2018-2020

July
October

Biotic

Vegetables

- epigean crop (lettuce)
- hypogeal crop (onion)
- extensive crop (maize)
- spontaneous plant (reed grass)

Animals

- terrestrial earthworms

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Sampling size

Abiotic

2018-2020

Biotic

Vegetables

- epigean crop (lettuce)
- hypogeal crop (onion)
- extensive crop (maize)
- spontaneous plant (reed grass)

Animals

- terrestrial earthworms

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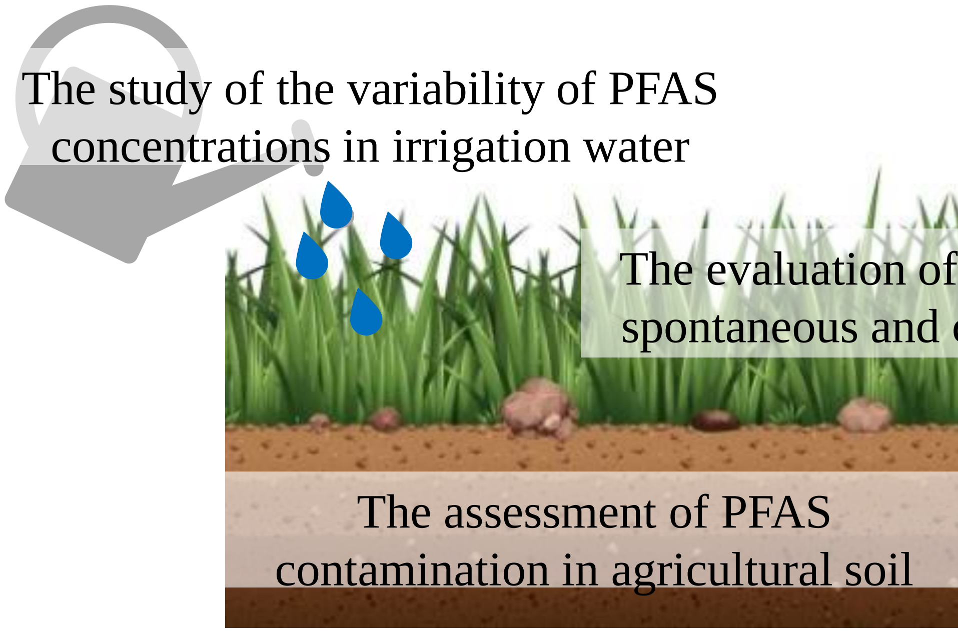
Aims



The study of the variability of PFAS concentrations in irrigation water

The evaluation of PFAS uptake in spontaneous and cultivated plants

The assessment of PFAS contamination in agricultural soil

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Analytical procedures

Perfluorinated compounds Holistic Environmental Interinstitutional eXperience

Standard Operating Procedures (SOPs) for the analytical determination and quantification of PFAS in environmental matrices

[Deliverable n.1 of the Action C.1]

Project reference	LIFE16 ENV/IT/000488
Project acronym	LIFE PHOENIX
Project full title	Perfluorinated compounds HOlistic ENvironmental Interinstitutional eXperience
Action C.1:	Environmental Monitoring
Due date of deliverable	30/09/2018
Lead beneficiaries	ARPAV, CNR-IRSA
Authors	Roberto Lava, Caterina Cecchinato, Massimiliano Prenzato, Fabio Biancato, Francesca Zanon e Michele Gerotto (ARPAV) Claudia Ferrario, Sara Valsecchi e Stefano Polesello (CNR-IRSA)

Dissemination Level

PU	Public	
CO	Confidential, only for members of the consortium (including the Commission Services)	X
CI	Classified, as referred to in Commission Decision 2001/844/EC	

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The analytical procedures were developed to optimize the determination of short-chain PFAS (C<8) due to their higher potential to be translocated and bioaccumulated in plants than long-chain congeners.

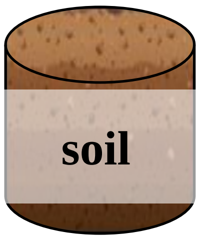
PFAS considered

Acido perfluorobutanoico	PFBA
Acido perfluoropentanoico	PFPeA
Acido perfluoroesanoico	PFHxA
Acido perfluoroeptanoico	PFHpA
Acido perfluoroottanoico	PFOA
Acido perfluorononanoico	PFNA
Acido perfluorodecanoico	PFDA
Acido perfluoroundecanoico	PFUnDA
Acido perfluorododecanoico	PFDoDA
Acido perfluorobutansolfonico	PFBS
Acido perfluoroesansolfonico	PFHxS
Acido perfluoroottansolfonico	PFOS

Analytical procedures

arpav

Abiotic



Biotic

IRSA
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animals

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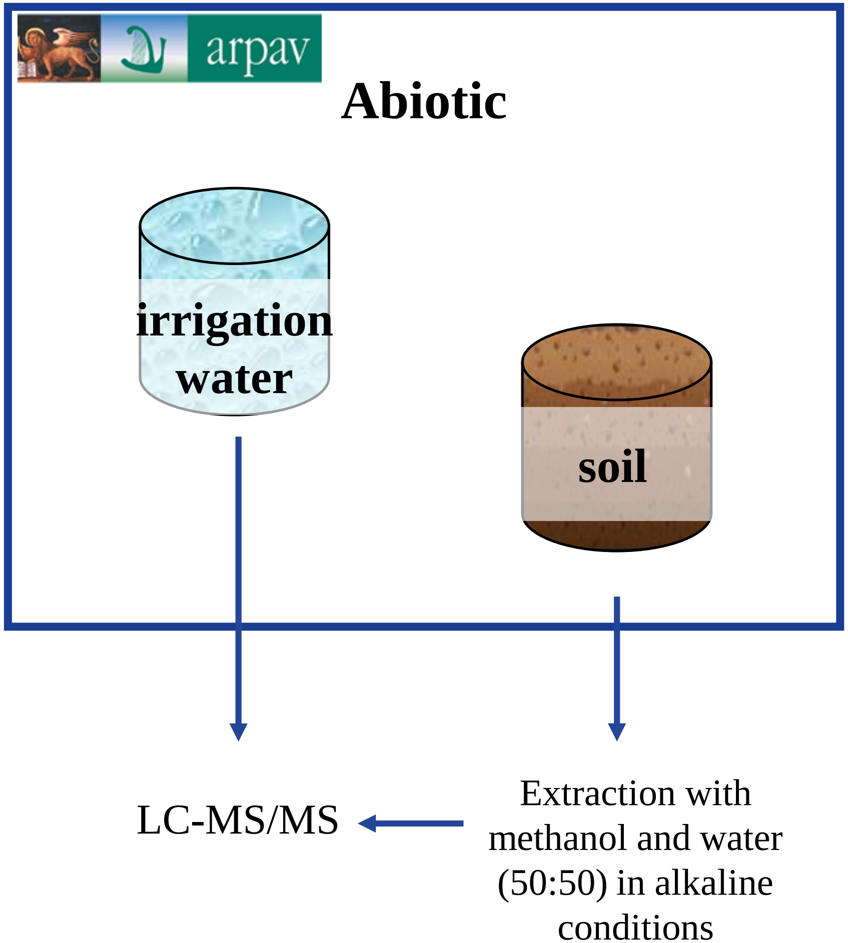
Analytical procedures



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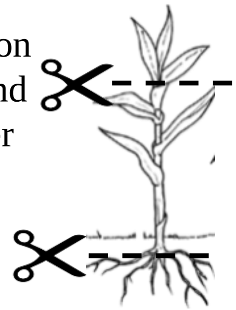
Analytical procedures

Webinar LIFE PHOENIX: metodiche per l'analisi di PFAS e contaminanti emergenti.
6 ottobre 2020

www.lifephoenix.eu/web/phoenix/-/ottimo-riscontro-per-il-webinar-pfas-e-contaminanti-emergenti

HPLC-MS/MS

Ultrasonic extraction with acetonitrile and water (90:10) after drying sample



TFC injection

Ultrasonic extraction with acetonitrile and water (90:10)

Biotic

vegetables

IRSA CNR

animals

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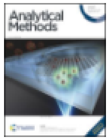
Analytical procedures



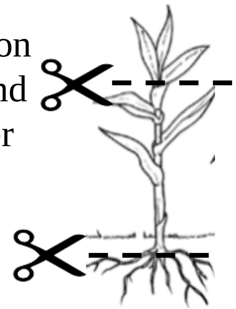
From the journal:
Analytical Methods

2021

Determination of perfluoroalkyl acids in different tissues of graminaceous plants

