PFAS as a test bed for the EU Green Deal zero pollution ambition from refractory and mobile organic chemicals: **technologies, solutions and strategies developed under the H2020 project SCENARIOS**

Francesco Dondero,

DISIT, Università del Piemonte Orientale, ITALY

francesco.dondero@uniupo.it

This project has received funding from the H2020 programme under Grant Agreement No. 101037509

SCENARIOS H2020 PROJECT

- ✓ **Strategies for health protection, pollution Control and Elimination of Next generAtion RefractIve Organic chemicals from the Soil, vadose zone and water**
- ✓ ***17 UE + 2 Israeli partners***
- ✓ ***PFAS detection, assessment and remediation***

No.	PARTNER	ROLE IN SCENARIOS	ADDED VALUE
1	UPO	WP1.Project Management * WP2untarget analysis of PFAS in environmental and biological matrices WP4. systems biology assessment	
2	UNIVERSITÀ DEL SALENTO	WP4.health and environmental risk assessment, toxicology in vitro WP6 Biostimulation, Bioaugmentation WP8.Social and sustainability assessment of SCENARIOS solution * WP9 DSS development	
3	comet	WP10.Stakeholder oriented communication, dissemination & training *	
4		WP2 Develop methods for targeted analysis of PFAS from water, wastewater and biosolids samples WP3.Environmental fate of PFAS *	
5	FORTH	WP2.Innovative analytical methods for detection and monitoring of PFAS * WP3 New validation methods towards the quick and smart determination in different environmental matrixes and biological fluids WP6.Innovative Nearly Zero Energy remediation solutions *	
6	UCLM Universidad de Castilla-La Mancha	WP6 biochar-based technologies in the bioremediation of PFAS-contaminated soils and plant health	
7	BfR Bundesinstitut für Risikobewertung	WP4.IATA and risk assessment of PFAS *	
8	SENSOIL	WP3, WP6 Provides advanced vadose zone monitoring systems for measurement of PFAS	
9	LOMARTOV	WP8 collaboration in LCA &LCC WP9.New proposal for replicability, exploitation and regulation standards *	
10	LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY LIST	WP Establishment of methods and approaches for the toxicity assessment of PFAS mixtures and for the testing itself	
11		WP4, WP6 Computational tasks	
12	NovaMechanics	WP5.Advanced in silico hazard approaches and cloud microservices *	
13	Tampere University	WP4 Bioinformatics analysis (omics) and In vitro test.	
14	UNIVERSITY OF BIRMINGHAM	WP4 Evaluation of the impacts of pollutants on keystone and indicator species	
15	envytech	WP7.Validation and demonstration * DEMO 2	
16	AOAL	WP7 DEMO 1	
17	Geo	WP3, WP7 Characterisation of the selected contaminated sites	
18	IDP ingeniería - medio ambiente - arquitectura	WP7 DEMO 3 WP9 Collaborate overall exploitation and impact maximisation activities within the project	
19	POLO GGB	WP4 Sytems biology assessment for sequencing and bioinformatic activities	

SCENARIOS

Symbol	Meaning
	Pilot Demo Sites
	Up-scaled Facilities
	International presence/Network
	Market Access
	Scientific Equipment/Facilities
	Engineering Expertise
*	Workpackage Leader

Project Information

SCENARIOS
Grant agreement ID: 101037509

Start date 1 November 2021
End date 31 October 2025

Funded under
H2020-EU.3.5.

