BIOAVAILABILITY OF ORGANIC CHEMICALS IN SOILS AND SEDIMENTS: POTENTIAL REGULATORY ASPECTS

JOSÉ JULIO ORTEGA CALVO

Instituto de Recursos Naturales y Agrobiología de Sevilla
Consejo Superior de Investigaciones Científicas
Spain
jjortega@irnase.csic.es

CSIC
Consejo Superior de Investigaciones Científicas

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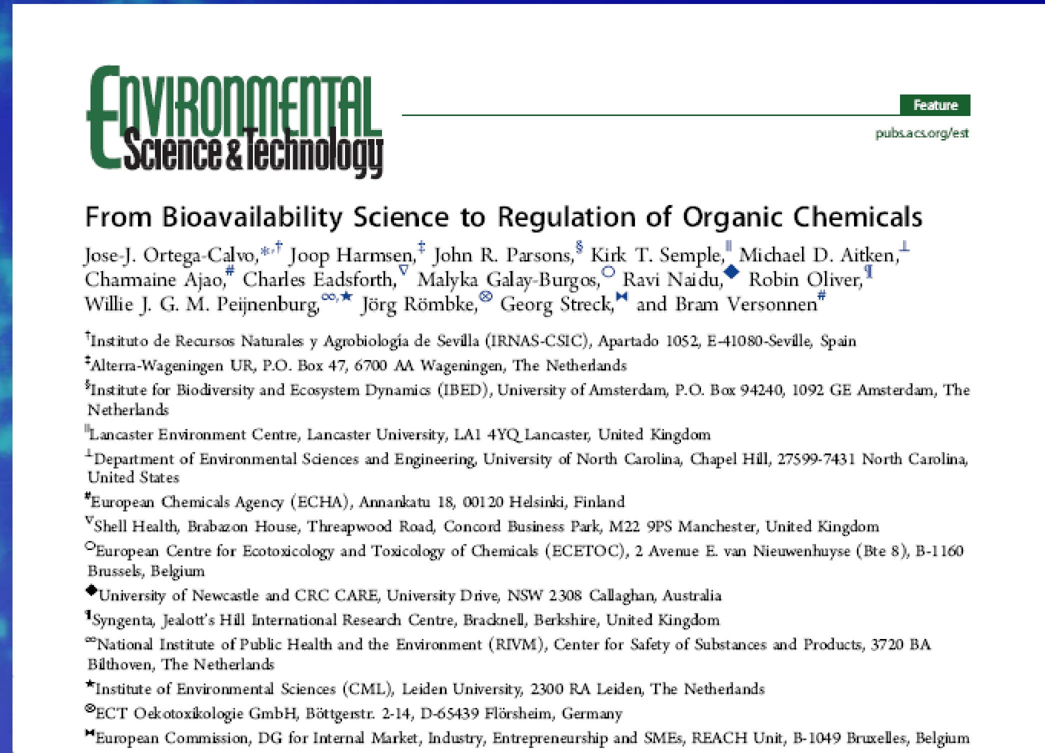
Instituto de Recursos Naturales y Agrobiología de Sevilla

OUTLINE

- LATEST DEVELOPMENTS IN BIOAVAILABILITY SCIENCE
    - MICROBIAL MECHANISMS
    - PHYSICOCHEMICAL METHODS
- REGULATORY SCANNING IN CHEMICAL POLLUTION
    - RETROSPECTIVE *VS.* PROSPECTIVE RA
    - NATL. & INTERNATIONAL POLICIES


Environmental Science & Technology

Feature

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From Bioavailability Science to Regulation of Organic Chemicals

Jose-J. Ortega-Calvo,[*,†] Joop Harmsen,[‡] John R. Parsons,[§] Kirk T. Semple,[‖] Michael D. Aitken,[⊥] Charmaine Ajao,[#] Charles Eadsforth,[∇] Malyka Galay-Burgos,[○] Ravi Naidu,[◆] Robin Oliver,[¶] Willie J. G. M. Peijnenburg,[∞,★] Jörg Römbke,[⊗] Georg Streck,[⧓] and Bram Versonnen[#]

[†]Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS-CSIC), Apartado 1052, E-41080-Seville, Spain

[‡]Alterra-Wageningen UR, P.O. Box 47, 6700 AA Wageningen, The Netherlands

[§]Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, P.O. Box 94240, 1092 GE Amsterdam, The Netherlands

[‖]Lancaster Environment Centre, Lancaster University, LA1 4YQ Lancaster, United Kingdom

[⊥]Department of Environmental Sciences and Engineering, University of North Carolina, Chapel Hill, 27599-7431 North Carolina, United States

[#]European Chemicals Agency (ECHA), Annankatu 18, 00120 Helsinki, Finland

[∇]Shell Health, Brabazon House, Threapwood Road, Concord Business Park, M22 9PS Manchester, United Kingdom

[○]European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), 2 Avenue E. van Nieuwenhuyse (Bte 8), B-1160 Brussels, Belgium

[◆]University of Newcastle and CRC CARE, University Drive, NSW 2308 Callaghan, Australia

[¶]Syngenta, Jealott's Hill International Research Centre, Bracknell, Berkshire, United Kingdom

[∞]National Institute of Public Health and the Environment (RIVM), Center for Safety of Substances and Products, 3720 BA Bilthoven, The Netherlands

[★]Institute of Environmental Sciences (CML), Leiden University, 2300 RA Leiden, The Netherlands

[⊗]ECT Oekotoxikologie GmbH, Böttgerstr. 2-14, D-65439 Flörsheim, Germany

[⧓]European Commission, DG for Internal Market, Industry, Entrepreneurship and SMEs, REACH Unit, B-1049 Bruxelles, Belgium

ES&T (2015) 49, 10255-10264

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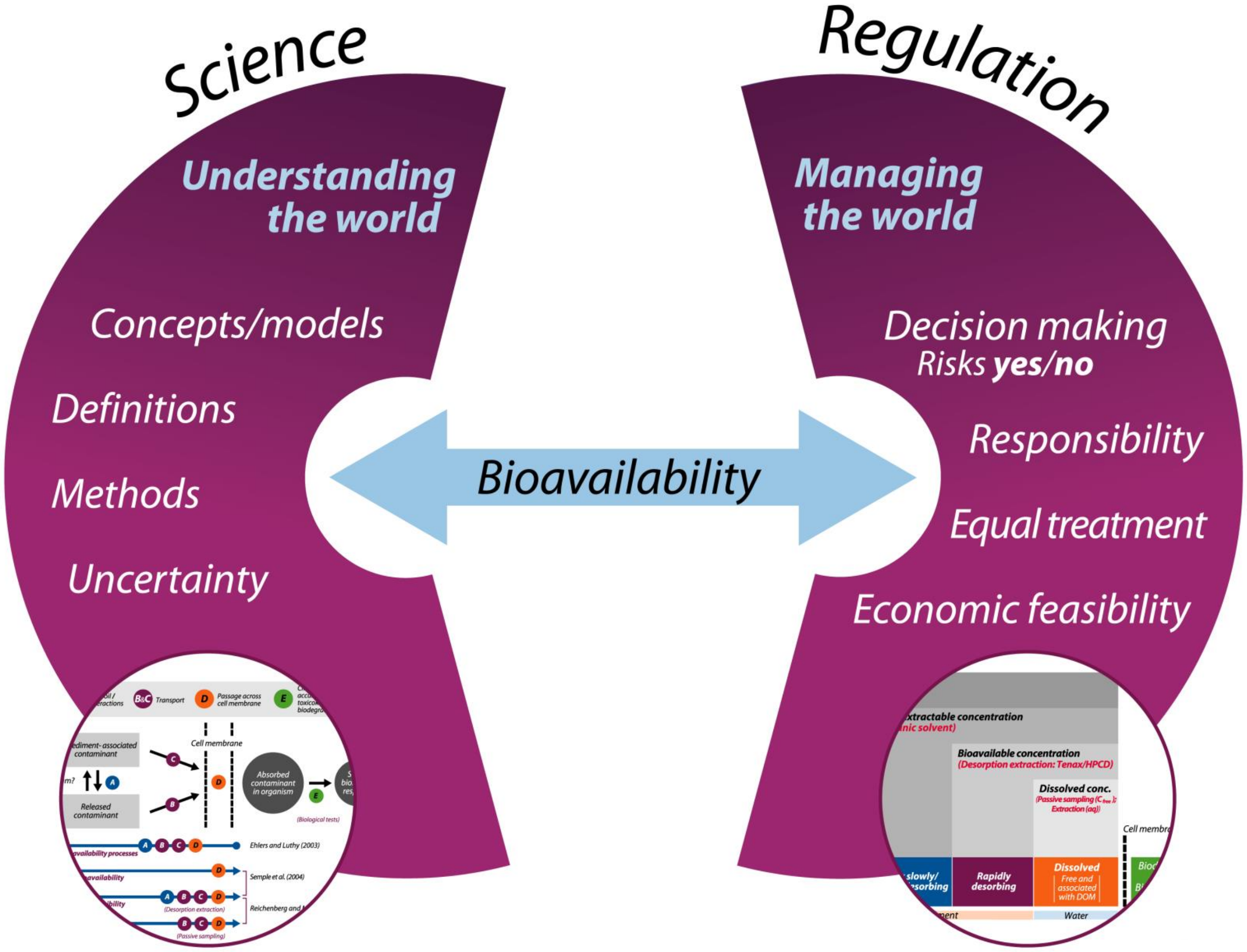
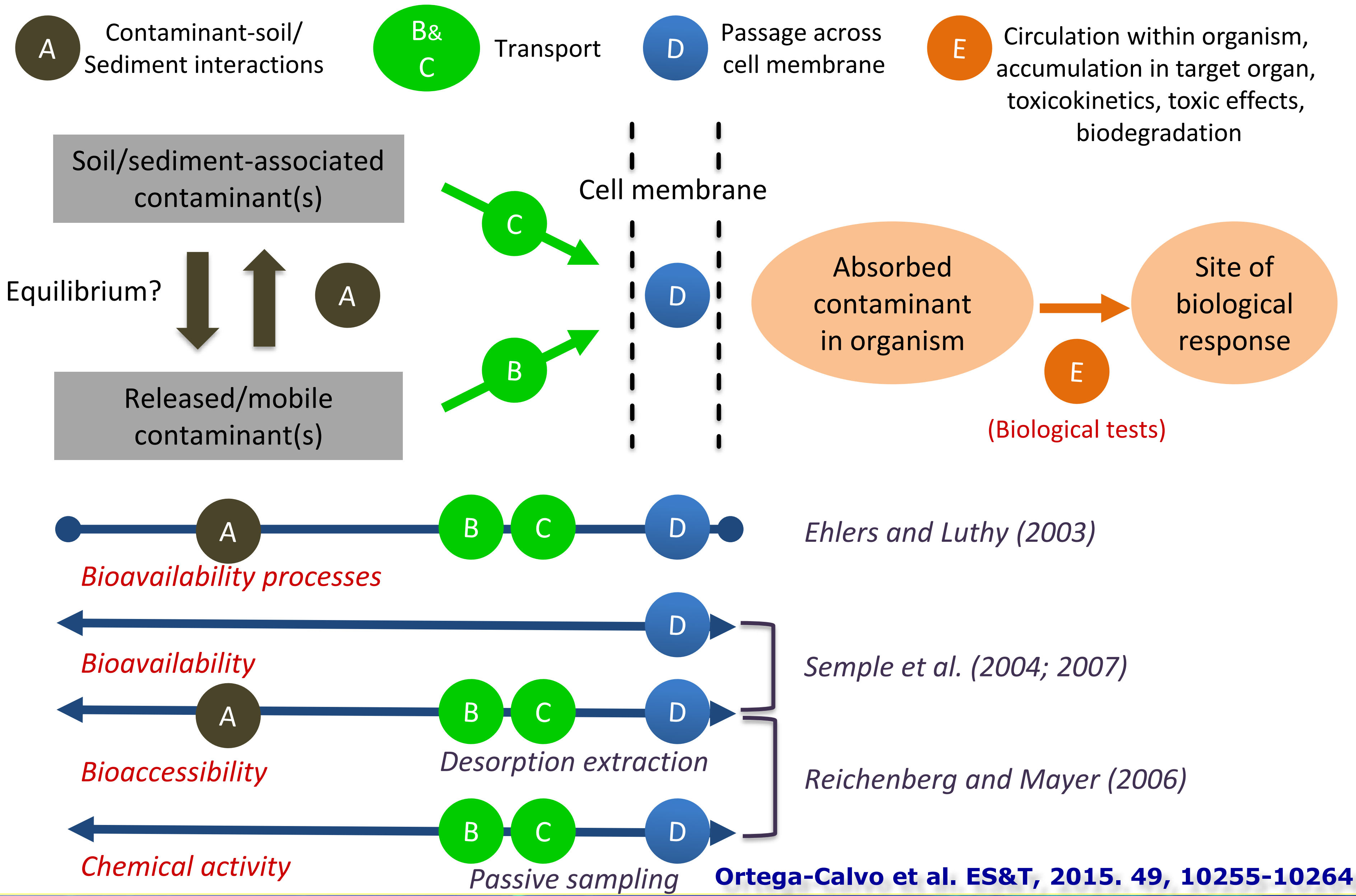
BRINGING DIFFERENT WORLDS TOGETHER