CLAUDIA FERRARIO, Sara Valsecchi, Roberto Lava, Marco Bonato and Stefano Polesello

HPLC-MS/MS ← Ultrasonic extraction with acetonitrile and water (90:10) after drying sample



Biotic

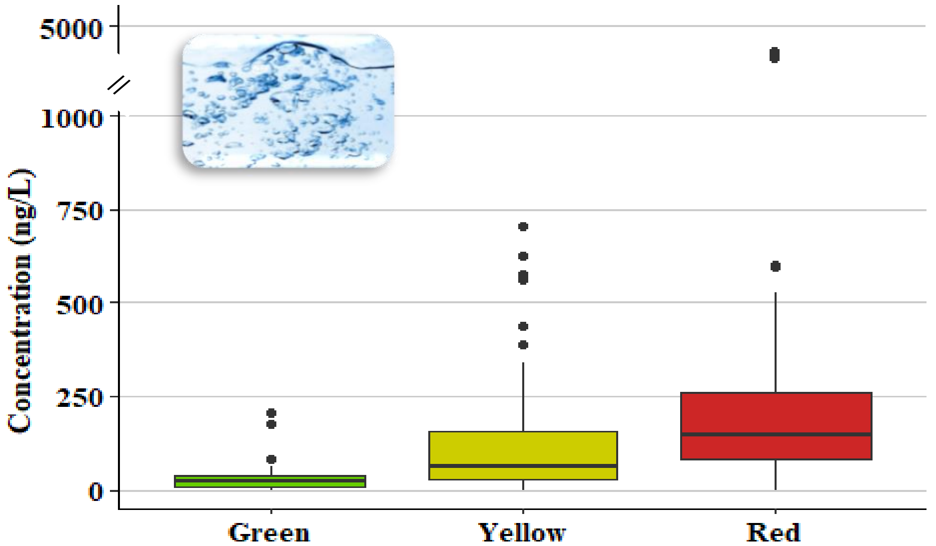
vegetables

Results 2018-2020

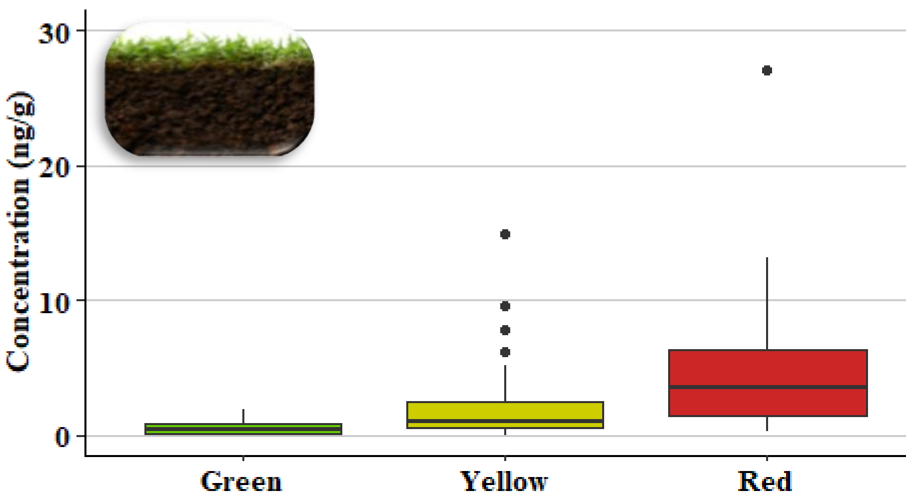
min-max
(average)

	Green	Yellow	Red
Water (ng/L)	<LOD – 217 (27)	<LOD – 764 (123)	<LOD – 4,694 (330)
Soil (ng/g)	<LOD – 1.9 (0.6)	<LOD – 14.9 (2.1)	<LOD – 27.1 (4.8)
Plant (ng/g ww)	<LOD – 4.8 (1.2)	<LOD – 9.8 (1.4)	<LOD – 10.4 (2)

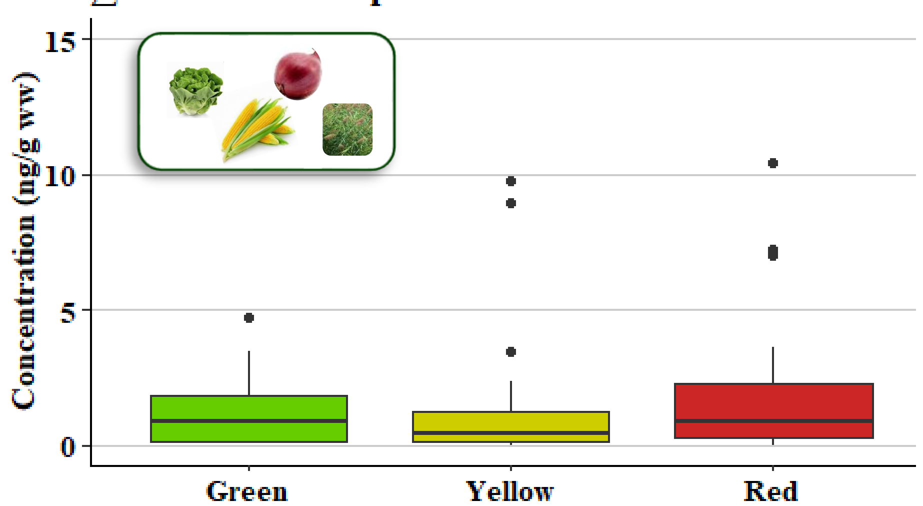
∑PFAS in irrigation water



∑PFAS in soil



∑PFAS in whole plant



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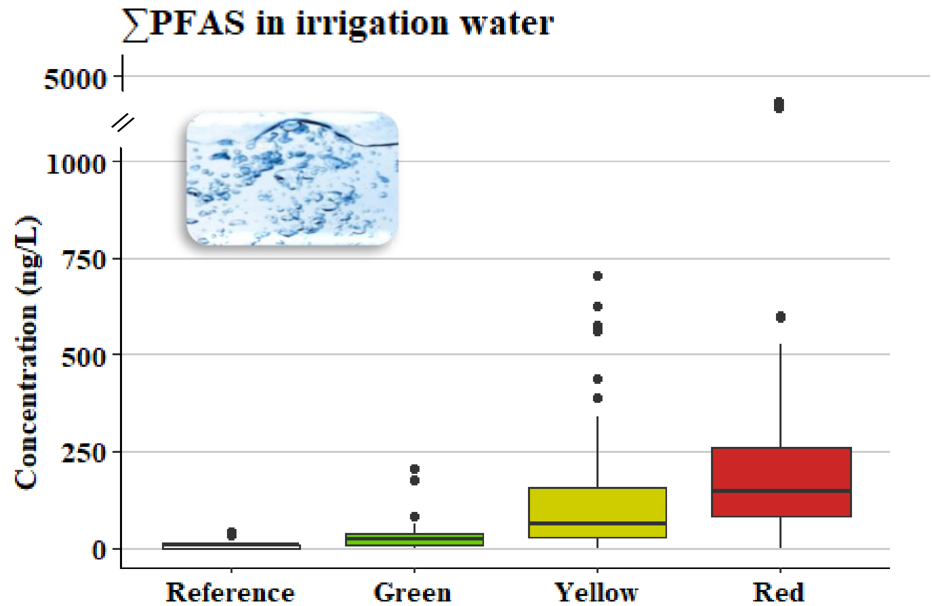
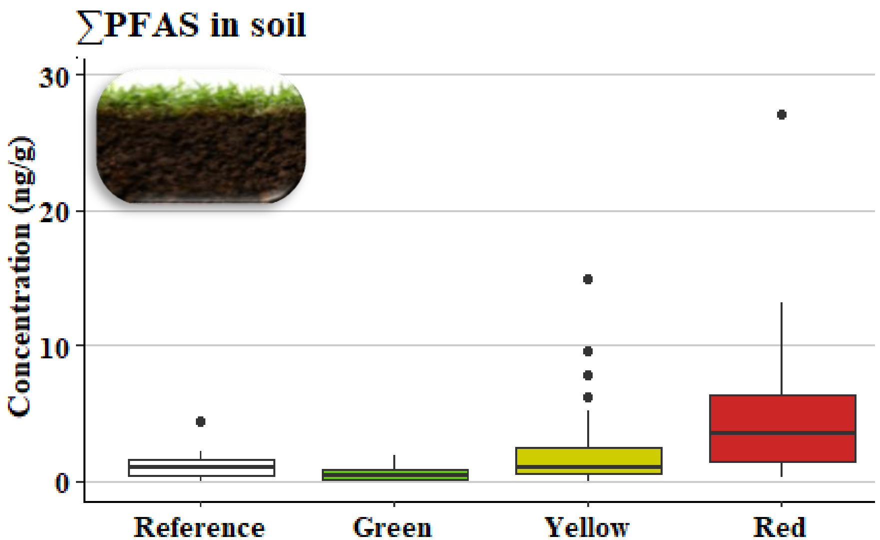
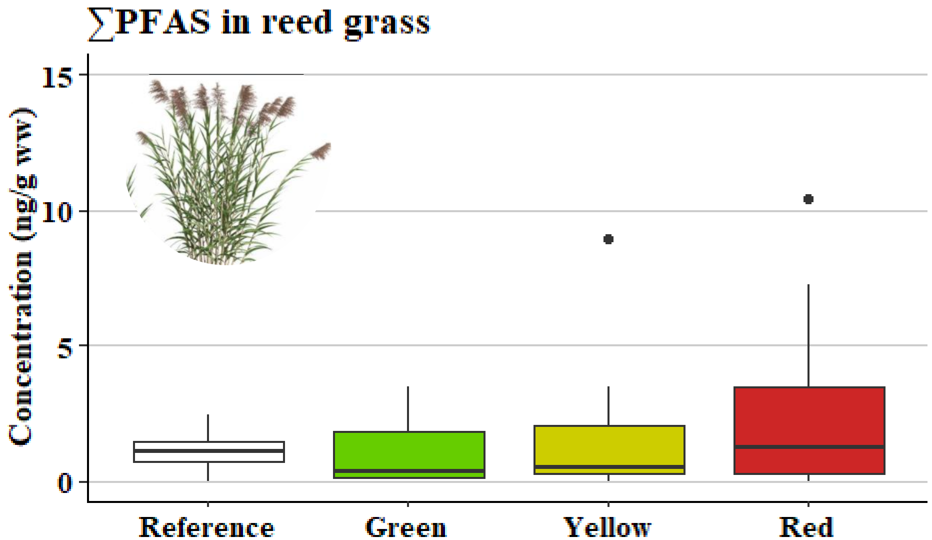
Results 2018-2020