Overall budget
€ 11 985 716,25

EU contribution
€ 11 985 716,25

Coordinated by
UNIVERSITA DEGLI STUDI DEL PIEMONTE ORIENTALE AMEDEO AVOGADRO
Italy

PROJECT STRUCTURE

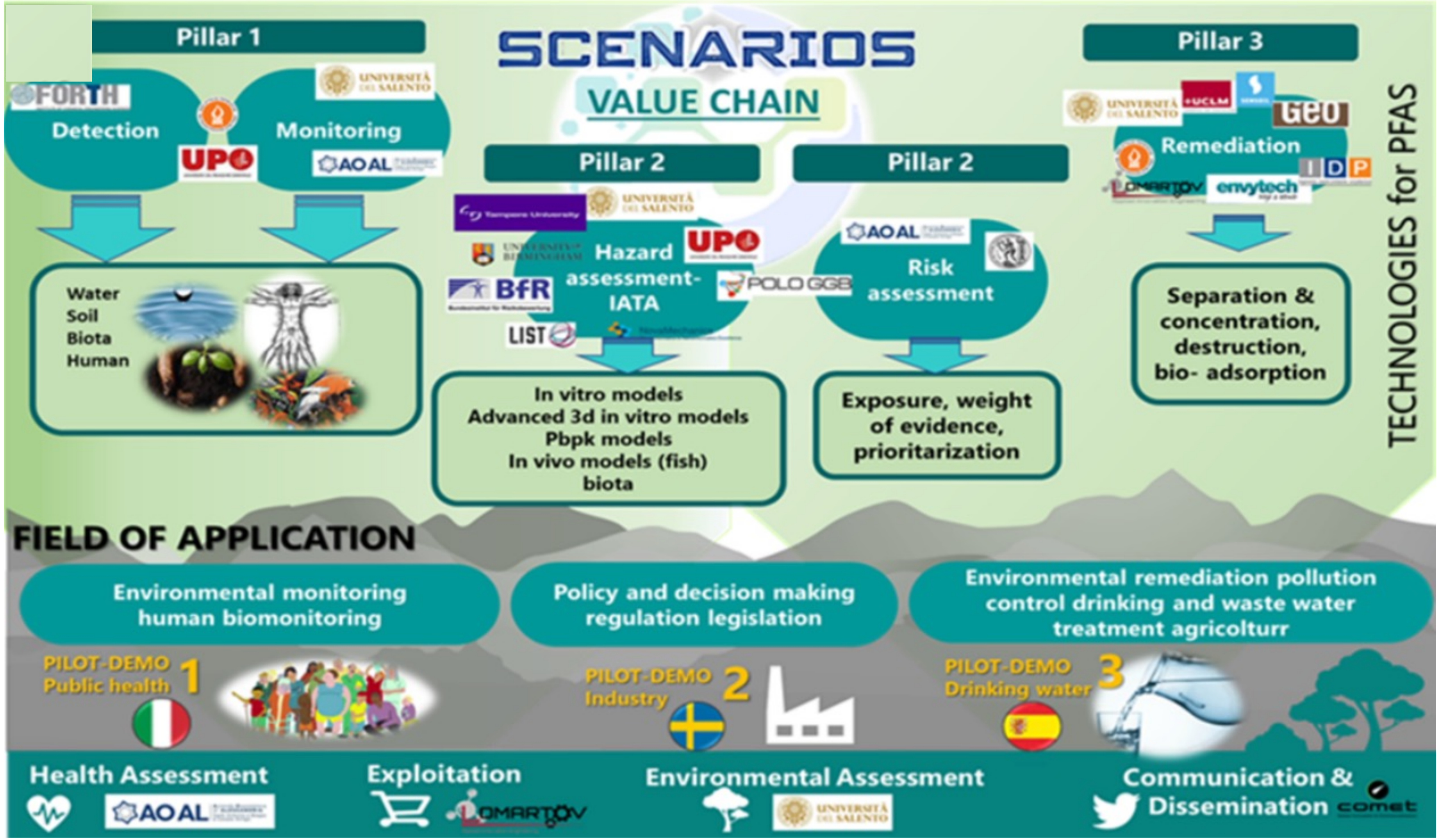
Data / Technical

Policy

Communication

1. WP1. Project management
2. **WP2. Innovative detection of PFAS**
3. **WP3. Environmental fate and PFAS transport****
4. **WP4. IATA and RA of PFAS**
5. **WP5. In silico hazard approach and cloud services**
6. **WP6. Innovative remediation solutions for PFAS***
7. WP7. Validation & Demonstration
8. WP8. Social and sustainability assessment
9. WP9. Replicability, exploitation and regulation
10. WP10. Communication and dissemination
11. WP11. Ethics requirements