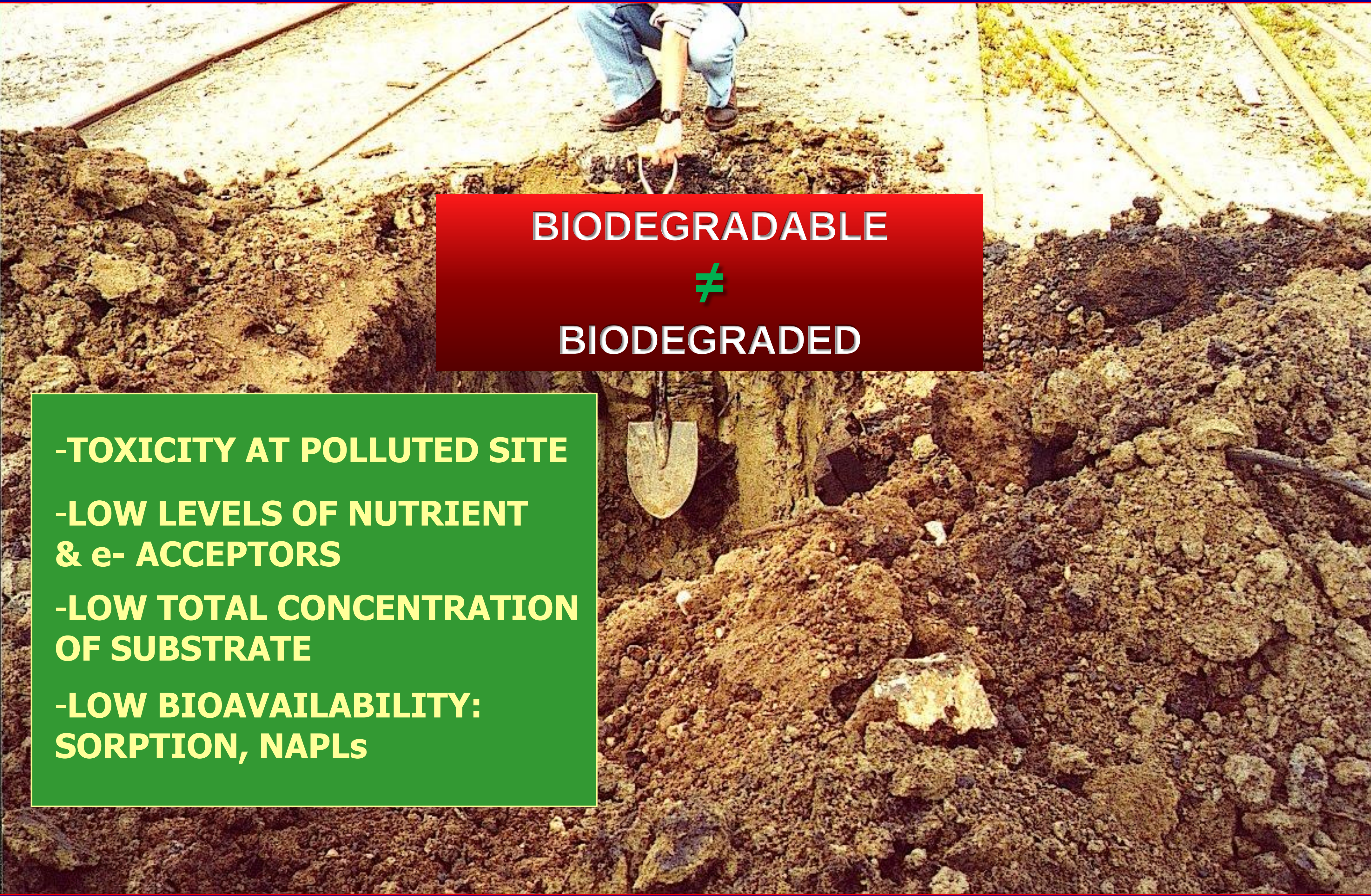


Ortega-Calvo et al. ES&T, 2015. 49, 10255-10264

BIOAVAILABILITY SCIENCE



Ortega-Calvo et al. ES&T, 2015. 49, 10255-10264



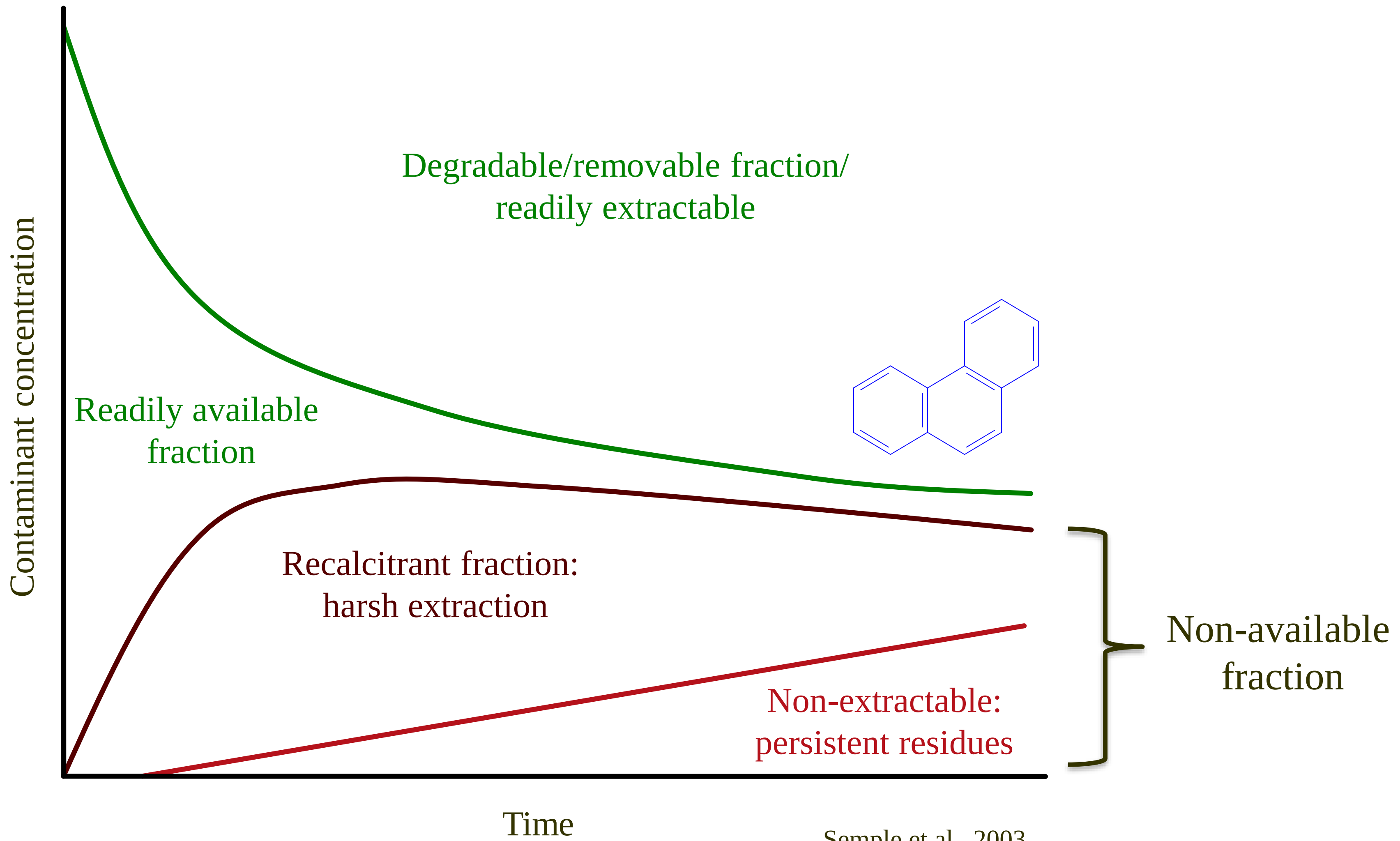
BIODEGRADABLE

≠

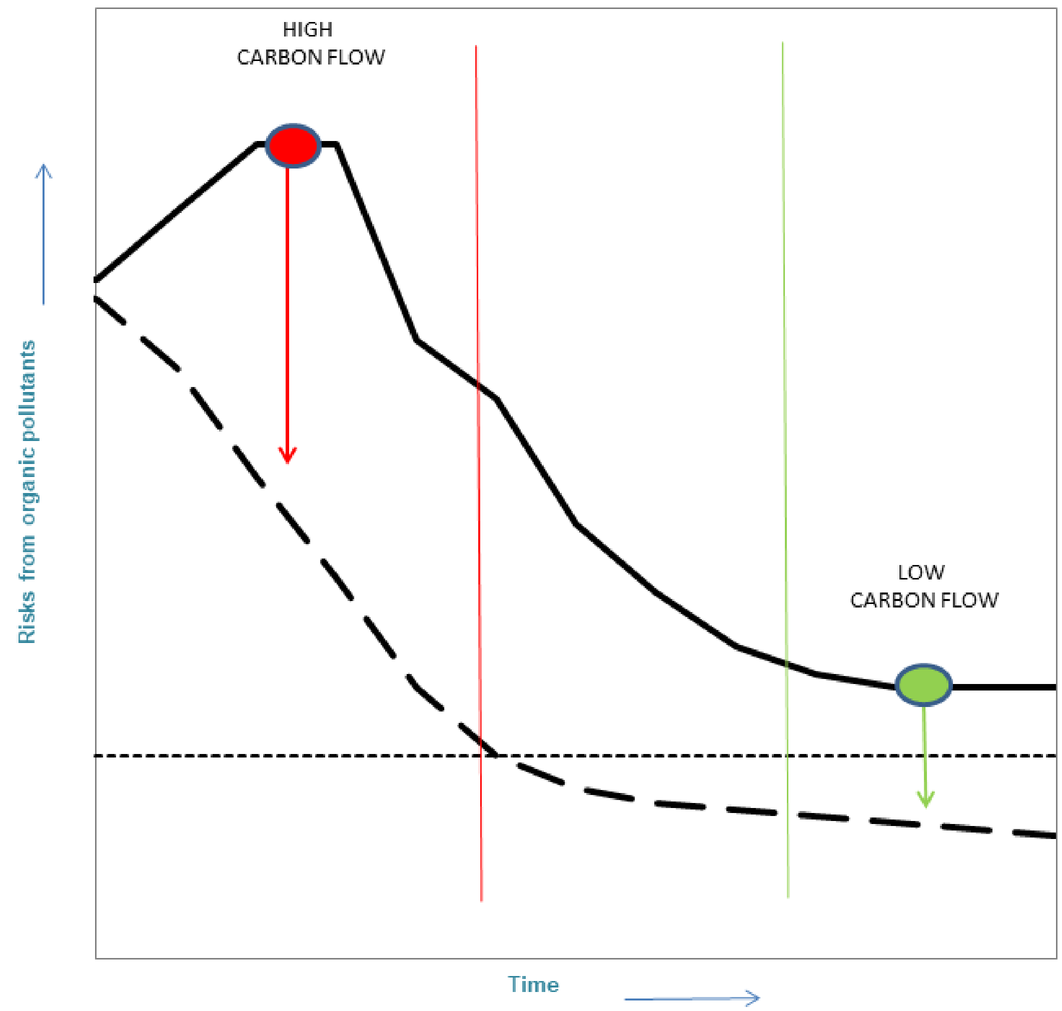
BIODEGRADED

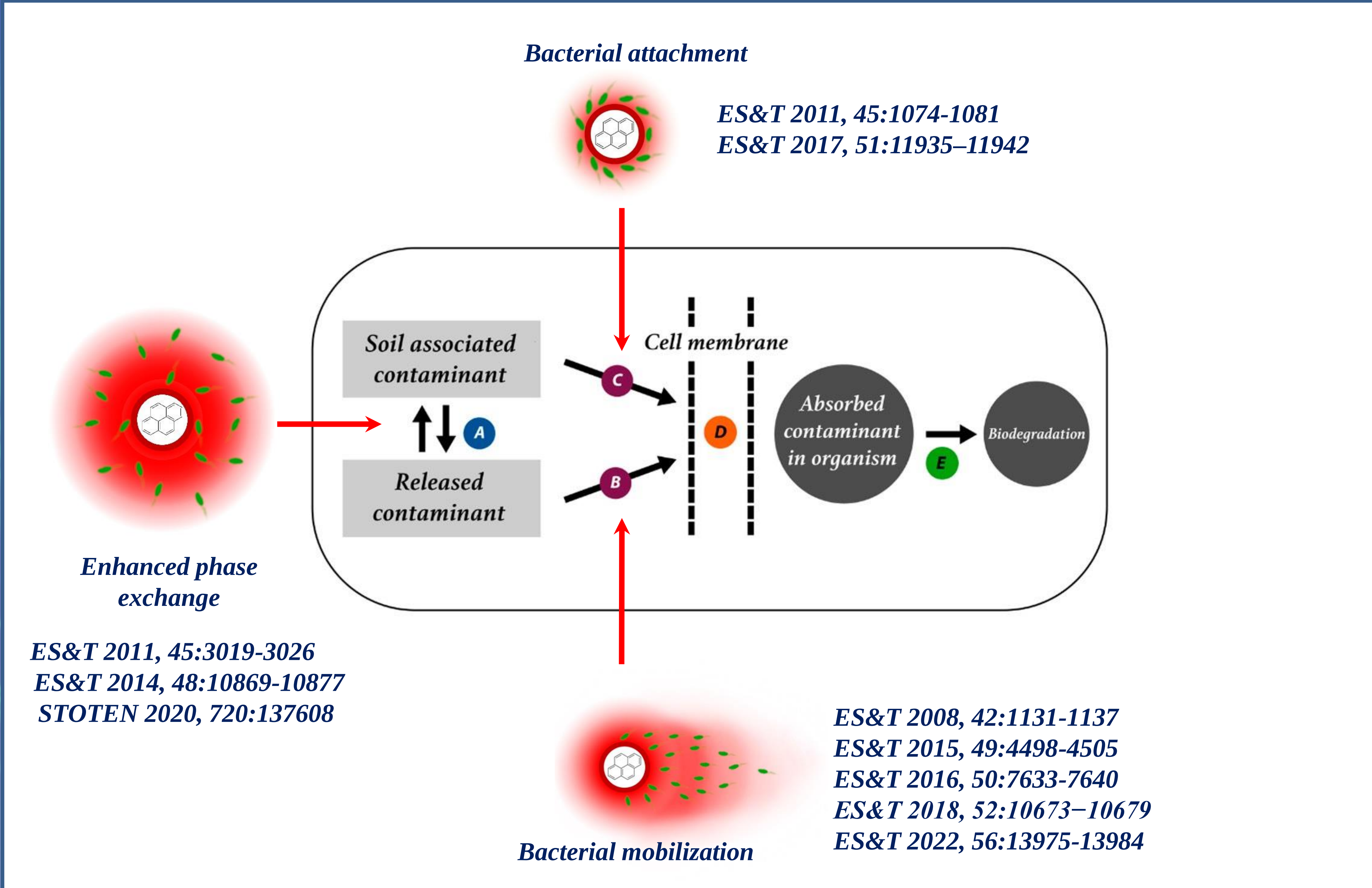
- **-TOXICITY AT POLLUTED SITE**
- **-LOW LEVELS OF NUTRIENT & e- ACCEPTORS**
- **-LOW TOTAL CONCENTRATION OF SUBSTRATE**
- **-LOW BIOAVAILABILITY: SORPTION, NAPLs**