Comparison to "reference site"







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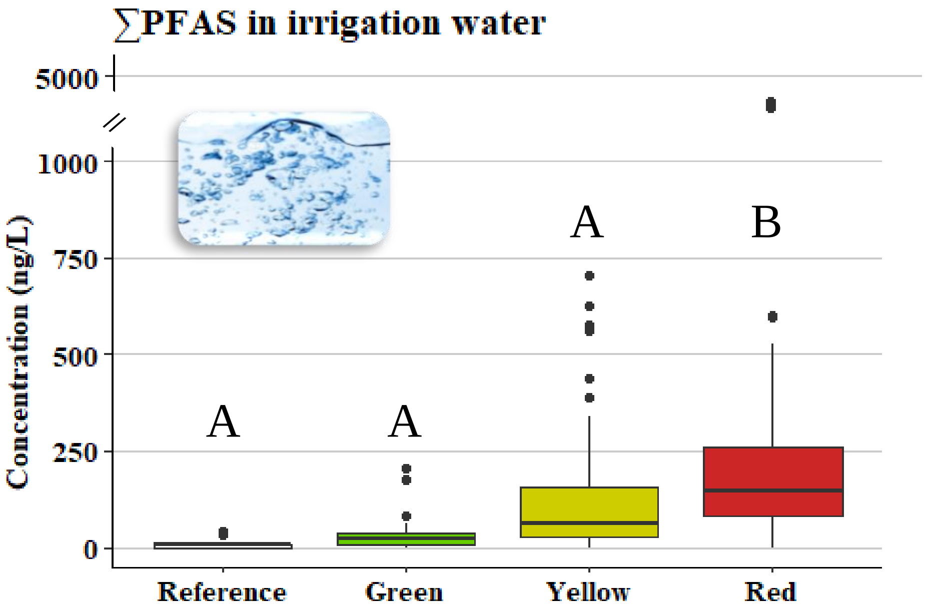
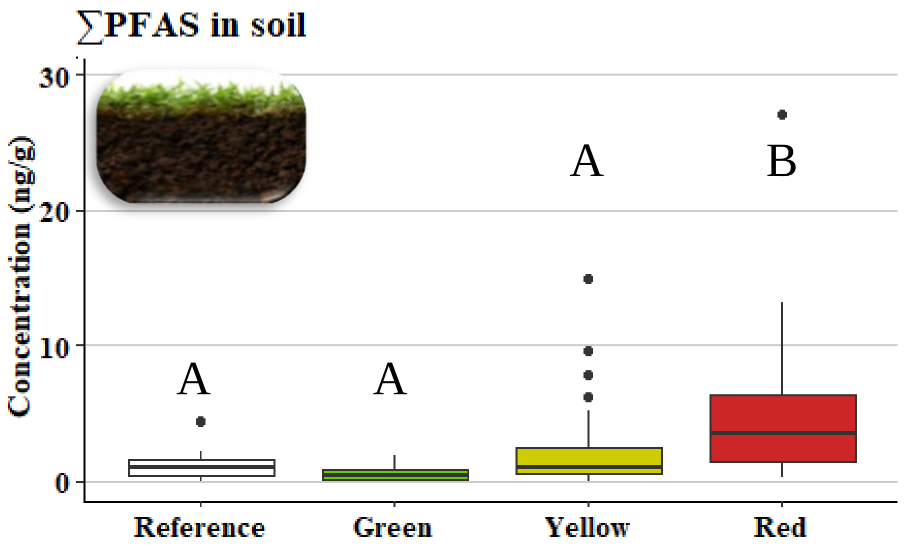
Results 2018-2020

Comparison to “reference site”

ANOVA test

PFAS concentrations in the red area were significantly higher than in other areas for waters and soil





Green and yellow areas were no more contaminated by PFAS than the reference area

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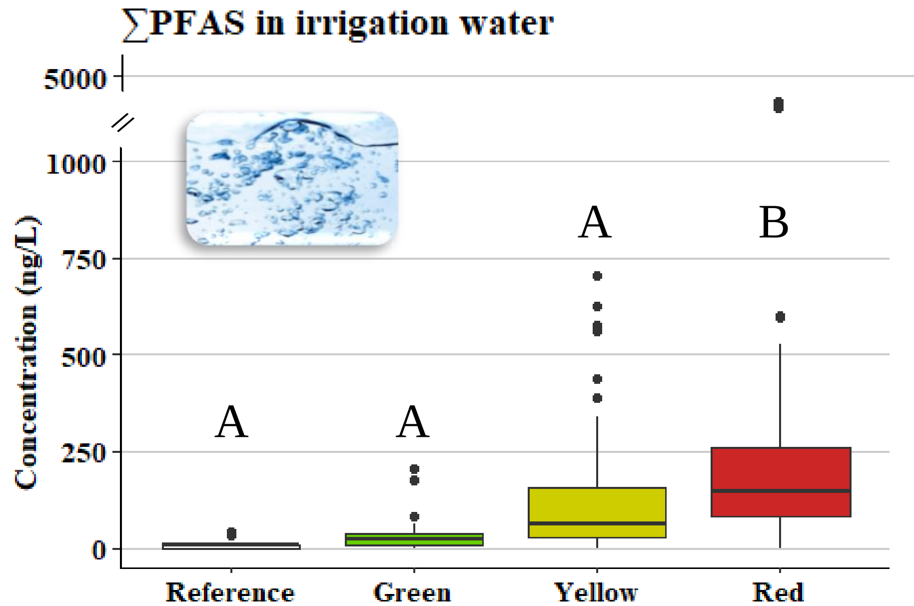
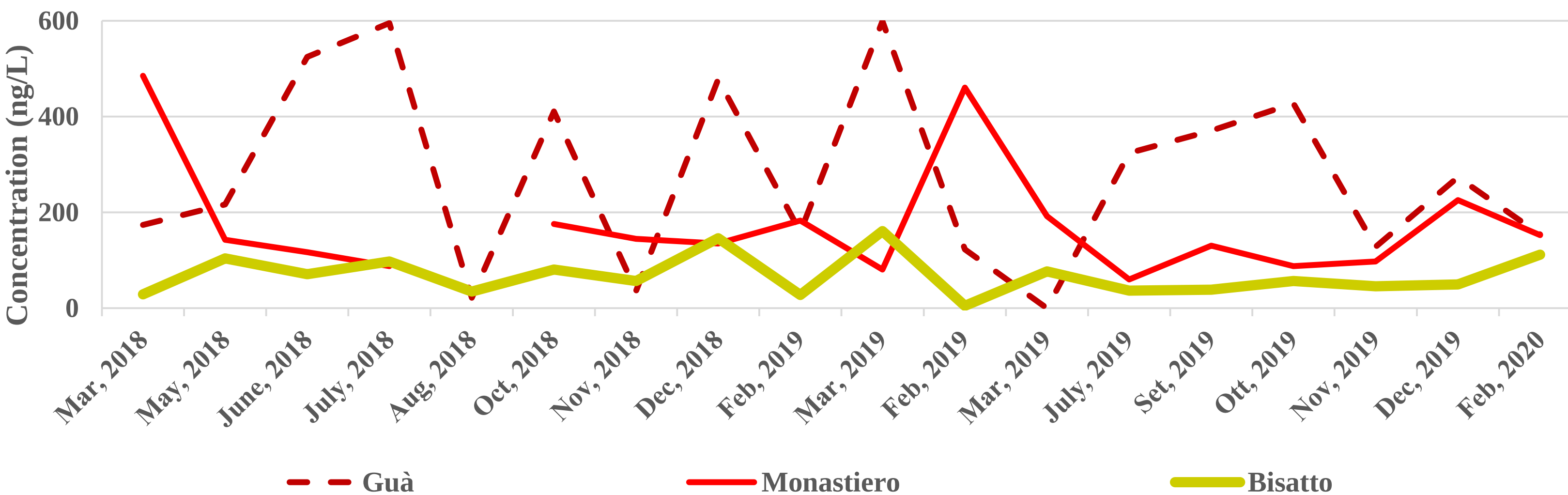
Results 2018-2020