SCENARIOS VALUE CHAIN



PILLAR 1

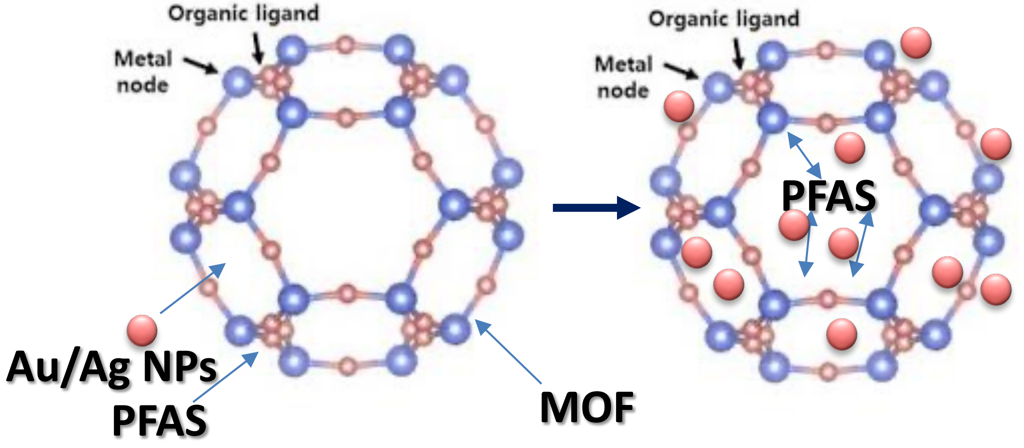
- **Smart detection of PFAS (sensor based detection)**
  - Implementing a fast and accurate determination of PFAS to allow inexpensive wide-scale measurement & (bio)monitoring of PFAS congeners.
  - PFAS mobilization from top-soil to underground water
    - EGU22-12790 A “multiple lines of evidence approach” for site characterization and high-resolution 3D geological modelling/risk assessment of PFAS contaminated sites in Sweden and Israel.
    - EGU22-8629 PFAS transport in the unsaturated zone
    - EGU22-1886 Numerical simulation of dissolved PFAS transport in unsaturated soil columns

SERS DETECTION

SCENARIOS EGU FORTH INSTITUTE OF CHEMICAL ENGINEERING SCIENCES LAMS

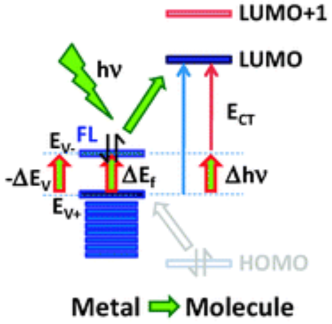
MOFs

1. Adsorption of molecules & Encapsulation or decoration with Ag/Au NPs



2. Charge-transfer resonance in MOF substrates

Charge transfer possibility between analyte/MOFs



Strategy flow chart

Synthesis of MOFs

Decoration/ Encapsulation of Au/Ag NPs to MOFs + Characterization of MOFs and MOFs@Au/Ag + Test of the adsorption capability of MOFs

Investigation of their suitability either as solid substrates or MOF/colloidal substrates

MOFs adsorption capability for PFOA/PFOS

BET

NH2-MIL101 — PFOA → F/Cr= 1.6; PFOS → F/Cr= 0.5

S_{BET}= 800-1100 m²/g

V_{pores}= 0.475 cc/g Pore width ~1.5 nm

MIL101 — PFOA → F/Cr= 3.2; PFOS → F/Cr= 3.8

S_{BET}= 1250 m²/g

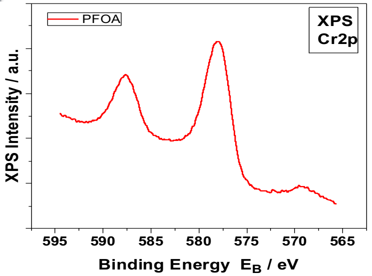
V_{pores}= 1.087 cc/g Pore width ~1.3- 3 nm