Fate and behaviour of organic contaminants in soil

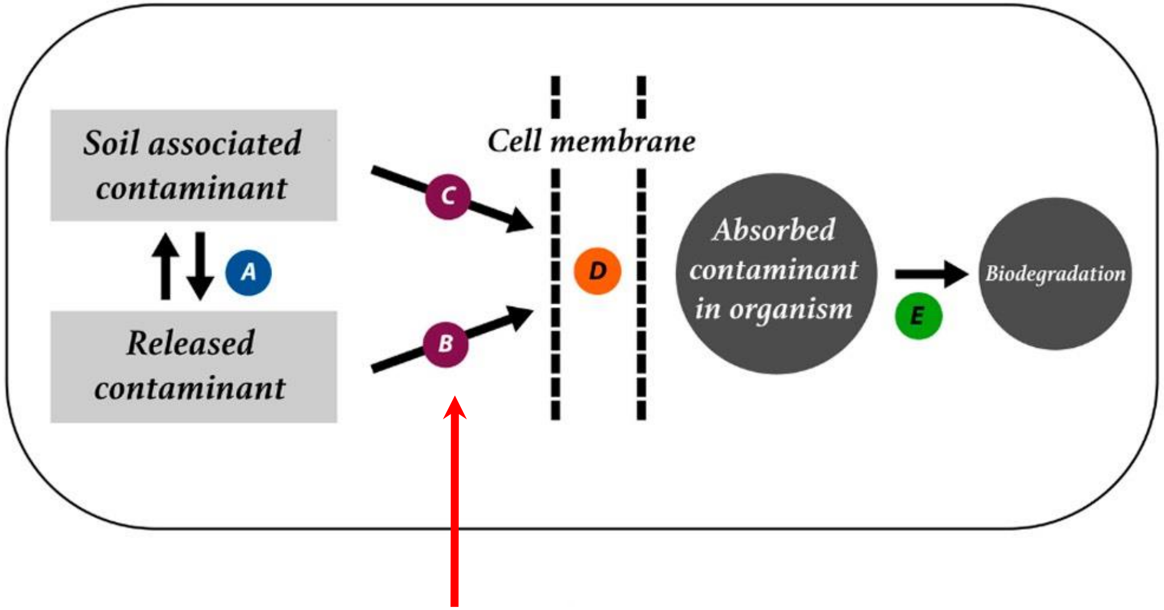


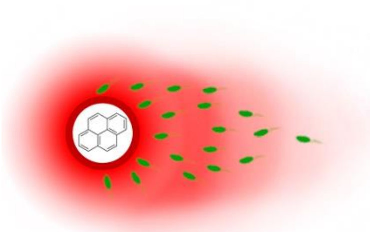
Semple et al., 2003


HIGH
CARBON FLOW
LOW
CARBON FLOW
Risks from organic pollutants
Time



Ortega-Calvo et al. , 2020. Handbook of Environmental Chemistry, 100:243-266

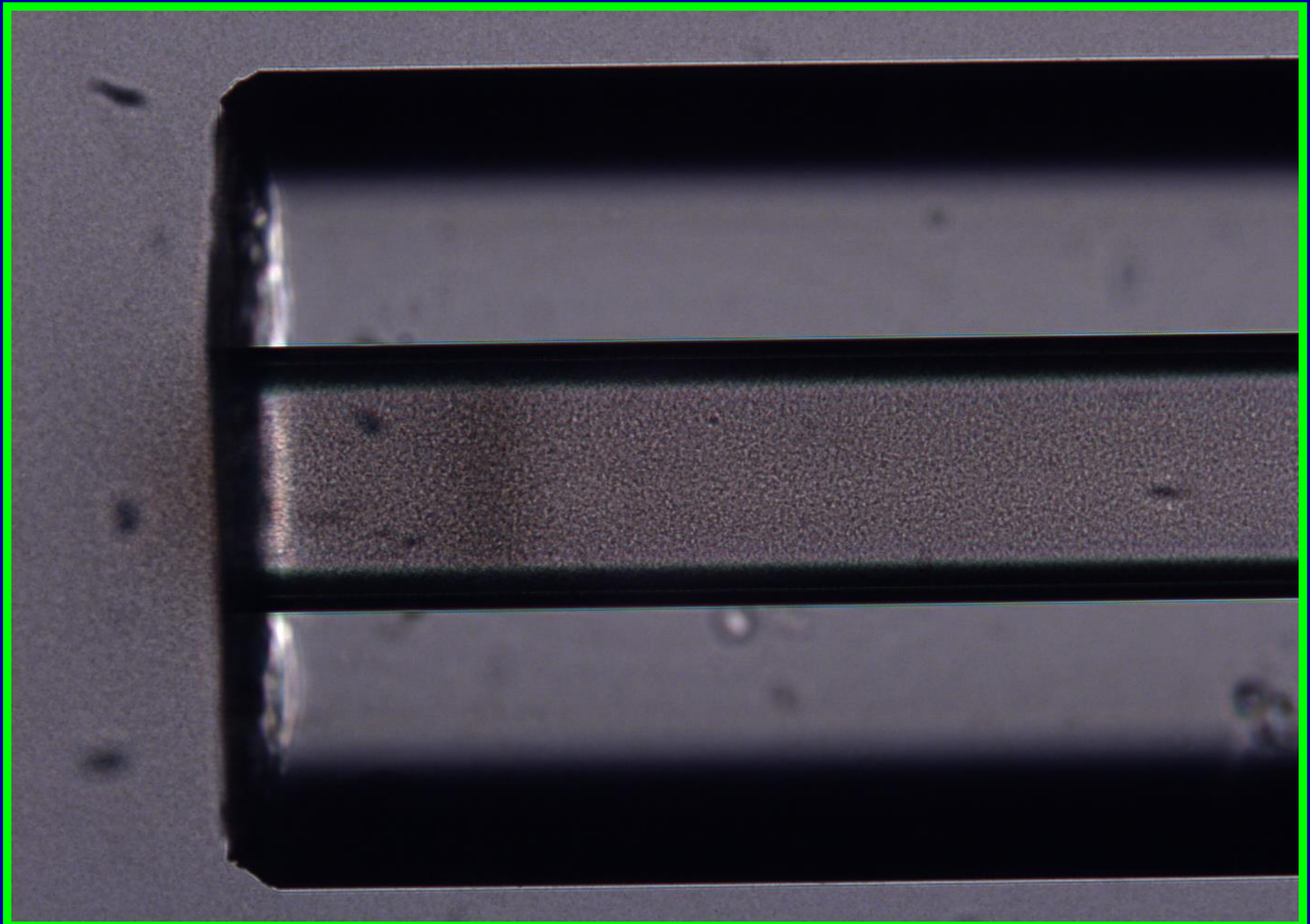




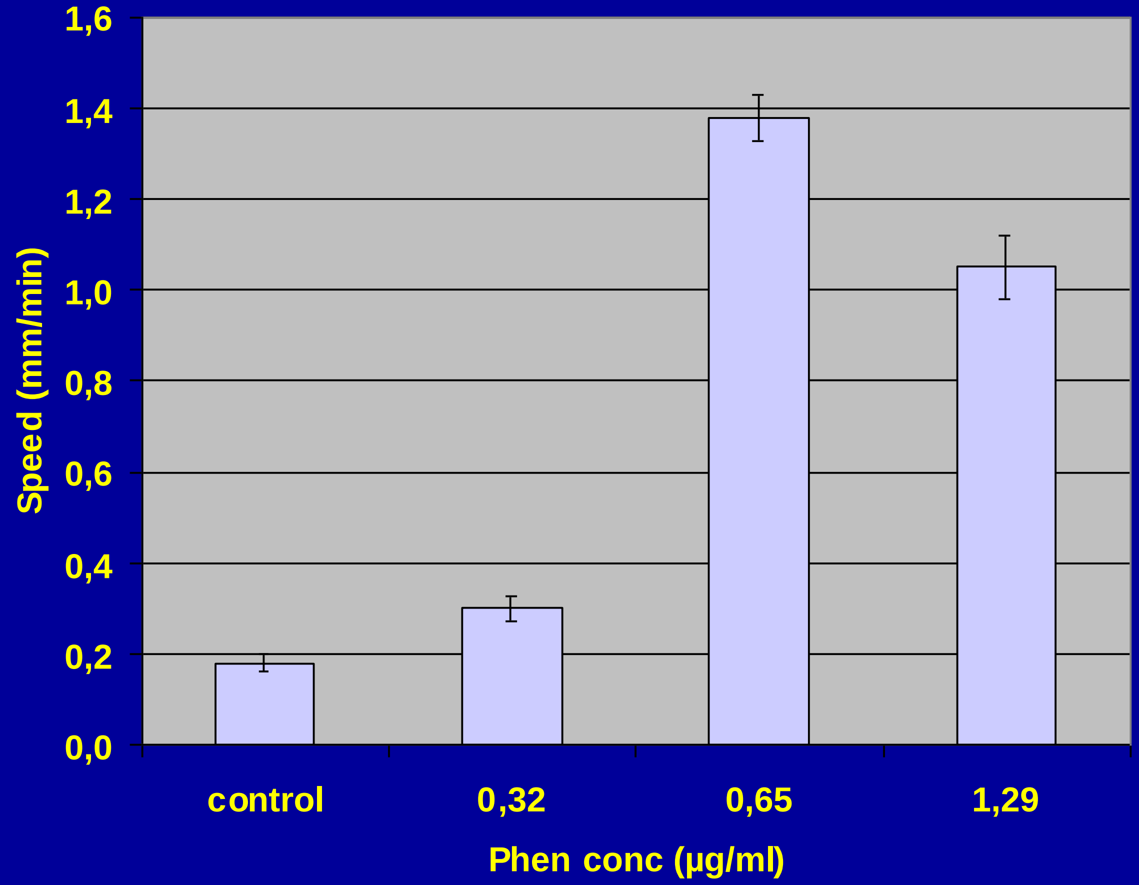
Bacterial mobilization

ES&T 2008, 42:1131-1137
ES&T 2015, 49:4498-4505
ES&T 2016, 50:7633-7640
ES&T 2018, 52:10673−10679
ES&T 2022, 56:13975-13984

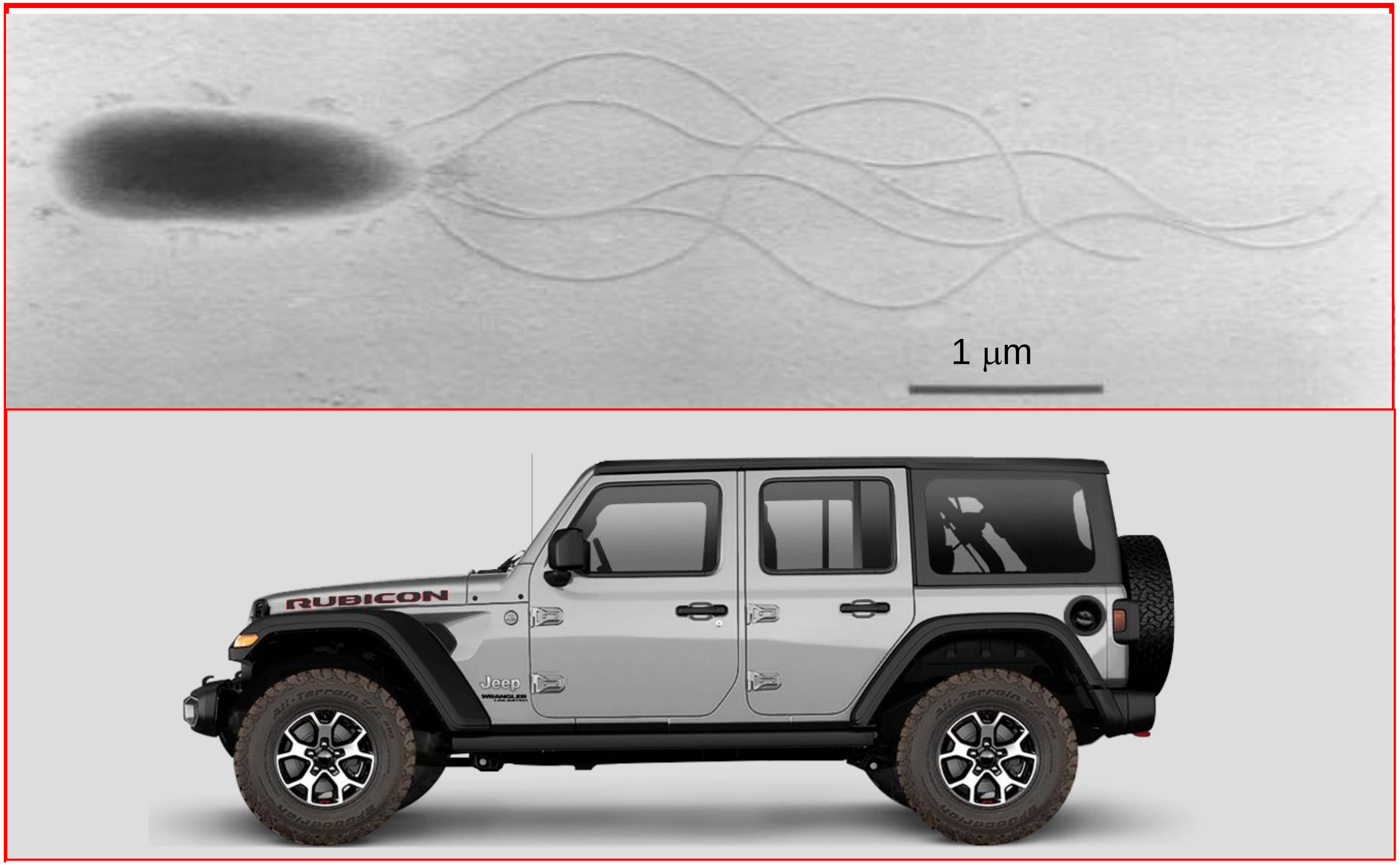
Ortega-Calvo et al. , 2020. Handbook of Environmental Chemistry, 100:243-266