Comparison to "reference site"

The levels of PFAS in irrigation waters showed high variability throughout the year





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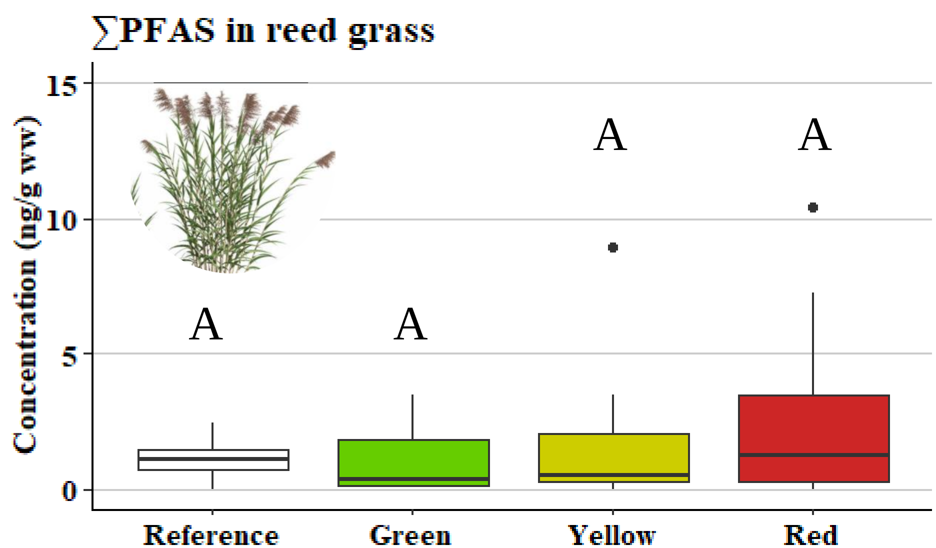
Results 2018-2020

Comparison to “reference site”

Reed grass is a ubiquitous aquatic vegetal species often used for phytodepuration in artificial wetlands

The three areas were no more contaminated by PFAS than the reference area



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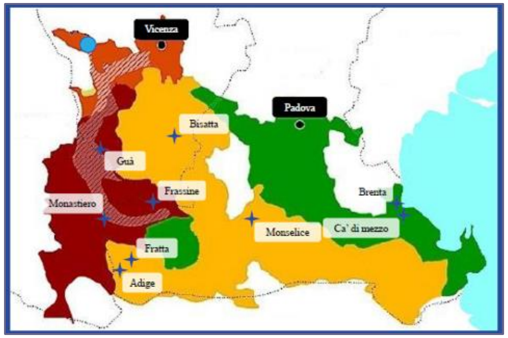
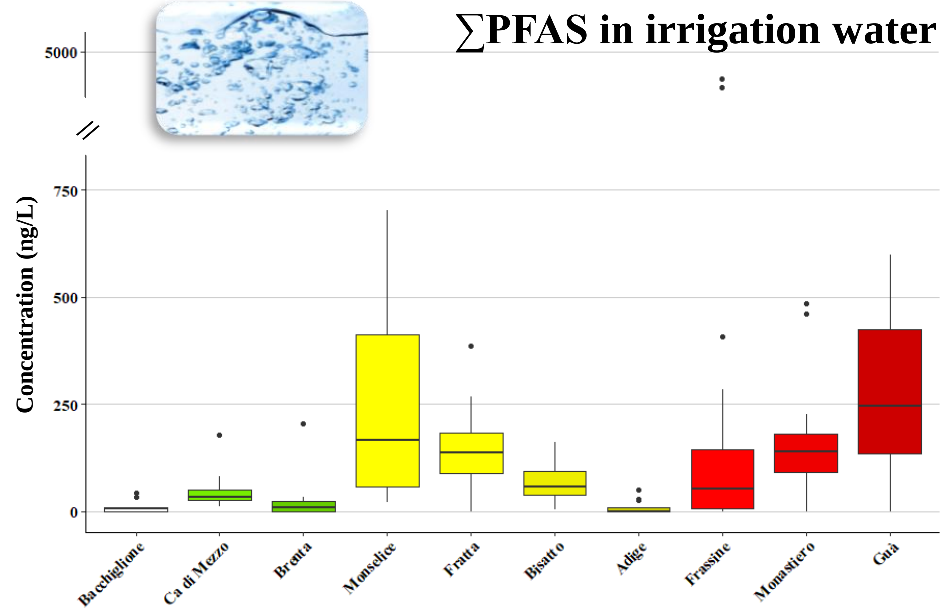
Results 2018-2020