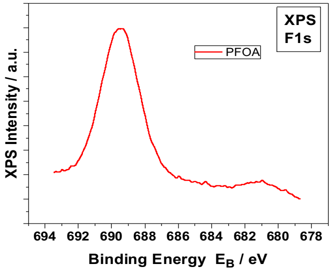
NH2-MIL101@Au — PFOA → F/Cr= 1.4

S_{BET}= 350 m²/g

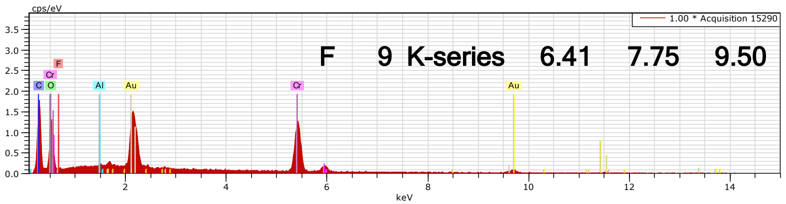
V_{pores}= 0.231 cc/g Pore width ~1.3 nm

XPS





EDX

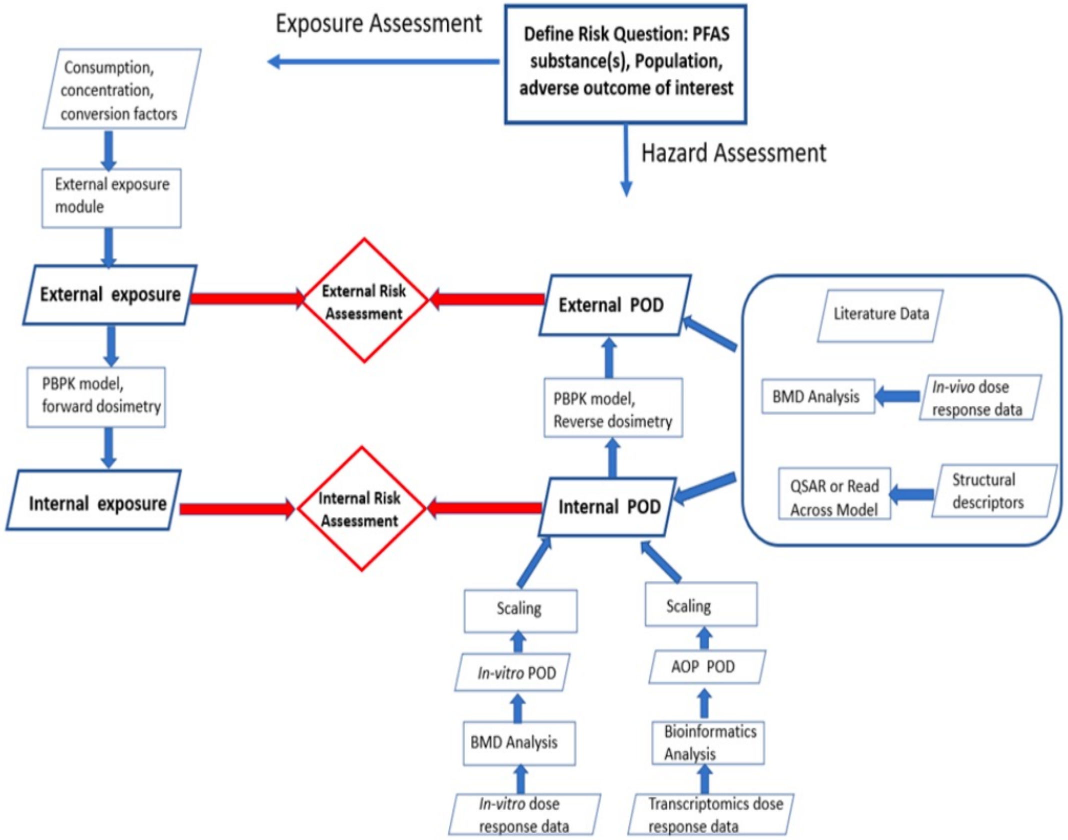


PILLAR 2

- **HAZARD & RISK ASSESSMENT**
  - **Expanding Risk and long-term toxicity Assessment to non-regulated, non-restricted, poor-data PFAS congeners and mixtures,**
  - **implementing a specific class Integrated Approaches to Testing and Assessment (IATA)**