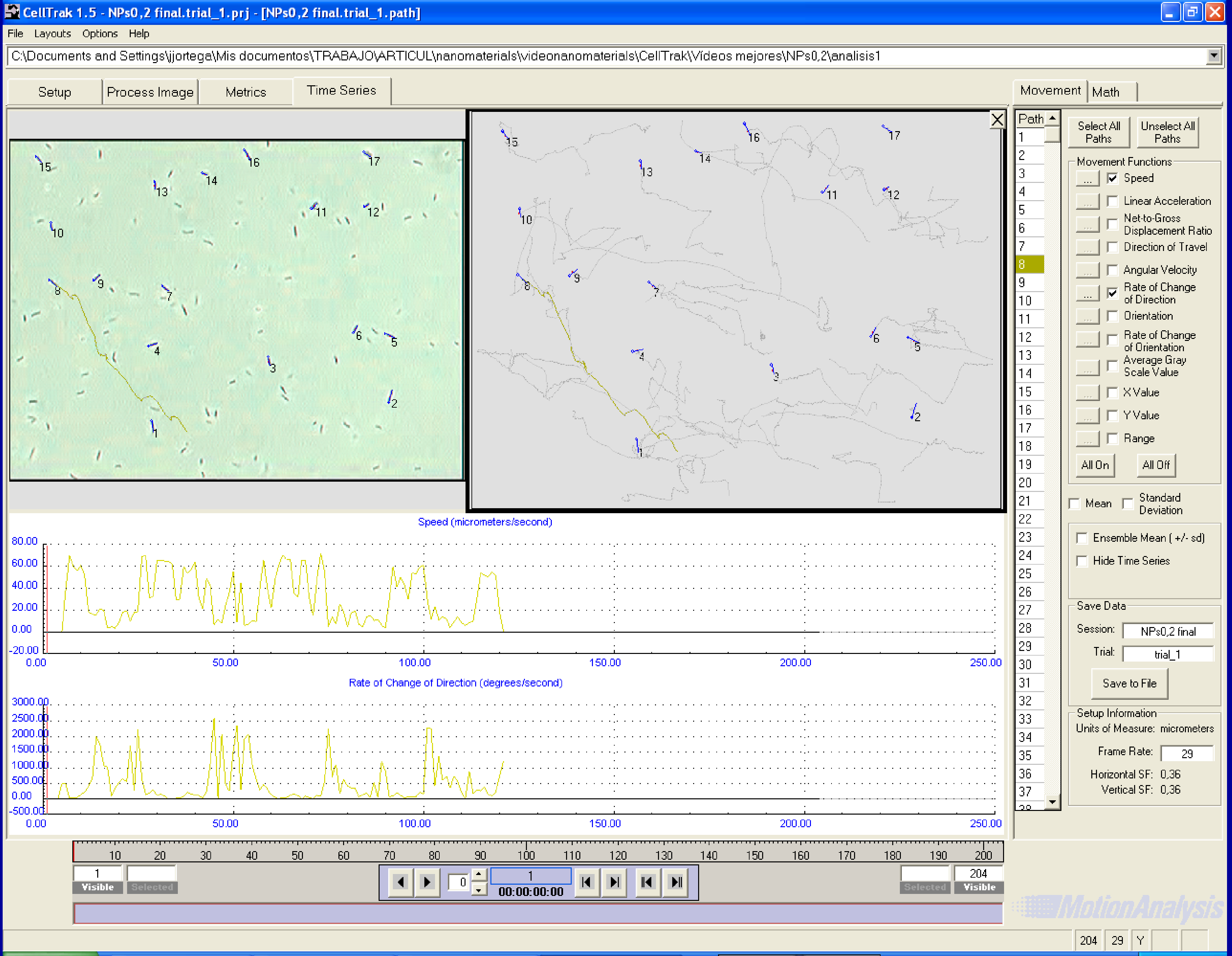


Chemotaxis towards phenanthrene in *Pseudomonas putida* 10D



J.J. Ortega-Calvo, A.I. Marchenko, A.V. Vorobyov, R.V. Borovick, *FEMS Microbiol. Ecol.* 2003, *44*, 373-381


1 μm
RUBICON
Jeep



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Direction of Travel
Angular Velocity
Rate of Change of Direction
Orientation
Rate of Change of Orientation
Average Gray Scale Value
X Value
Y Value
Range
All On
All Off
Mean
Standard Deviation
Ensemble Mean (+/- sd)
Hide Time Series
Save Data
Session: NPs0,2 final
Trial: trial_1
Save to File
Setup Information
Units of Measure: micrometers
Frame Rate: 29
Horizontal SF: 0,36
Vertical SF: 0,36
Speed (micrometers/second)
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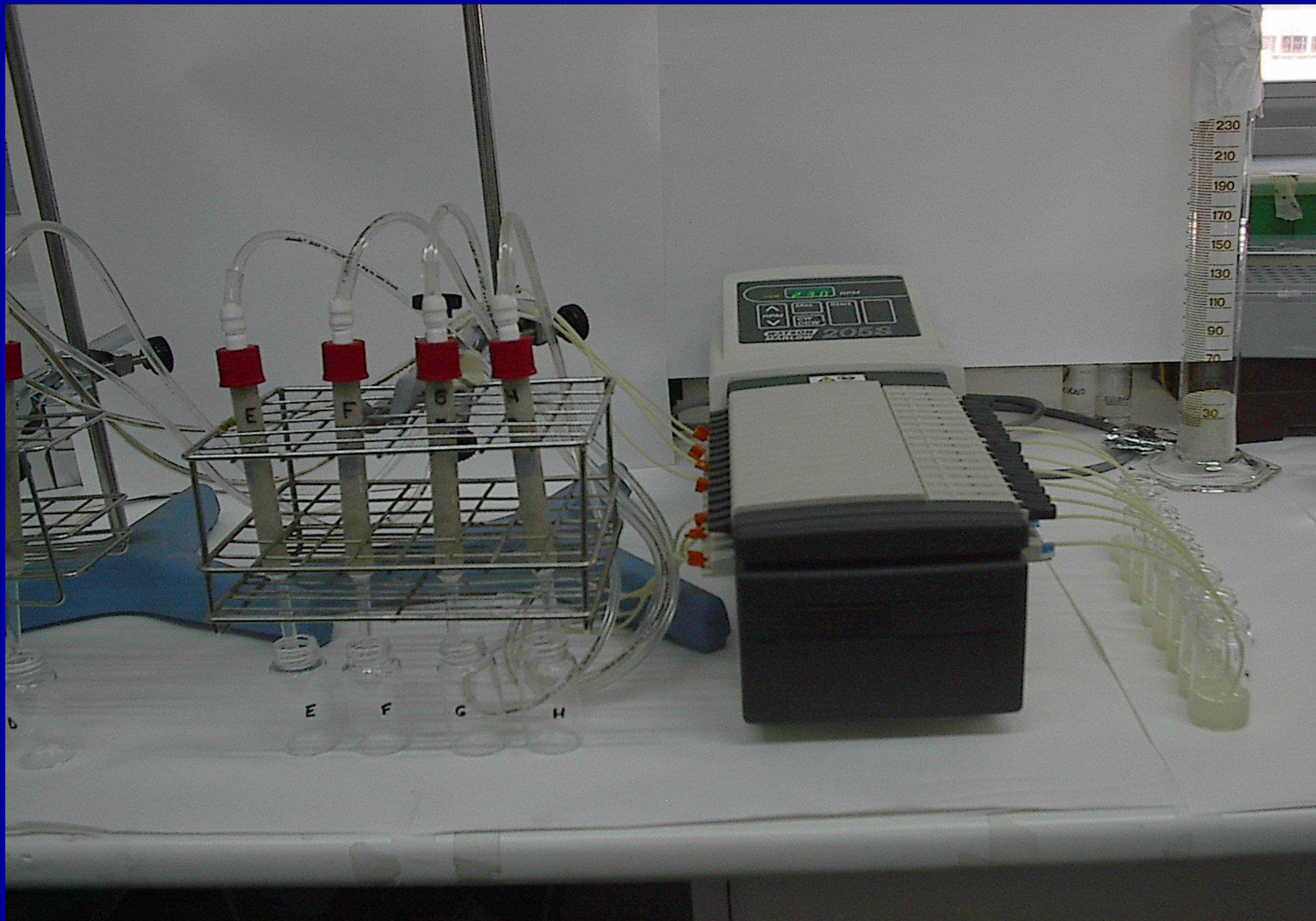
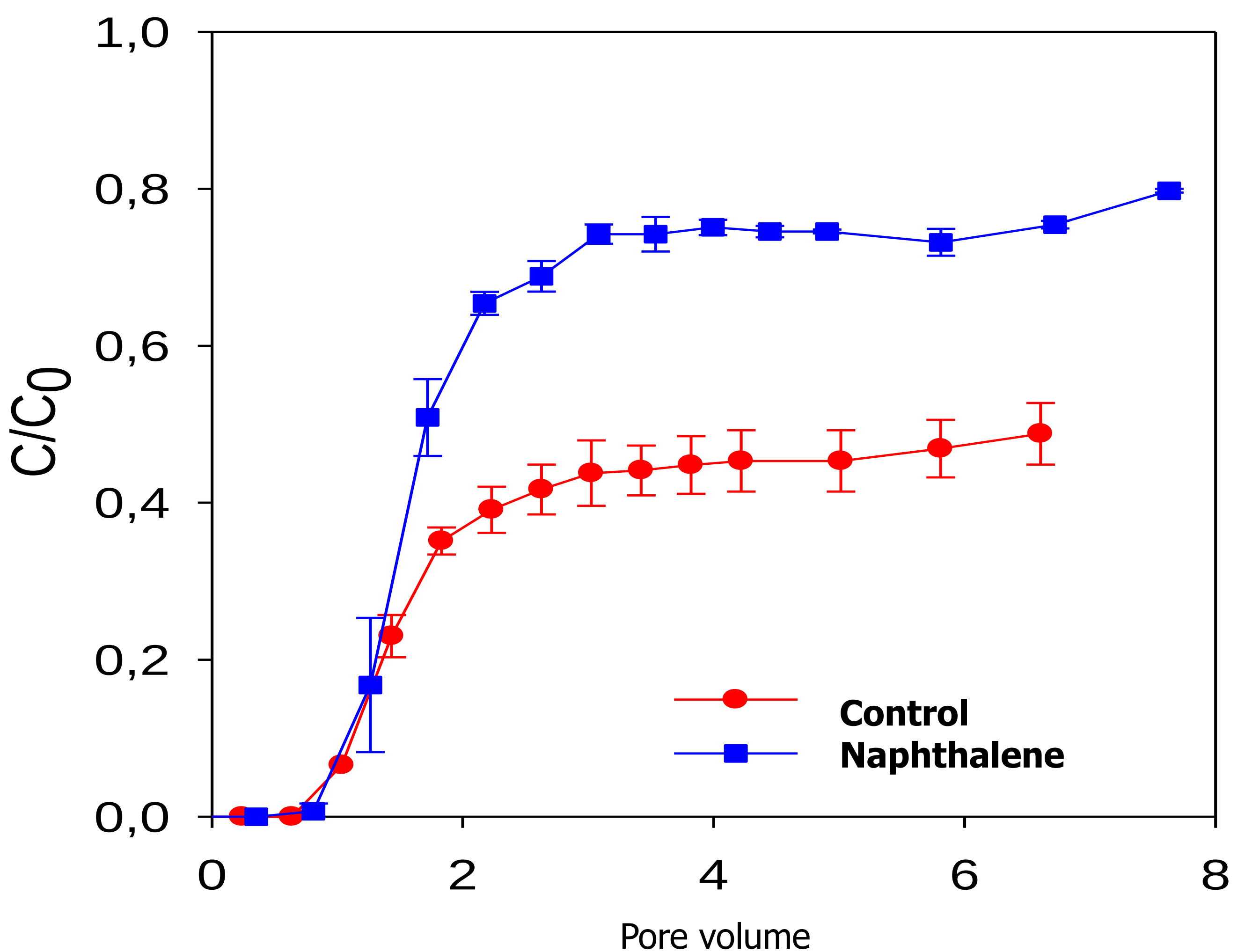
CHEMOTAXIS
COLUMN METHOD



P. Velasco-Casal et al., *Environ. Sci. Technol.* 2008, 42:1131-1137

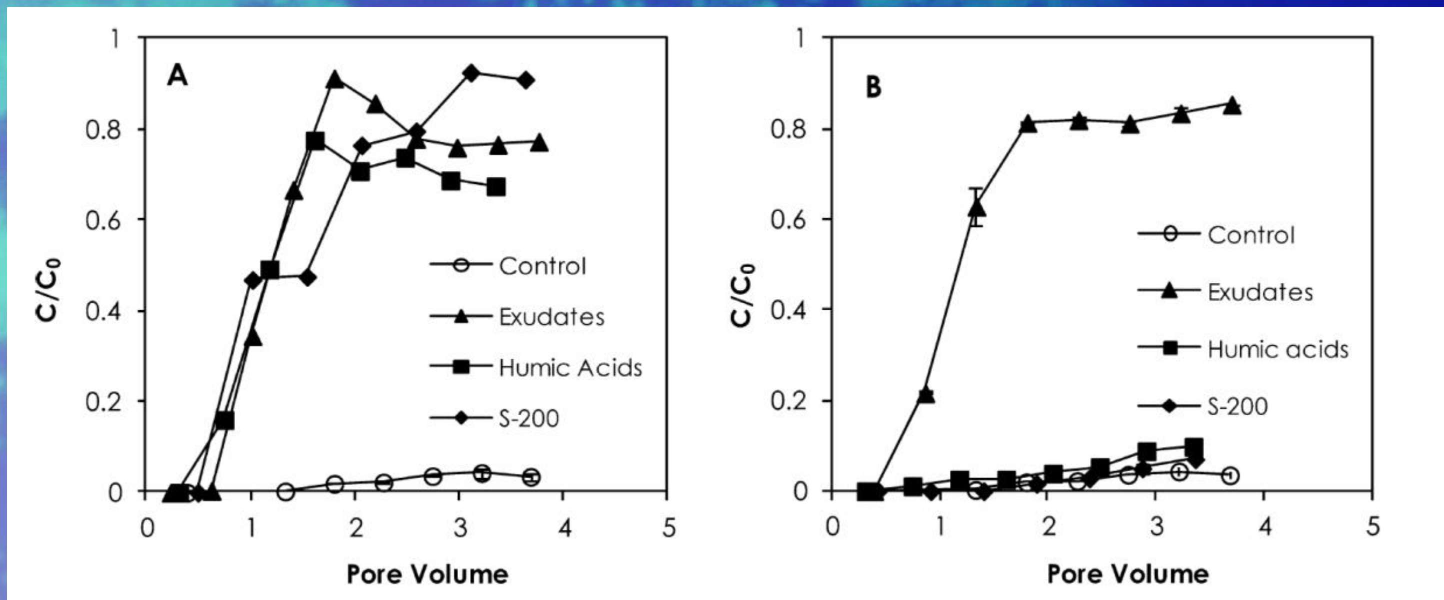
BREAKTHROUGH CURVES OF *PSEUDOMONAS PUTIDA* G7 TRANSPORTED THROUGH SAND COLUMNS: NAPHTHALENE