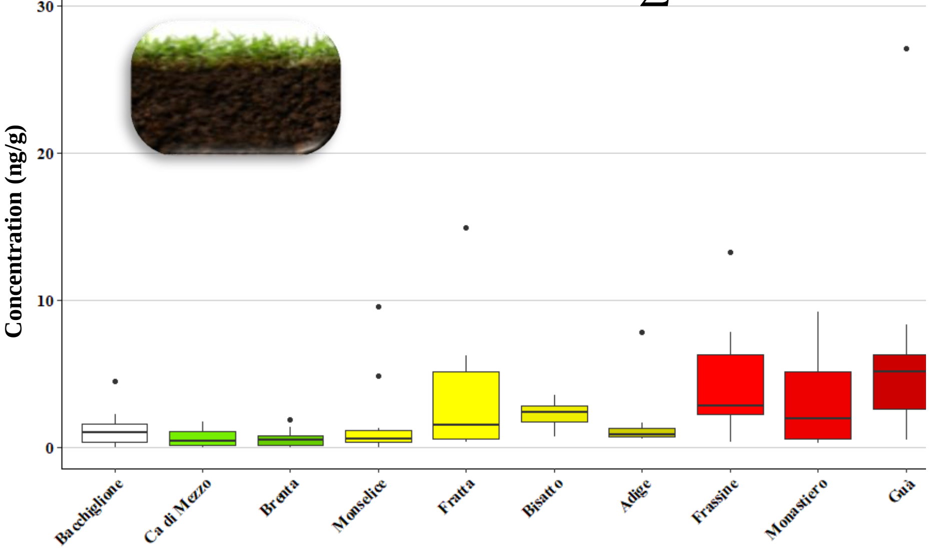
Site comparison



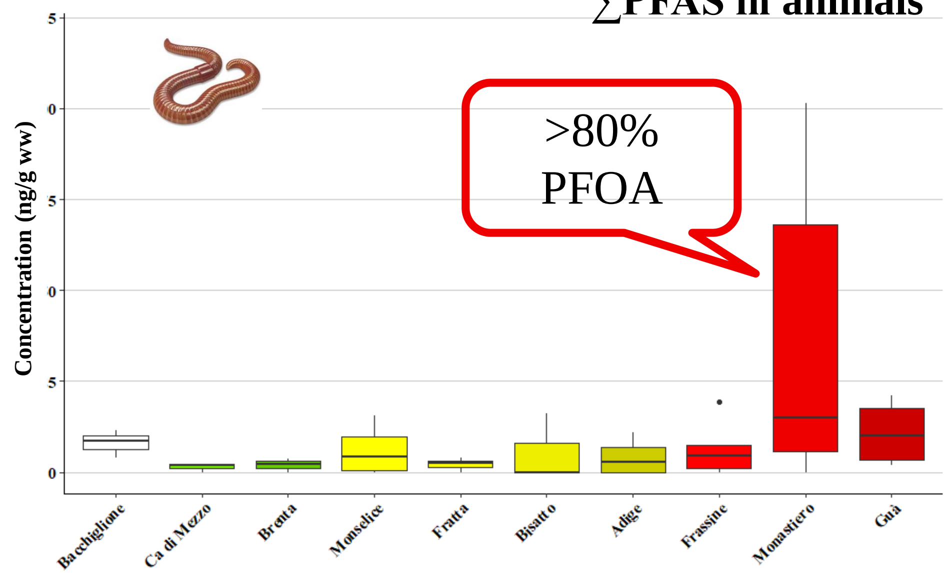
∑PFAS in irrigation water



∑PFAS in soil



∑PFAS in animals



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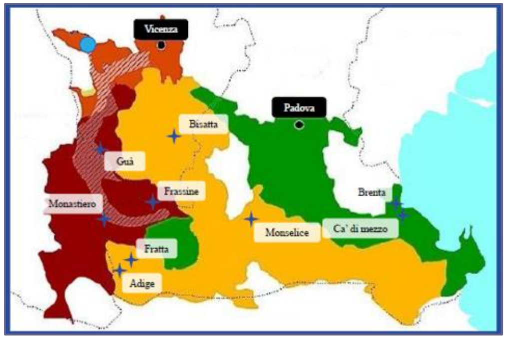
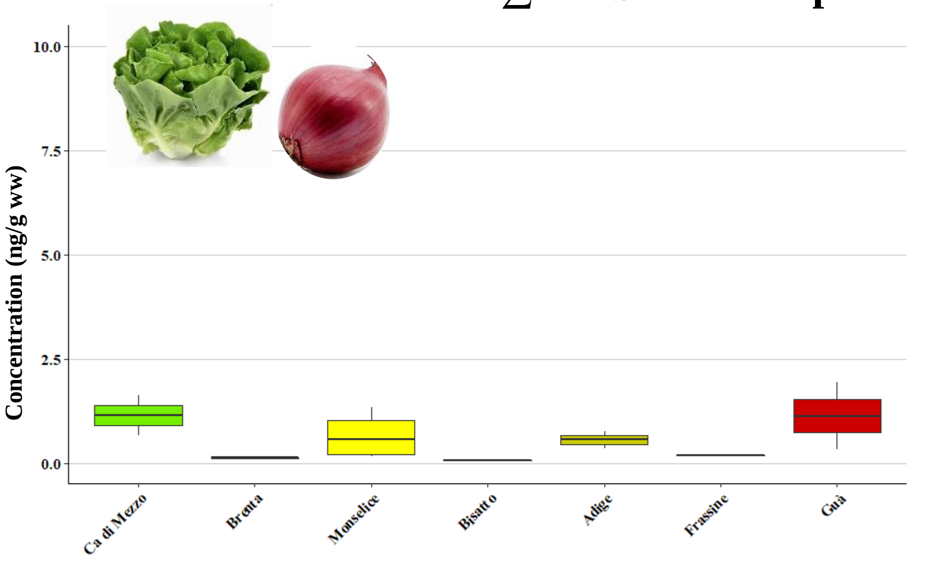
Results 2018-2020

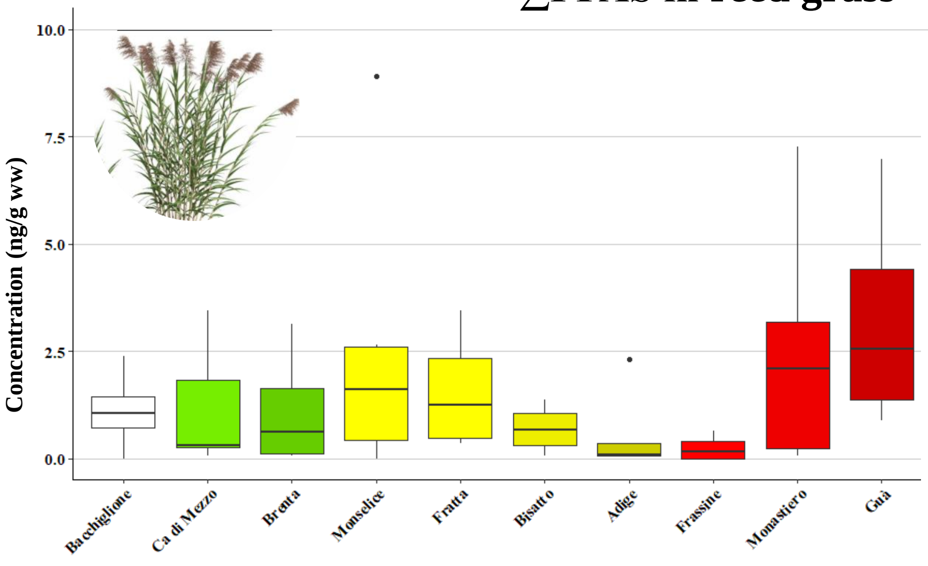
Site comparison



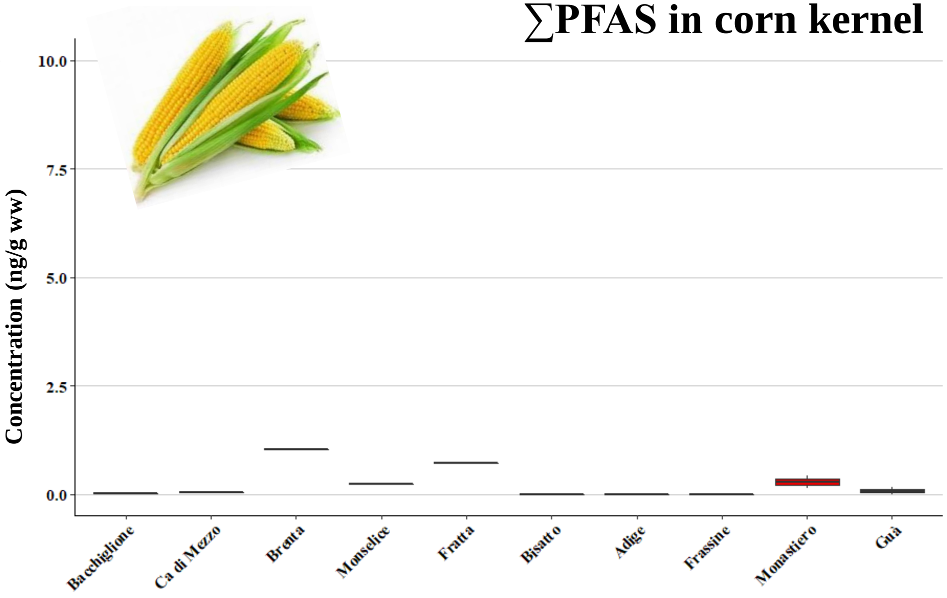
∑PFAS in edible plants



∑PFAS in reed grass



∑PFAS in corn kernel



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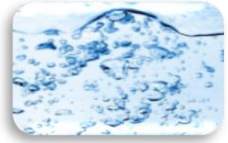
Results 2018-2020