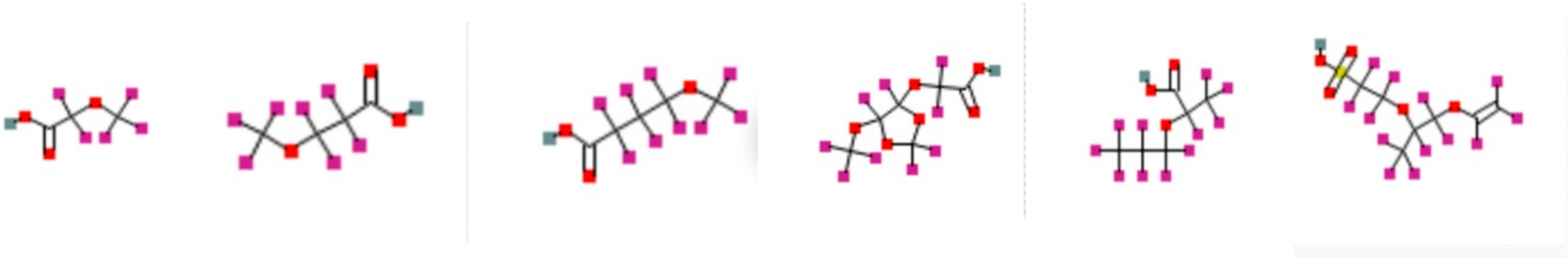
EXPOSURE plus HAZARD assessment

- PFAS prioritization
- Hazard assessment
  - Tiered PFAS One Health- toxicology *in vitro & in vivo*
  - NAMs: organoids, omics sciences, advanced bioinformatics, AOPs
- Exposure assessment, IVIVE; PBPK modelling
- Covid-19, Immune response

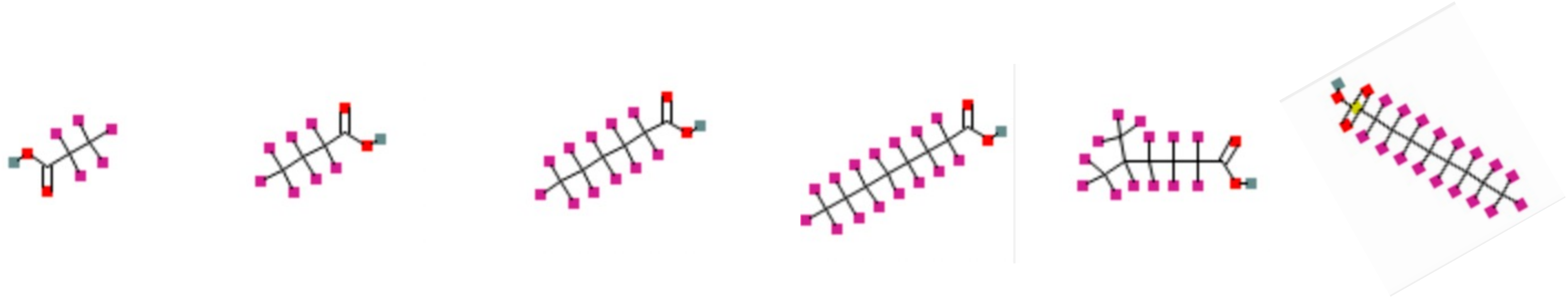


Keywords: Poor-data PFAS; System Toxicology; Long term; Transgenerational effects; Fish; invertebrates; Mesocosms; Ecosystems; Trophic factor