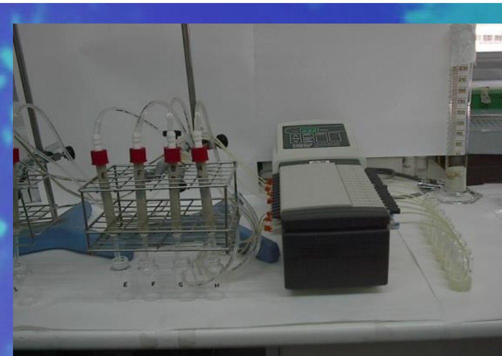


C. Jimenez-Sanchez et al. *Environ. Sci. Technol.* , 2015, 49:4498-4505

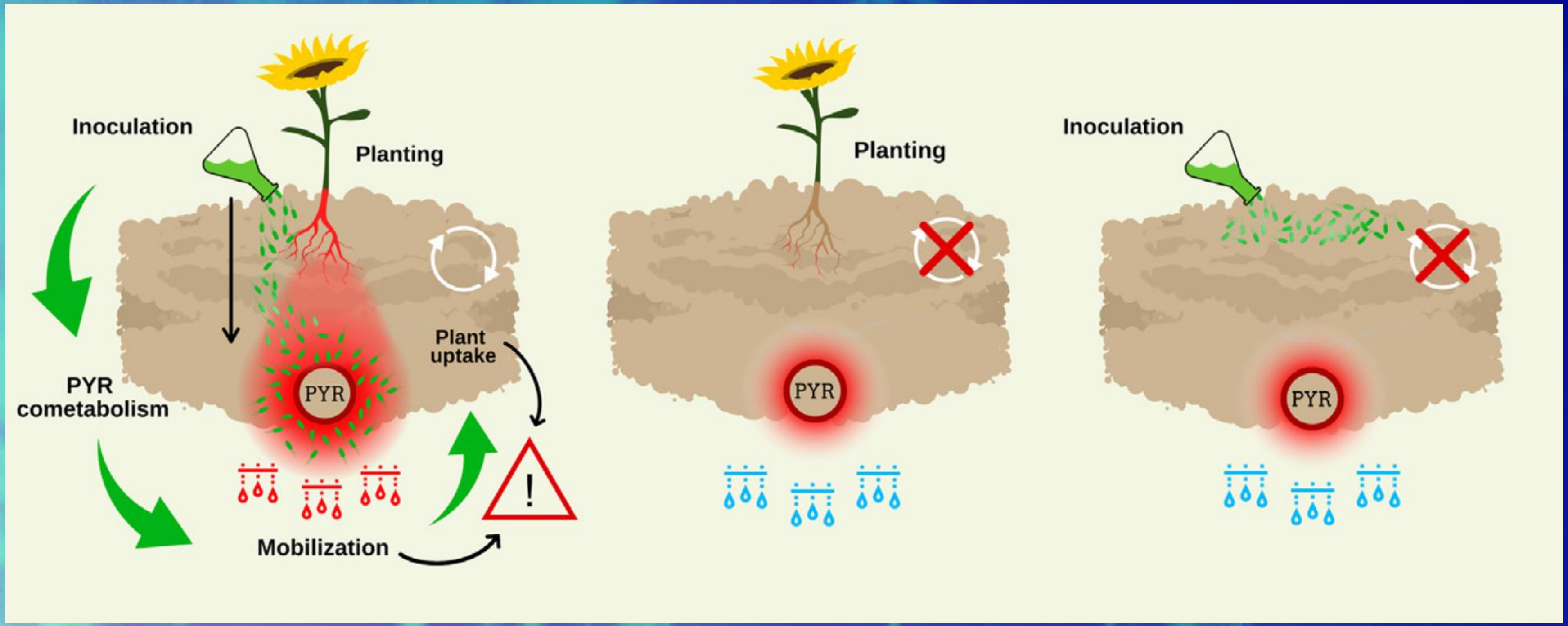
BREAKTHROUGH CURVES OF *PSEUDOMONAS PUTIDA* G7 TRANSPORTED THROUGH SAND COLUMNS: EXUDATES FROM *HELIANTHUS ANNUUS* VS. OTHER DOM SOURCES

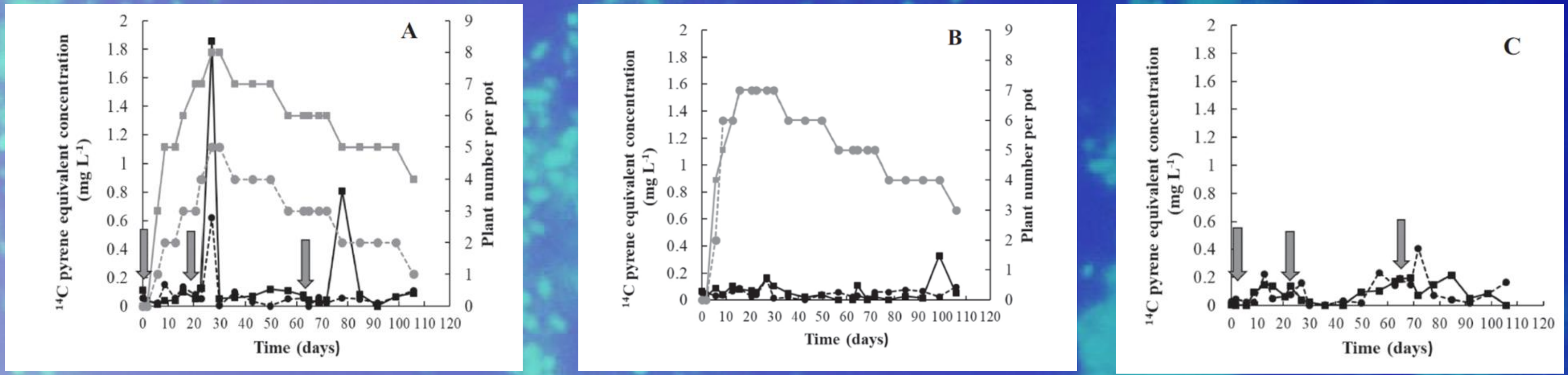
High TOC (100 mg/L) **Low TOC (10 mg/L)**



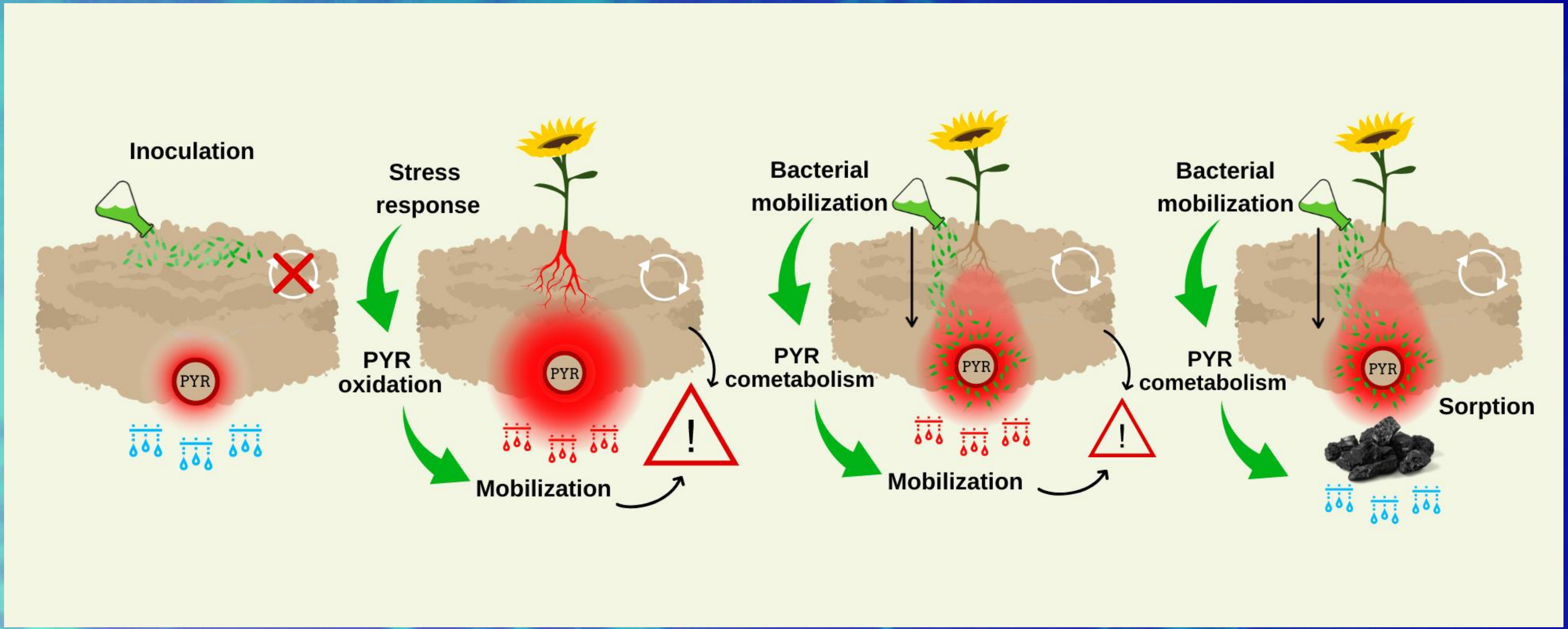


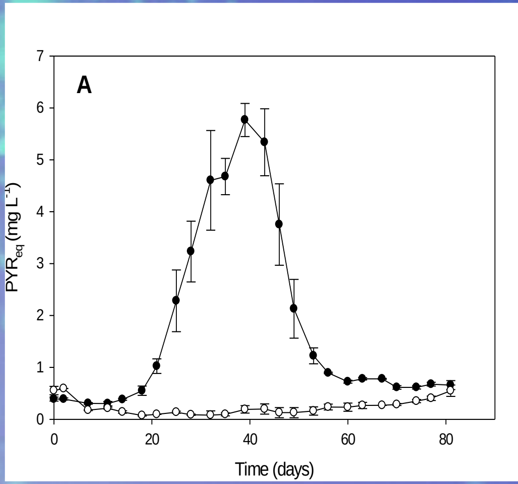
Fernandez-Lopez et al. *Sci. Total Environ.*, 2021. 760, 143408

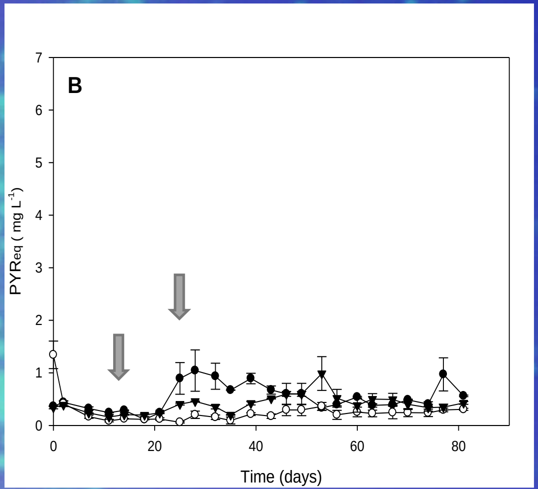


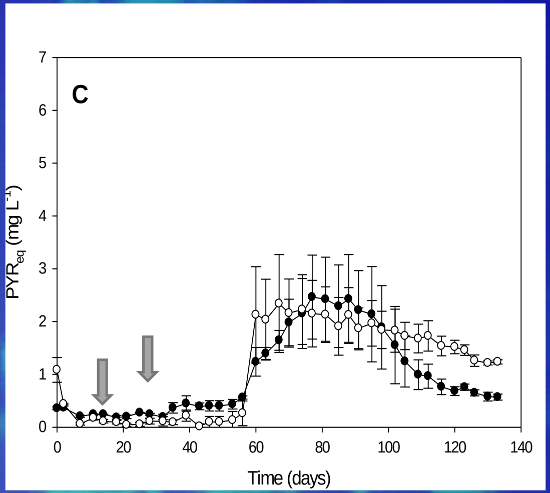


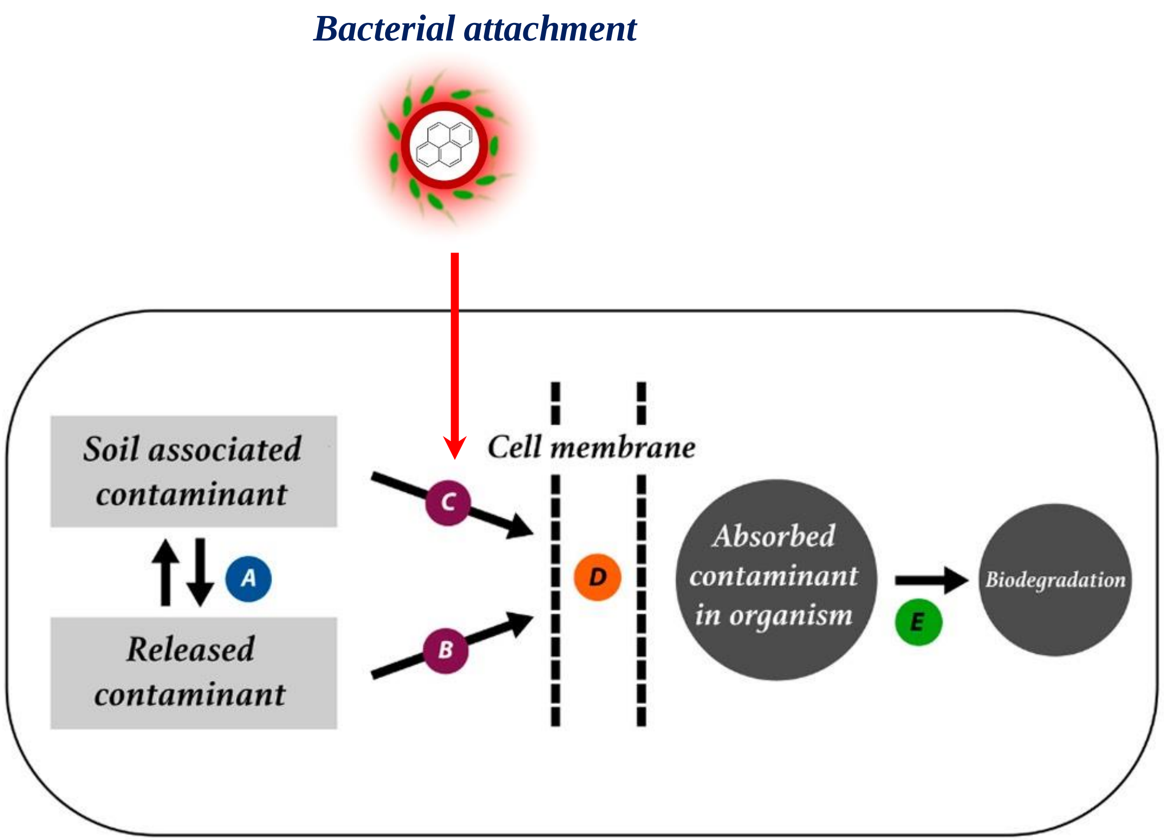
Castilla-Alcantara et al. *Sci Total Environ* 868 (2023) 161600