PFAS composition

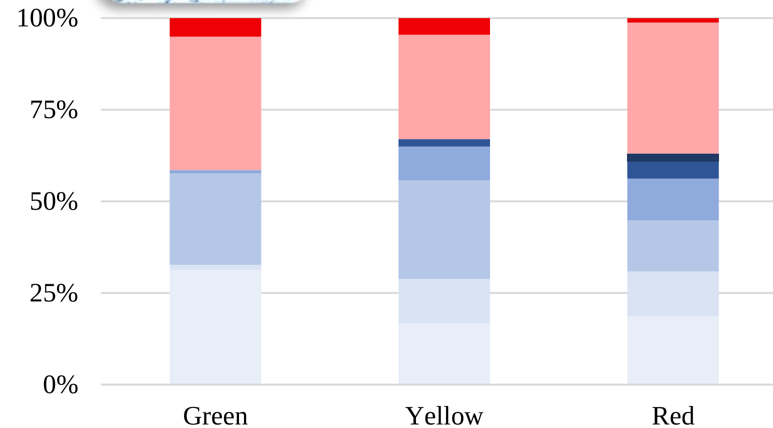
PFBA PFPeA PFBS PFHxA PFHpA PFHxS

C < 8 C ≥ 8

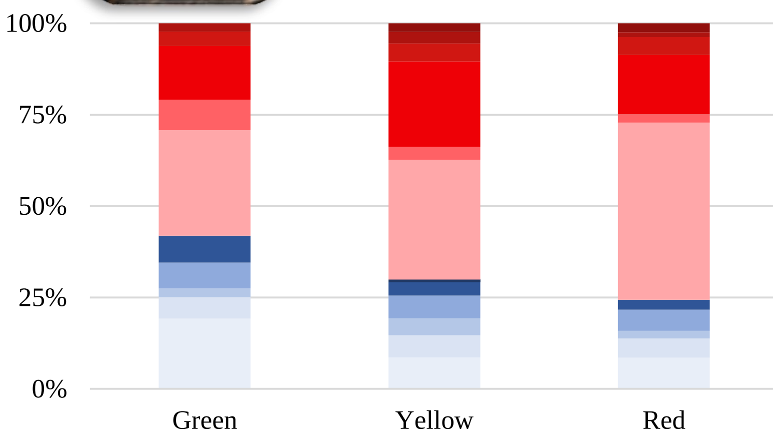
PFOA PFNA PFOS PFDA PFUnDA PFDoDA



∑PFAS in irrigation water



∑PFAS in soil



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Results 2018-2020

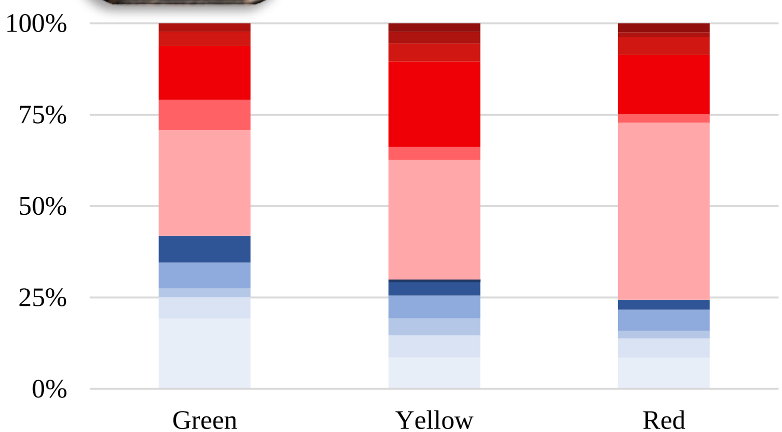
Total organic carbon (TOC) in soil

PFBA PFPeA PFBS PFHxA PFHpA PFHxS

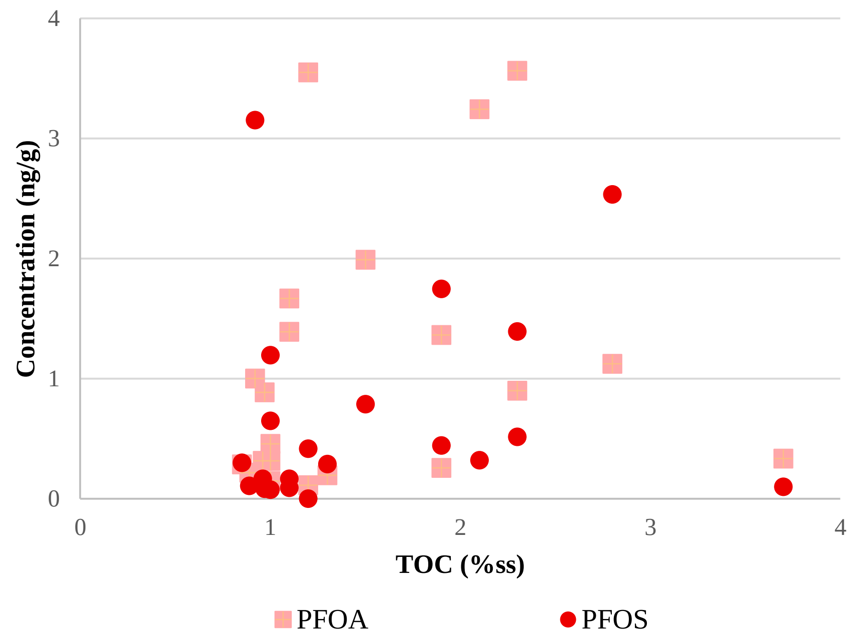
C < 8 C ≥ 8

PFOA PFNA PFOS PFDA PFUnDA PFDoDA

∑PFAS in soil



TOC vs ∑PFAS in soil



No correlation between TOC and ∑PFAS was found

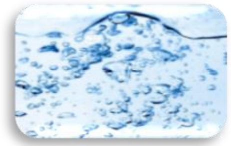
Results 2018-2020

PFAS composition

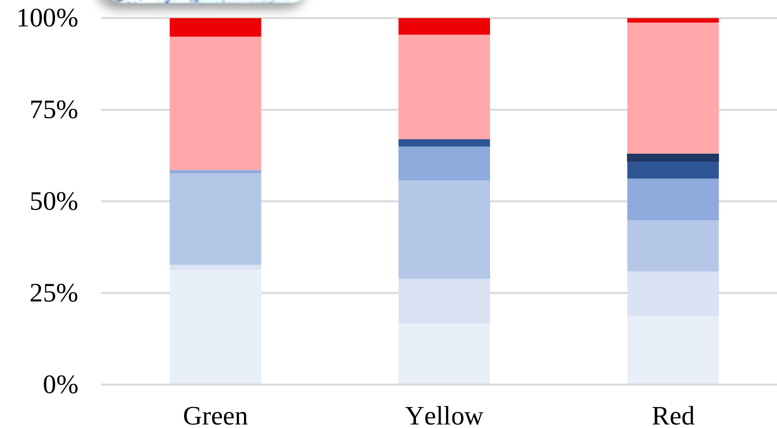
PFBA PFPeA PFBS PFHxA PFHpA PFHxS

C < 8 C ≥ 8

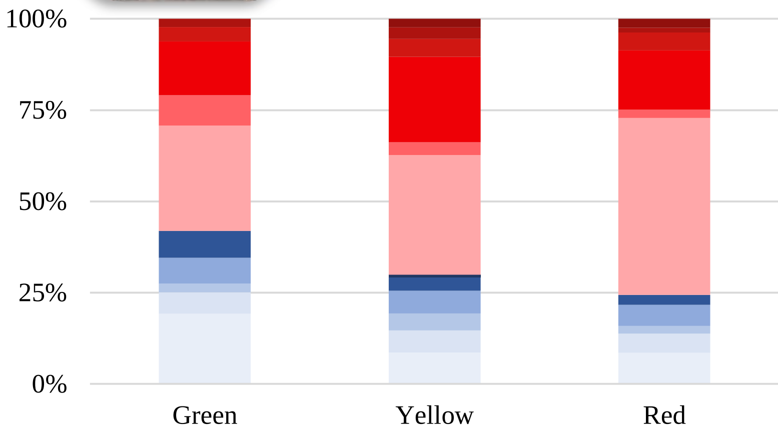