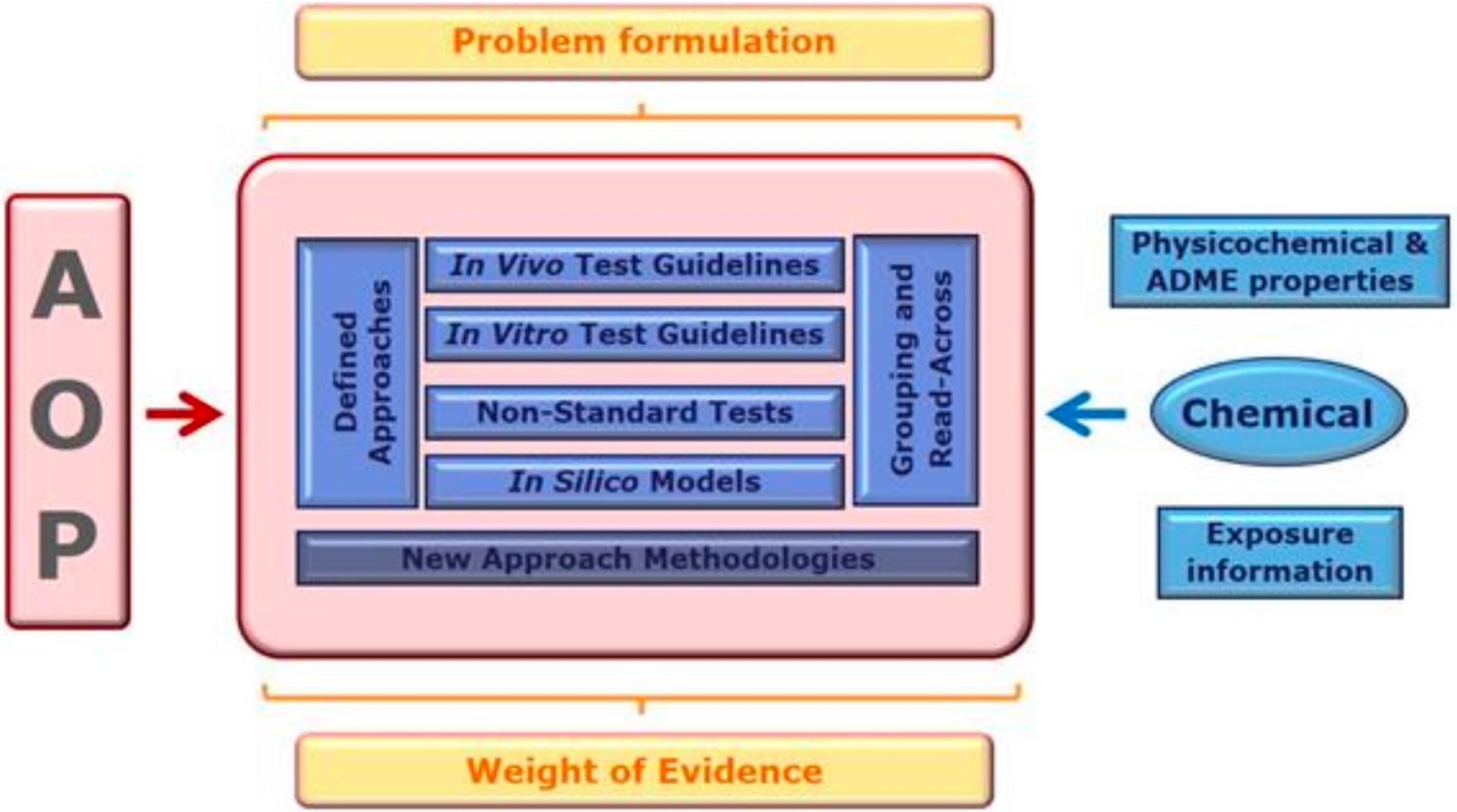
Poor-data PFAS



NEXT GENERATION PFAS vs LEGACY



IATA tool



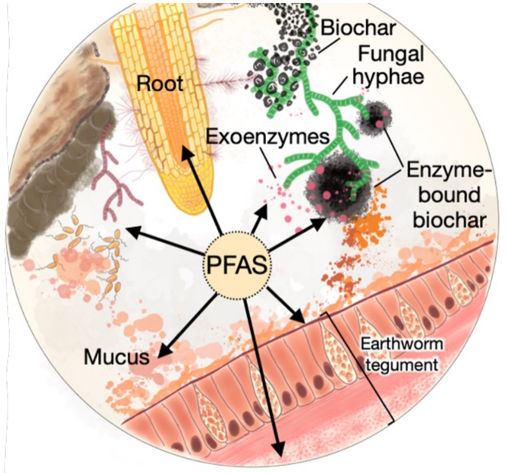
OECD, 2020

PILLAR 3

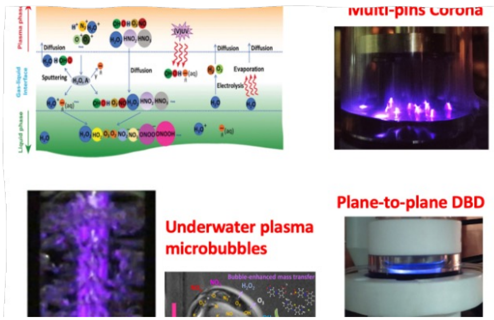
- **INNOVATION FOR PFAS REMEDIATION**
  - Devising innovative, green and zero-energy technologies for cost-effective pollution control and remediation of PFAS
  - PFAS removal and concentration from wastewater
    - EGU22-13567 Stabilization and reuse of PFAS contaminated soil and treatment of leachate and groundwater by Surface Active Foam Fractionation (SAFF) EGU22-8629 PFAS transport in the unsaturated zone
  - PFAS destruction
    - EGU22-12885 Investigation of Nanosecond Pulsed Cold Atmospheric Plasma (NSP-CAP) as a Means to the Highly Energy Efficient Degradation of PFAS in water

REMEDIATION SOLUTIONS

- Novel plasma reactors for destruction of PFAS from water and soil
- Surface Active Foam Fractionation (SAFF) optimization for low carbon chain
- Soil washing
- Bio-activated carbon-based adsorbents for PFAS removal in soil
- Bioremediation (microorganism)
- Development of hybrid systems and treatment trains



PFAS fate in earthworm-