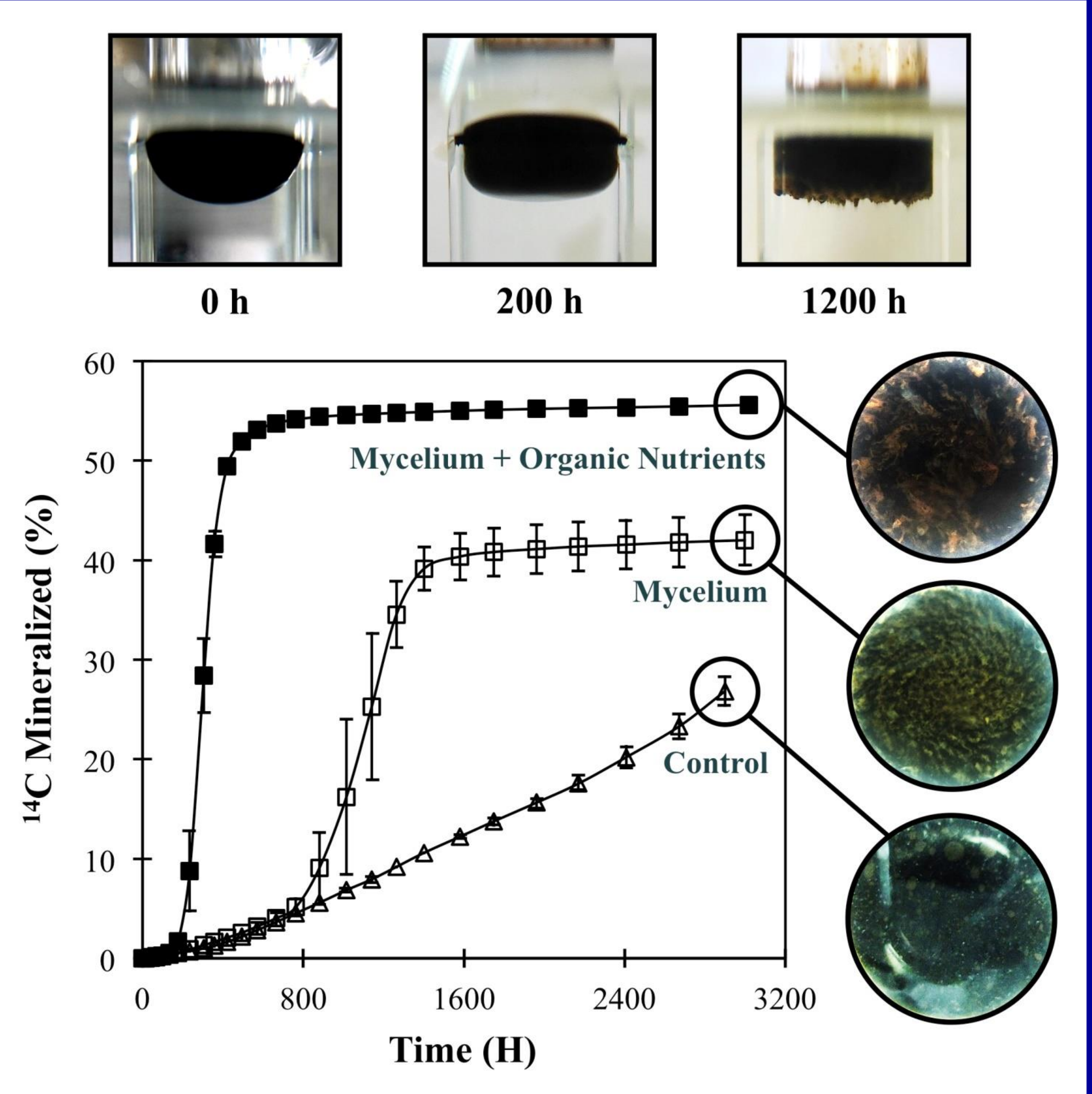




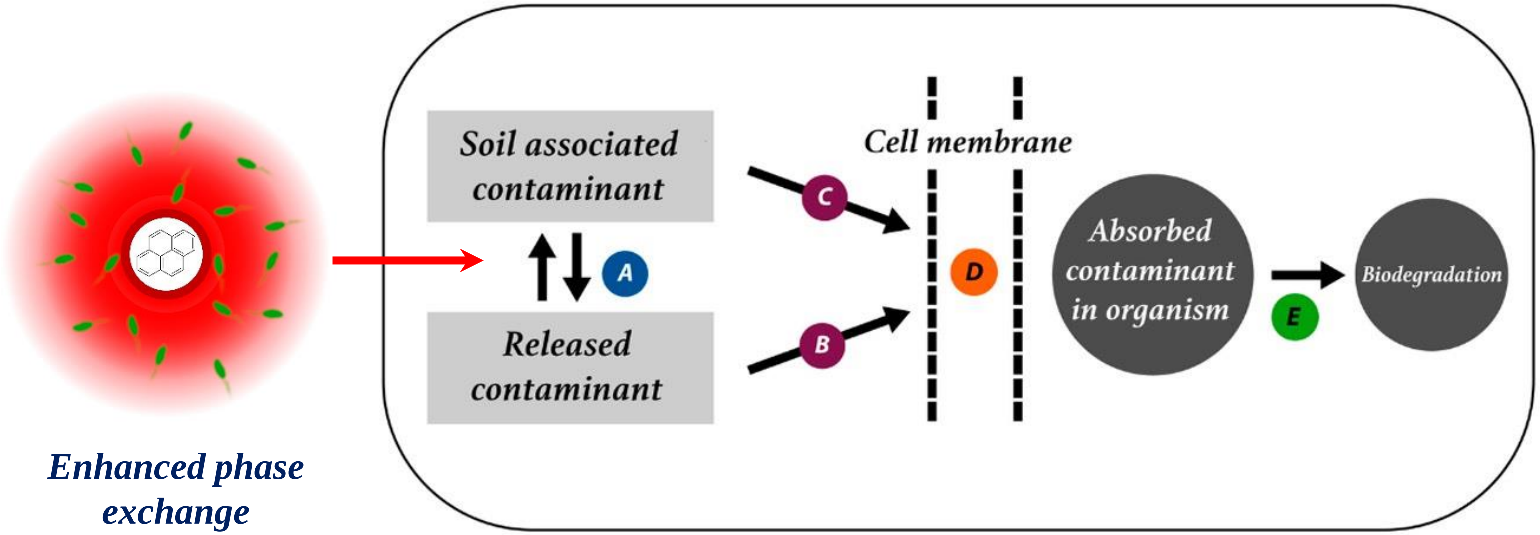


Ortega-Calvo et al. , 2020. Handbook of Environmental Chemistry, 100:243-266

Mycelium-enhanced bacterial degradation of polycyclic aromatic hydrocarbons



Sungthong et al., *Environ. Sci. Technol.*, 2017, *51*, 11935–11942



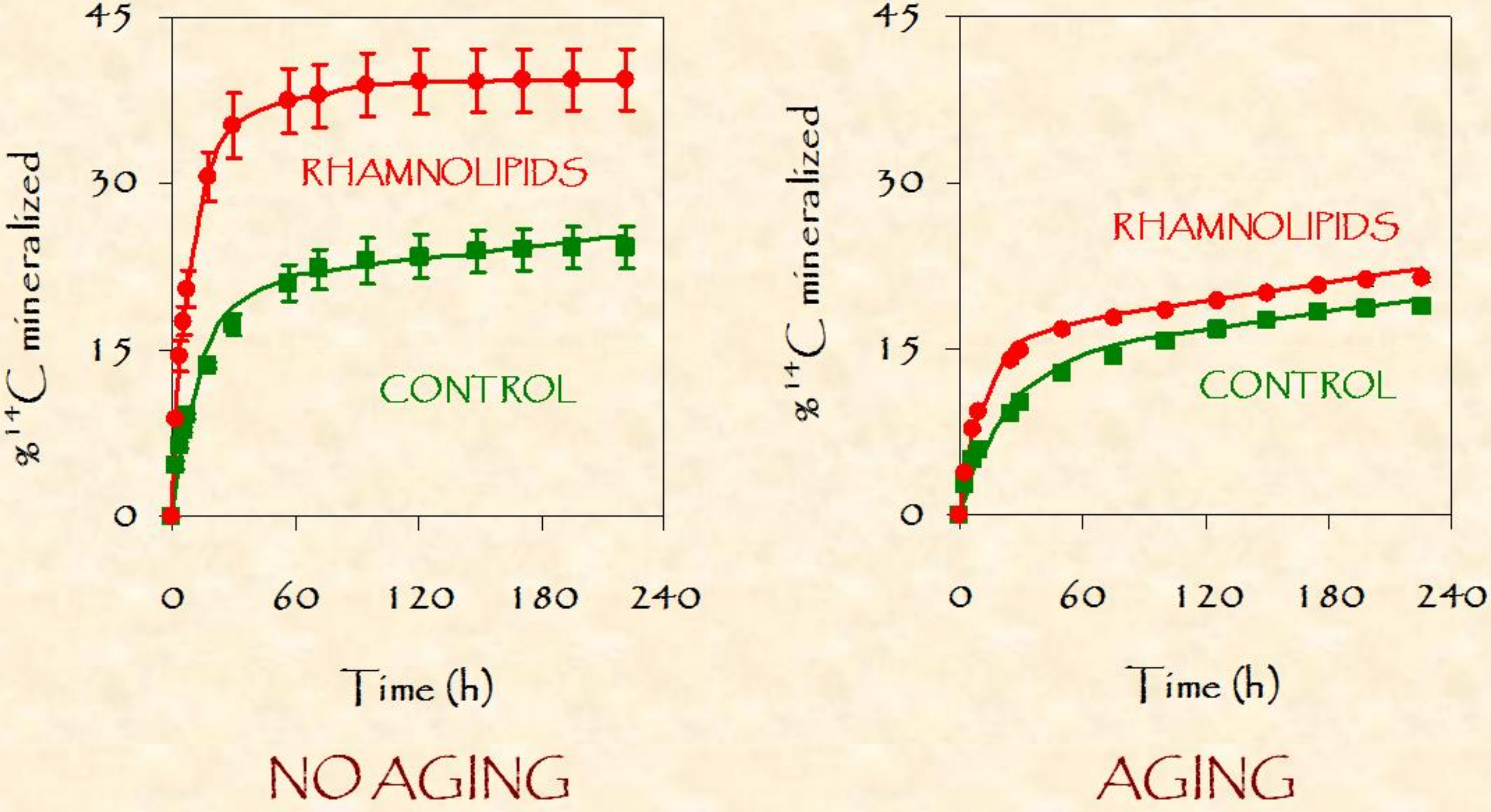
Enhanced phase exchange

ES&T 2011, 45:3019-3026
ES&T 2014, 48:10869-10877
STOTEN 2020, 720:137608

Ortega-Calvo et al. , 2020. Handbook of Environmental Chemistry, 100:243-266

E. Congiu & J.J. Ortega-Calvo, *Environ. Sci. Technol.* , 2014, 45:3019-3026

BIOSURFACTANTS INFLUENCE ON BIOAVAILABILITY OF SORBED PYRENE: ROLE OF DESORPTION KINETICS



Posada-Baquero et al. *Sci. Total Environ.*, 2020. 720, 137608

RHIZOSPHERE-ENHANCEMENT OF BIOSURFACTANT ACTION

1. BIODEGRADATION

1.A EVOLUTION OF TOTAL PAHs CONCENTRATION (SOXHLET EXTRACTION & HPLC), EFFECT OF PLANTING (SUNFLOWERS) AND BIOSURFACTANTS ADDITION (RHAMNOLIPIDS AT 7 mg/g) AFTER PLANT ONTOGENETIC CYCLE

1.B SEPARATE SLURRY EXPERIMENTS (EXCESS OF NUTRIENTS, SHAKING, RADIORESPIROMETRY AND ANALYSIS OF RESIDUAL CONCENTRATIONS)

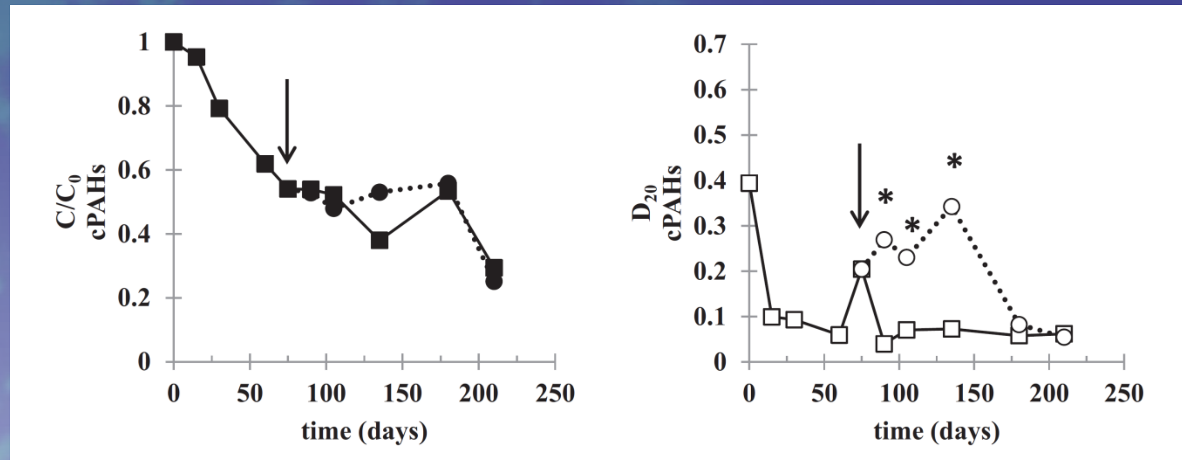
2. BIOAVAILABILITY

DESORPTION EXTRACTION (ISO 16751)
KINETICS AND SINGLE-POINT EXTRACTION AT 20 H

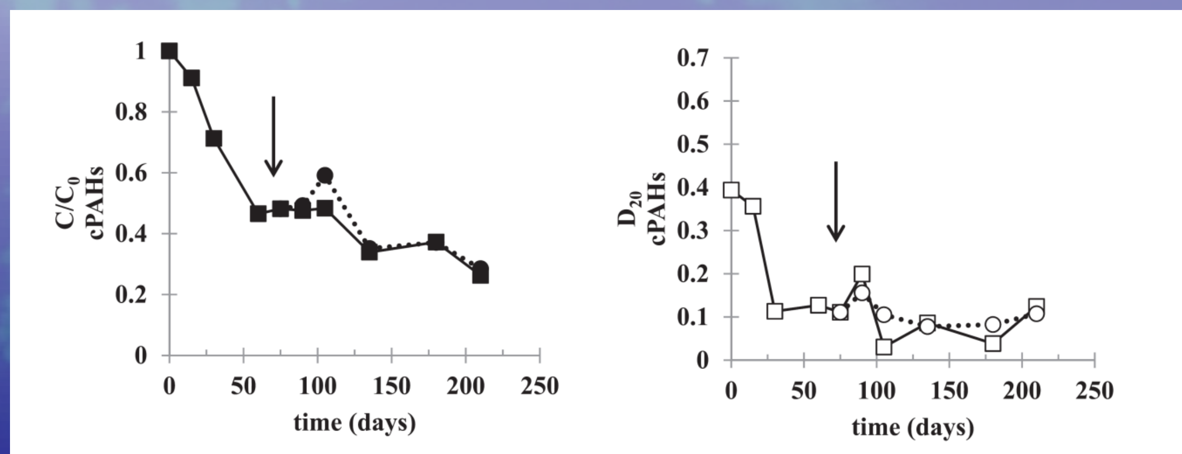
Posada-Baquero et al. *Sci. Total Environ.*, 2020. 720, 137608