PFOA PFNA PFOS PFDA PFUnDA PFDoDA



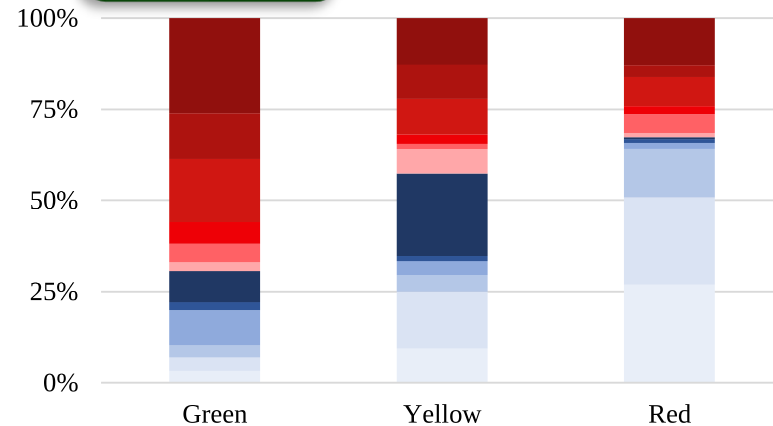
∑PFAS in irrigation water



∑PFAS in soil



∑PFAS in whole plant



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PFAS composition in plants

PFBA PFPeA PFBS PFHxA PFHpA PFHxS

C < 8 **C ≥ 8**

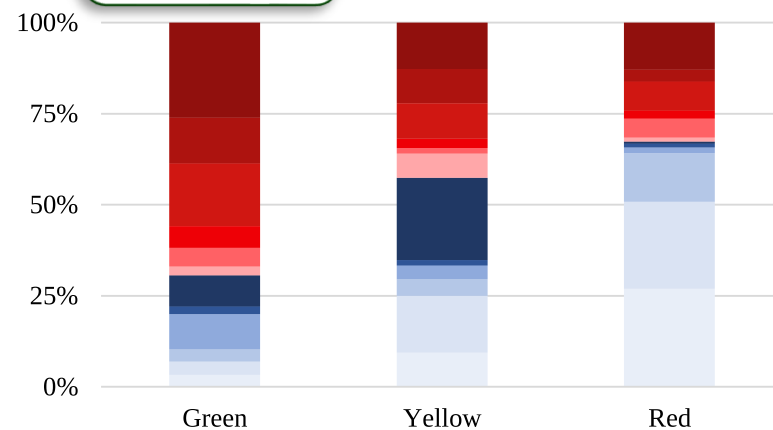
released in the past
and accumulated in the soil

PFOA PFNA PFOS PFDA PFUnDA PFDoDA

recent origin

The composition of vegetal contamination was affected by the sampling site.

∑PFAS in whole plant



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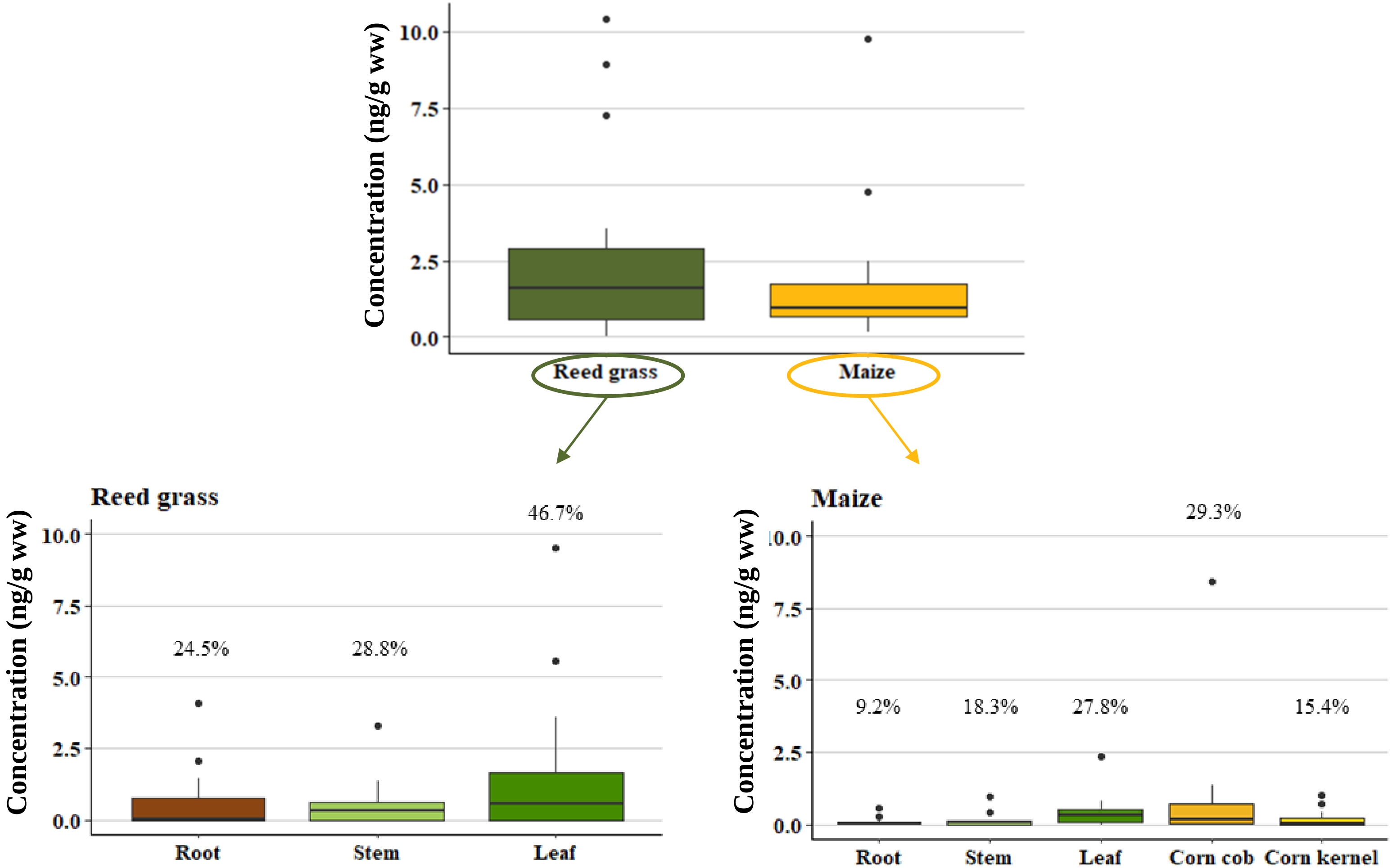
Results 2018-2020

PFAS partition in vegetal fractions



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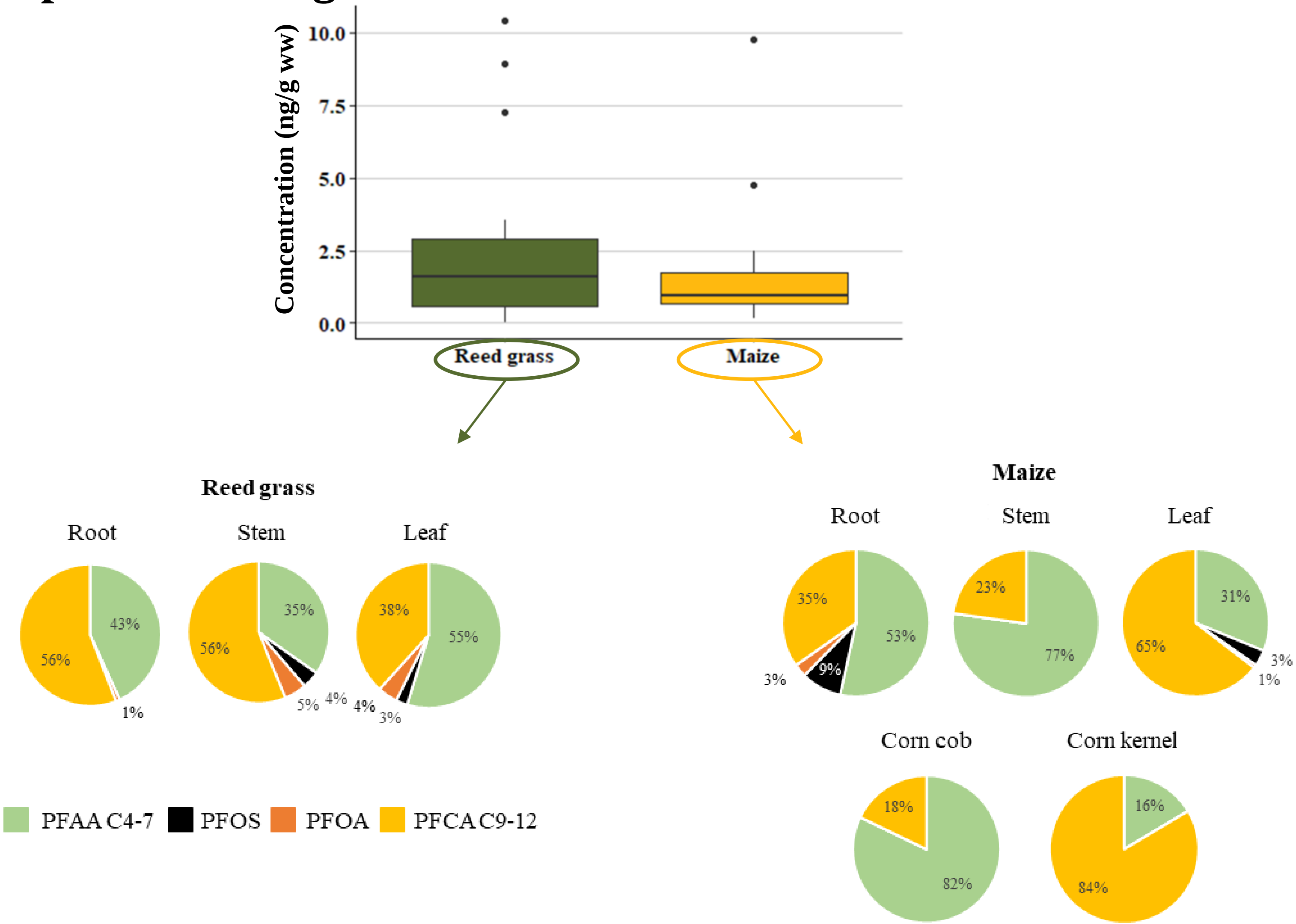
Results 2018-2020