Keywords: Biochar; Ex situ; in situ; air bubbles; advanced oxidation; biostimulation; benchmarking

DEMONSTRATION

- **DEMO1. Human biomonitoring using WP2 smart analytical methods.**
- DEMO2. PFAS remediation in underground water using WP6 hybrid technologies.
- DEMO3. PFAS remediation in drinking water using SAFF and cold plasma.

Keywords: Remediation; geological characterization; industry; fire-fighting

DEMONSTRATION

- WP7 - ACTIVITIES:
- DEMO1. Human biomonitoring using WP2 smart analytical methods.
- **DEMO2. PFAS remediation in underground water using hybrid technologies.**
- DEMO3. PFAS remediation in drinking water using SAFF and cold plasma.

Keywords: legacy PFAS; alternative PFAS; geology; industry; fire-fighting sites.

DEMONSTRATION

- WP7 - ACTIVITIES:
- DEMO1. Human biomonitoring using WP2 smart analytical methods
- DEMO2. PFAS remediation in underground water using WP6 hybrid technologies
- **DEMO3**. PFAS remediation in drinking water using SAFF and cold plasma.

Keywords: legacy PFAS; alternative PFAS; geology; industry; fire-fighting sites.

This project has received funding from the H2020 programme under Grant Agreement No. 101037509

Thank you for your attention

francesco.dondero@uniupo.it

https://scenarios-project.eu