RHIZOSPHERE-ENHANCEMENT OF BIOSURFACTANT ACTION

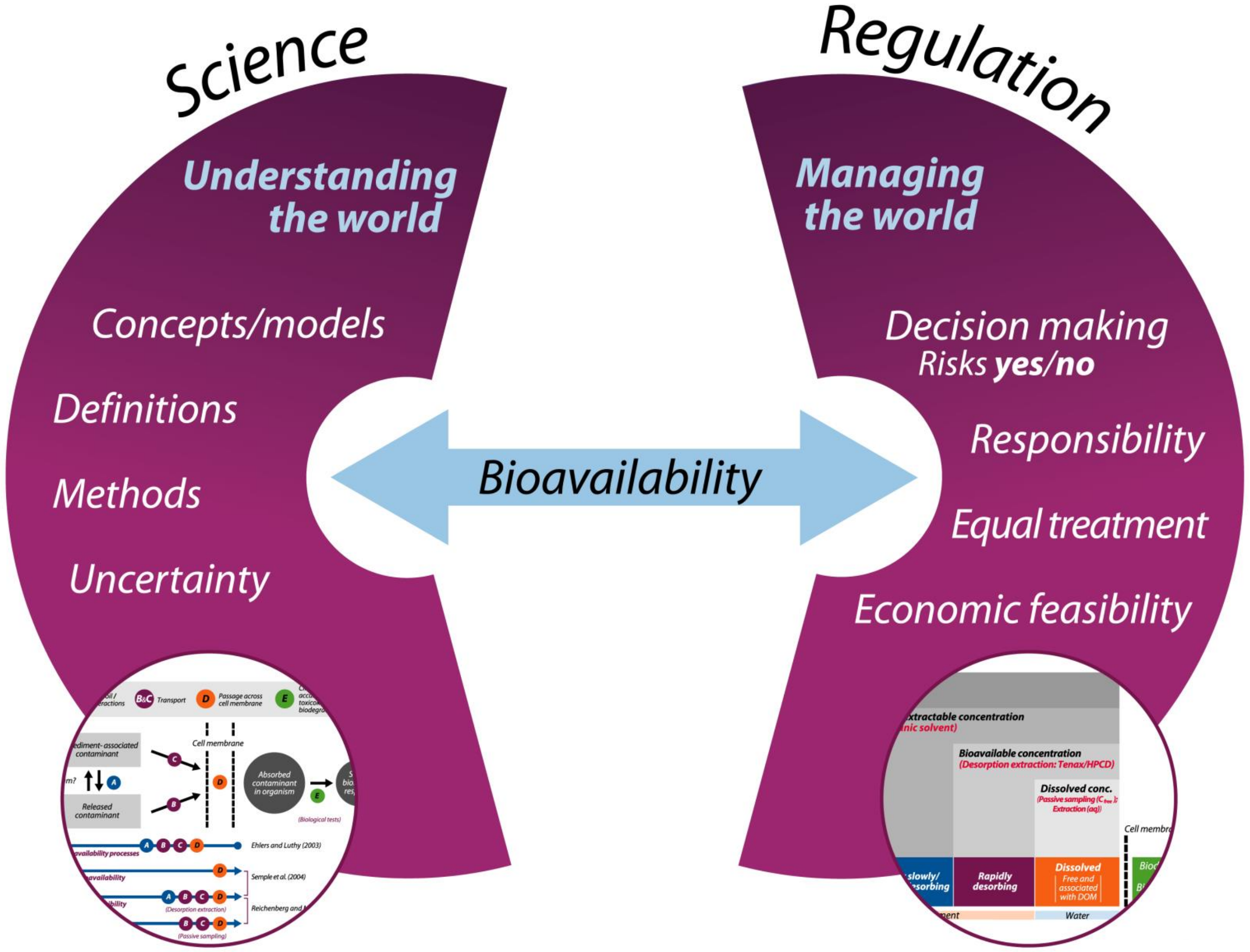
PLANTED



UNPLANTED



BRINGING DIFFERENT WORLDS TOGETHER



Ortega-Calvo et al. ES&T, 2015. 49, 10255-10264

BIOAVAILABILITY: REGULATION

Soil quality — Environmental availability of non-polar organic compounds — Determination of the potentially bioavailable fraction and the non-bioavailable fraction using a strong adsorbent or complexing agent

INTERNATIONAL STANDARD

ISO 16751

First edition
2020-06

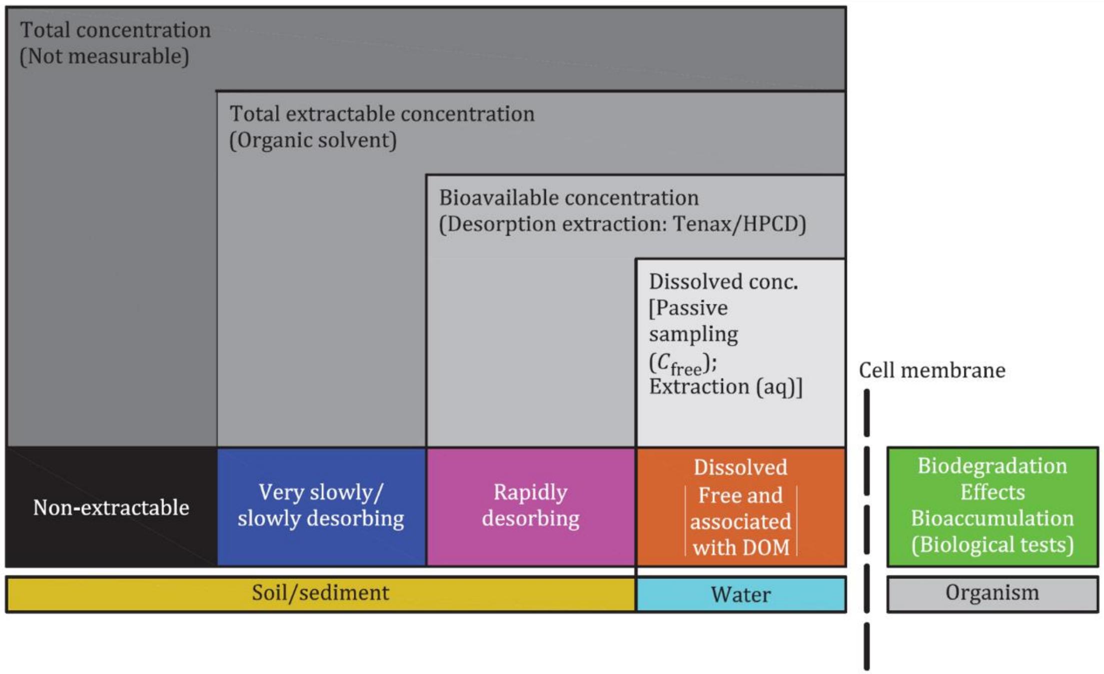


Figure 2 — Measurement of bioavailability of organic chemicals: a simplified scheme for use in regulation [Source: Ortega-Calvo et al. (2015)]

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BIOAVAILABILITY: REGULATION

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Received: 11 February 2021 | Revised: 29 September 2021 | Accepted: 6 December 2021 1

Critical Review

Scientific concepts and methods for moving persistence assessments into the 21st century

Russell Davenport,[1] Pippa Curtis-Jackson,[2] Philipp Dalkmann,[3] Jordan Davies,[4] Kathrin Fenner,[5,6] Laurence Hand,[7] Kathleen McDonough,[8] Amelie Ott,[1,9] Jose Julio Ortega-Calvo,[10] John R. Parsons,[11] Andreas Schäffer,[12] Cyril Sweetlove,[13] Stefan Trapp,[14] Neil Wang,[15] and Aaron Redman[16]

[1]School of Engineering, Newcastle University, Newcastle upon Tyne, UK
[2]Environment Agency, Wallingford, Oxfordshire, UK
[3]Bayer AG, Crop Science Division, Environmental Safety, Monheim, Germany
[4]LyondellBasell, Rotterdam, The Netherlands
[5]Eawag, Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland
[6]Department of Chemistry, University of Zürich, Zürich, Switzerland
[7]Syngenta, Product Safety, Jealott's Hill International Research Centre, Bracknell, UK
[8]P&G, Global Product Stewardship, Mason, Ohio, USA
[9]European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC), Brussels, Belgium
[10]Instituto de Recursos Naturales y Agrobiología de Sevilla, Consejo Superior de Investigaciones Científicas, Sevilla, Spain
[11]Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, The Netherlands
[12]RWTH Aachen University, Institute for Environmental Research, Aachen, Germany
[13]L'Oréal Research & Innovation, Environmental Research Department, Aulnay-sous-Bois, France
[14]Department of Environmental Engineering, Technical University of Denmark, Bygningstorvet, Lyngby, Denmark
[15]Total Marketing & Services, Paris la Défense, France
[16]ExxonMobil Petroleum and Chemical, Machelen, Belgium

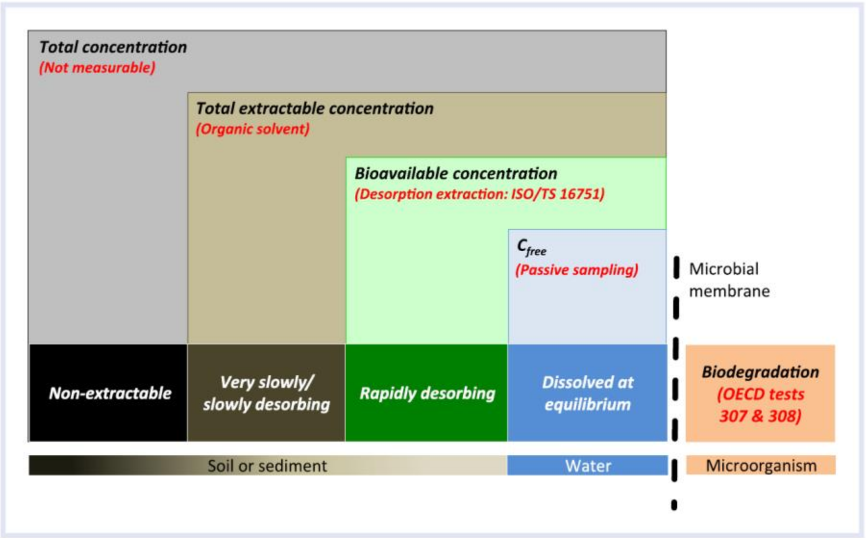

FIGURE 2 Proposal for integrating bioavailability science into OECD simulation tests, by incorporating desorption ISO methods and passive sampling determinations into the standard simulation tests for soils (OECD TG 307) and sediments (OECD TG 308). C_{free}, freely dissolved concentration at equilibrium. Figure reproduced with permission from Ortega-Calvo et al. (2020)

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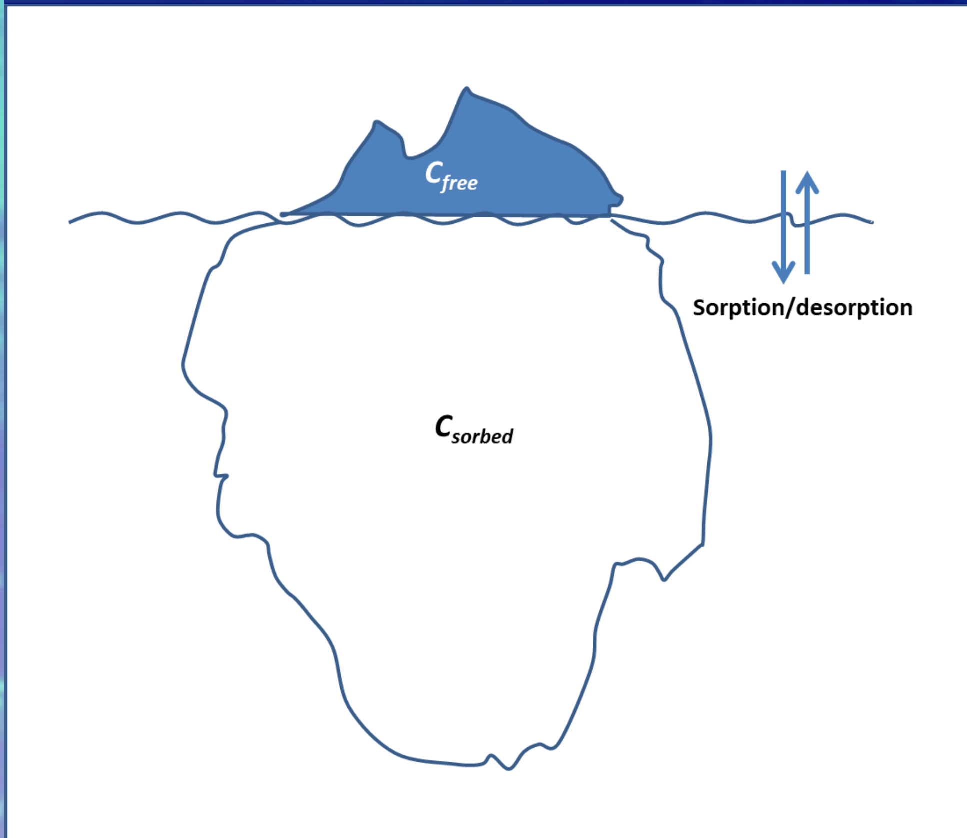
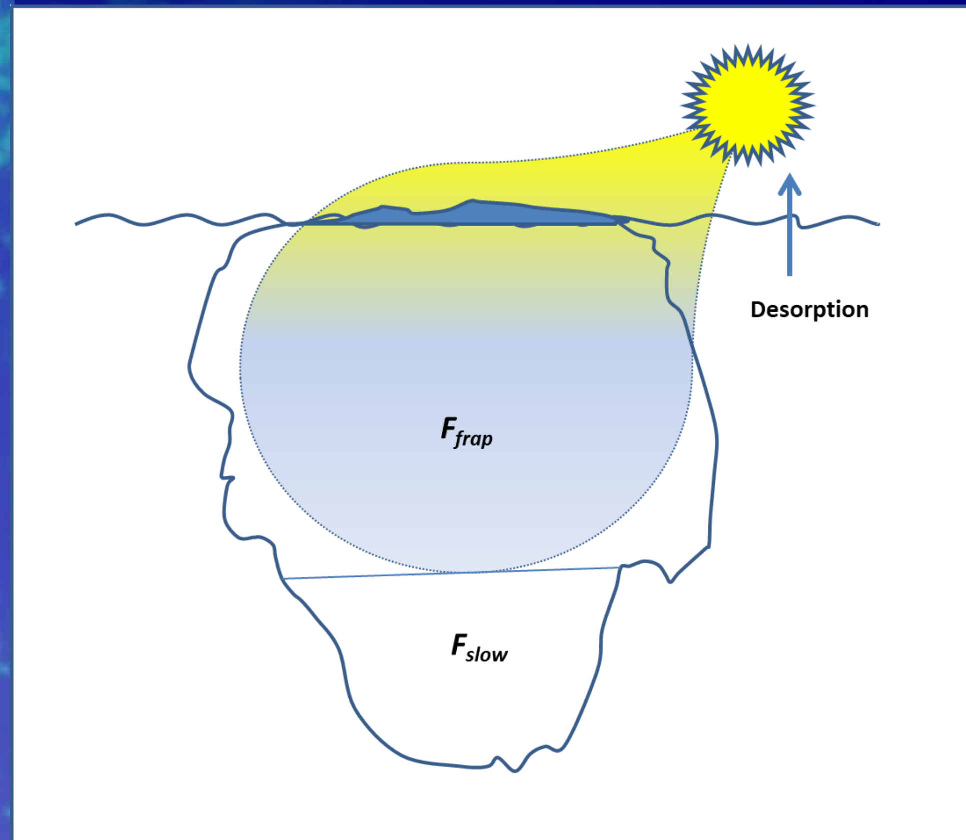
C_{free}