PFAS composition in vegetal fractions



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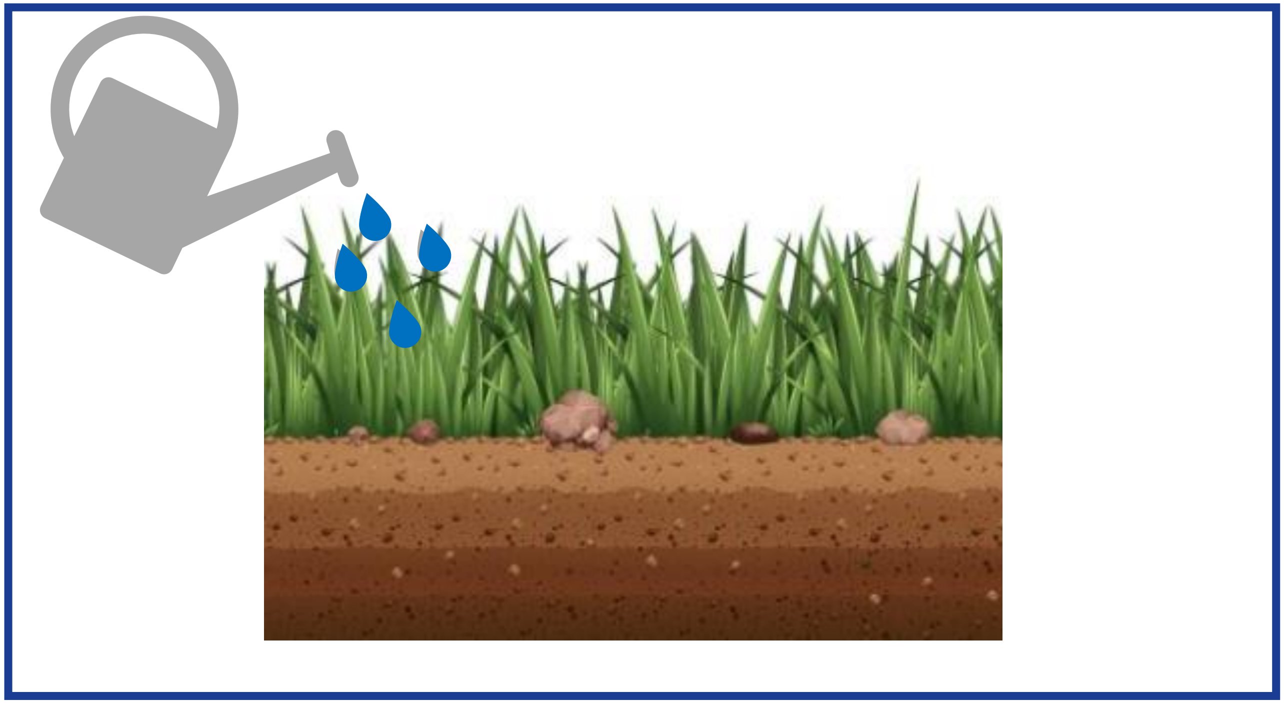
Conclusions



Conclusions

- The levels of PFAS in irrigation waters are characterized by a high variability due to the different water supply during the year.
- Events of higher contamination were occasionally recorded.

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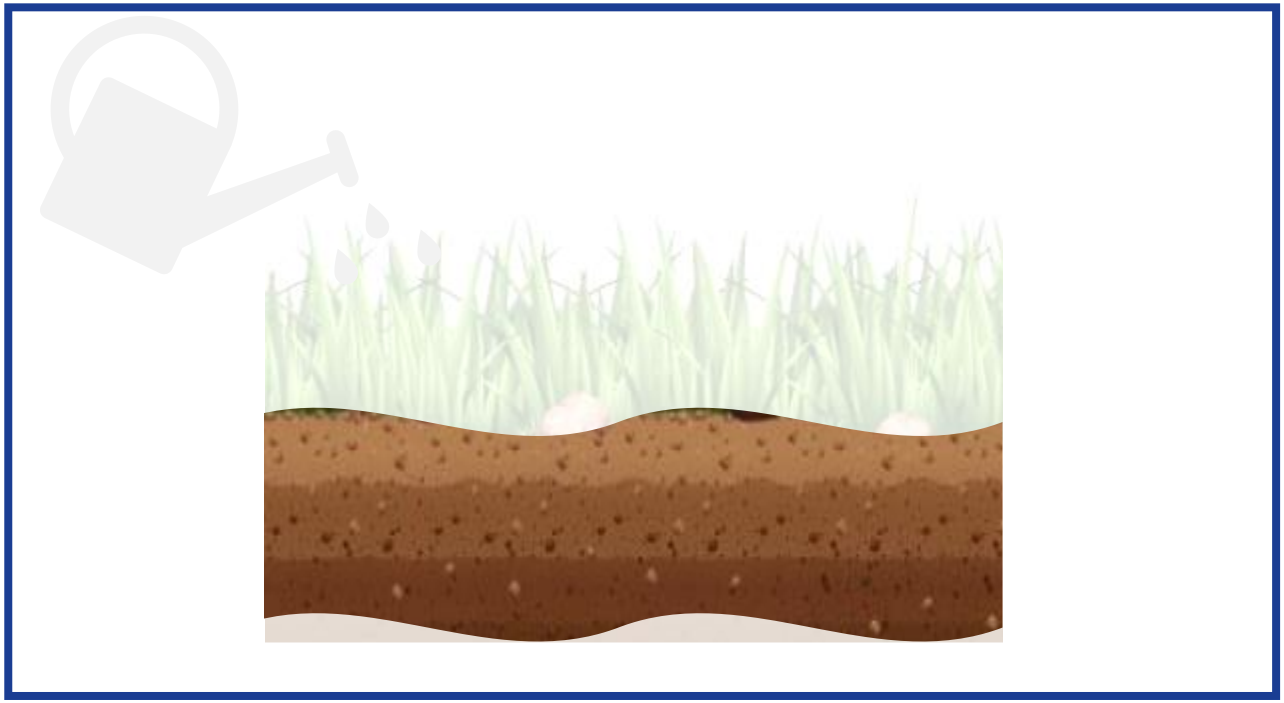
Conclusions

- Soil pollution reflects the area classification based on different levels of PFAS pressures: the highest concentrations were indeed found in samples from the red area.



Conclusions

- In whole plants, contamination level was similar in the three areas, regardless of sampling site.
- Plants collected in the green area were mainly polluted by long-chain compounds (C≥8), released in the past, while short-chain chemicals (C<8), of more recent origin, were dominant in vegetable samples taken in the red area, which is directly impacted by the industrial discharge in surface waters.

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Conclusions

- PFAS concentrations in edible plant samples (onion, lettuce, corn kernels) were lower than those measured in spontaneous species and never exceeded 2 ng/g ww.

PFAS (ng/g ww)

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- The ability of reed grass to accumulate PFAS makes this plant the model organism in monitoring of contaminated areas
- Reed grass can be used also for phytodepuration in artificial wetlands

Thanks for your attention

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