F_{rap}



Ortega-Calvo, 2019. Environmental Toxicology. Chapter 3.6.2. Assessing available concentrations of organic chemicals.
https://maken.wikiwijs.nl/147644/Environmental_Toxicology__an_open_online_textbook#!page-5415216

PASSIVE SAMPLING UPDATE

- Non-depletive, equilibrium based
- Solid polymers: polydimethylsiloxane, polyethylene, polyoxymethylene, polyacrylate, silicone rubber, as fibers or membranes
- In situ or ex situ
- Bioavailability defined as C_{free}, obtained at equilibrium (weeks), calculated from polymer-to-water partitioning coefficient
- Basis for bioaccumulation predictions based on EqP, for sediment toxicity/test exposures, and for sediment remediation goals (through K_{oc})
- No standard method available

nature protocols

PROTOCOL

https://doi.org/10.1038/s41596-020-0311-y

Check for updates

Ex situ determination of freely dissolved concentrations of hydrophobic organic chemicals in sediments and soils: basis for interpreting toxicity and assessing bioavailability, risks and remediation necessity

Michiel T. O. Jonker[1], Robert M. Burgess[2], Upal Ghosh[3], Philip M. Gschwend[4], Sarah E. Hale[5], Rainer Lohmann[6], Michael J. Lydy[7], Keith A. Maruya[8], Danny Reible[9] and Foppe Smedes[10]

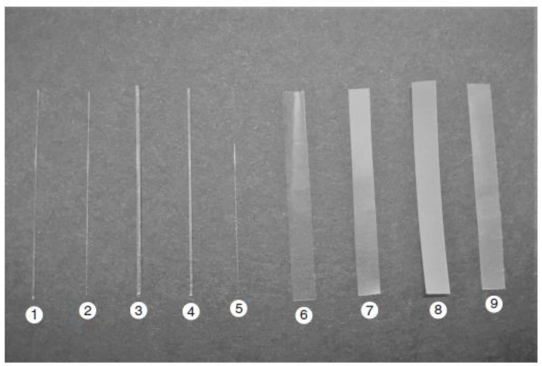
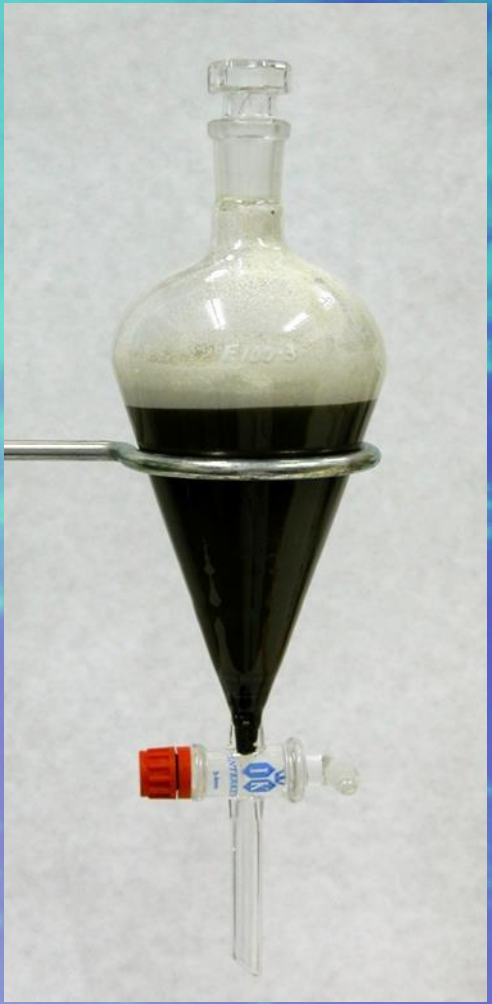


Fig. 1 | Photograph of different passive samplers. From left to right: (1) 10-μm PDMS-coated SPME fiber (core thickness, 200 μm), (2) 30-μm PDMS-coated SPME fiber (core thickness, 100 μm), (3) 30-μm PDMS-coated SPME fiber (core thickness, 500 μm), (4) 100-μm PDMS-coated SPME fiber (core thickness, 200 μm), (5) 30-μm polyacrylate-coated SPME fiber (core thickness, 100 μm), (6) 25-μm-thick PE, (7) 50-μm-thick PE, (8) 77-μm-thick POM, (9) 100-μm-thick PDMS. All samplers are 4 cm long. The four sheet samplers are approximately 5 mm wide; their weights are approximately 5 mg (6), 8 mg (7), 20 mg (8), and 20 mg (9).

Jonker et al. *Nature Protocols,* 15, 1800-1828 (2020)

PASSIVE SAMPLING UPDATE

- Consensus protocol, ring-tested by leading scientists in the field
- Key protocol considerations:
  - Polymer selection & preconditioning
  - Incubation conditions (e.g., equilibration)
  - Extraction & analytical procedures
  - C_{free} calculations
- Applications & limitations:
  - rRA (sediments) and pRA (REACH)
  - Hydrophobic chemicals $K_{ow} > 3$
    - Petroleum chemicals (PAHs, aliphatic chemicals)
    - Organochlorine pesticides (DDT, dieldrin, lindane)
    - PCBs, chlorobenzenes, chloroanilines
    - Other PBT compounds
  - Long equilibr. / biocide/ rapid decisions
  - Translation of Cfree into risk

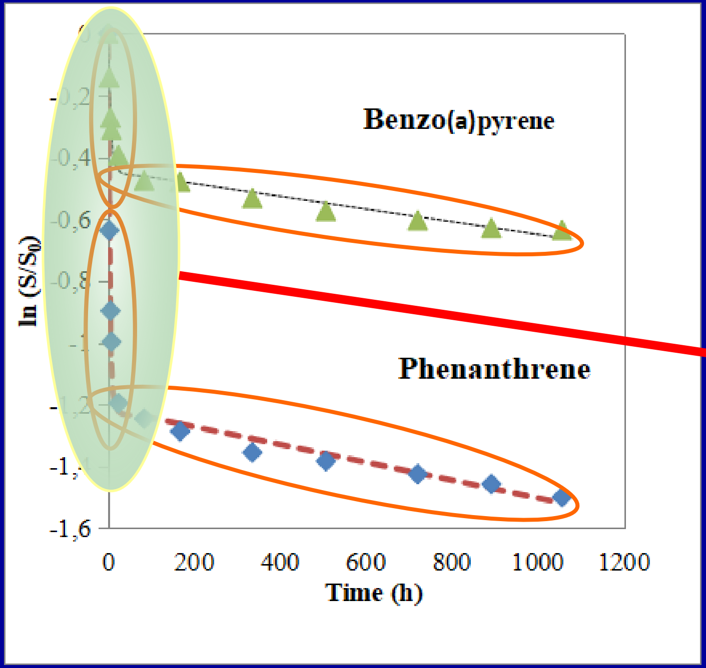


DESORPTION EXTRACTION UPDATE

- ISO method (ISO 16751) with Tenax and cyclodextrin available for non-polar OCs since 2020, as a full standard
- Bioavailable fraction as F_{fast}, obtained in a single step (20 h)
- Expressed in mass units: mg/kg d.m.
- Applicable to compounds with aqueous solubility <100 mg/L (K_{ow} > 3), theoretically applicable up to 1 000 mg/L
- Validated with PAHs and polychlorinated aromatics (PCBs, HCB, etc.)
- Better support from two-site model and perfect-sink assumption for Tenax, than for cyclodextrin

Desorption of PAHs from polluted soil- Tenax extraction

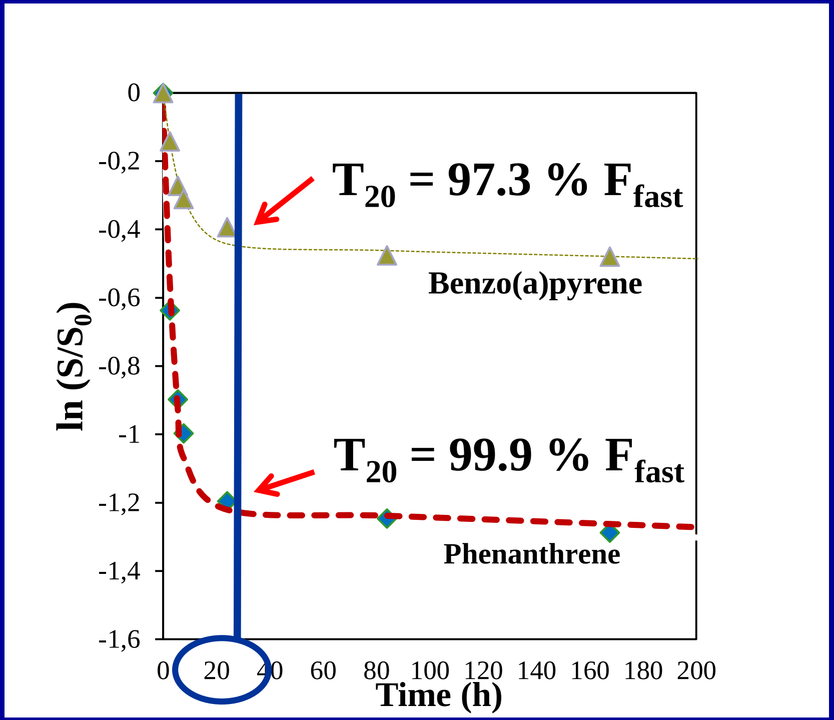
DESORPTION KINETICS



$S_t / S_0 = F_{fast} * \exp(-K_{fast} * t) + F_{slow} * \exp(-K_{slow} * t)$

Important in characterizing the different desorbing fractions present in the soil

SINGLE-POINT EXTRACTION: EXTRACTING F_{fast} as T_{20} (ISO 16751)



Quick bioavailability assessment through F_{fast}

DESORPTION EXTRACTION UPDATE

Science of the Total Environment 803 (2022) 150025

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journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

Determining the bioavailability of benzo(*a*)pyrene through standardized desorption extraction in a certified reference contaminated soil

Check for updates

Rosa Posada-Baquero [a], Kirk T. Semple [b], Miguel Ternero [c], José-Julio Ortega-Calvo [a,*]

[a] Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS), C. S. I. C., Seville, Spain
[b] Lancaster Environment Centre, Lancaster University, Lancaster LA1 4YQ, United Kingdom
[c] Departamento de Química Analítica, Facultad de Química, Universidad de Sevilla, Seville, Spain

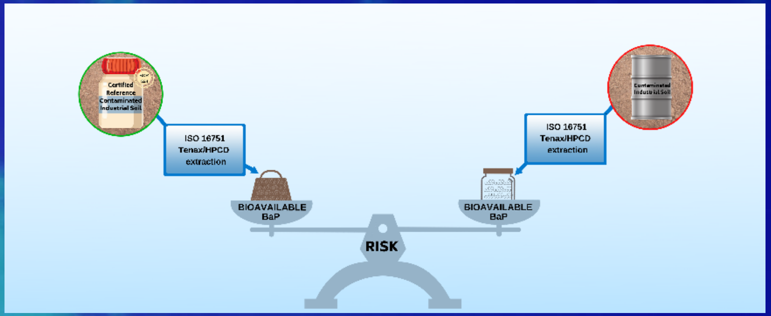


Table 3
Comparison of total and bioavailable concentrations of benzo(*a*)pyrene (BaP) in a certified reference material (BCR-524) and in field-contaminated soil and sediment.

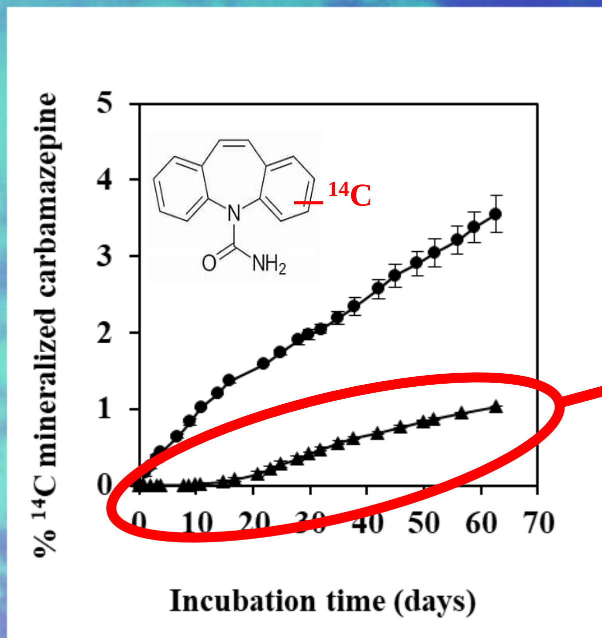
Sample/study description	TOC (%)[c]	BaP concentration (mg kg^{-1}) Total	Bioavailable	Method	T_{bio} (h)[a]	No. samples	Reference
Certified reference soil, BCR-524	12.3	8.82	1.84, 1.53	Tenax & HPCD, single point	20	1	This study
Industrial soils from the Netherlands; validation of ISO 16751	1.8–3.8	0.67–4.63	0.02–0.17	Tenax, single point	20	4	ISO Technical Committee (2020)
Industrial soils from Spain, Italy and France; biological treatments	0.9–7.1	0.57–56.50	0.017–5.69	Tenax, single point	20	11	Posada-Baquero et al. (2019b)
Soil and sediment from The Netherlands; landfarming for 25 years	2.3–6.9	0.7–17.0	0.011–6.39	Tenax, single point	20	8	Harmsen and Rietra (2018)
Estuary sediments from New York, USA; basic research on desorption	4.4–5.7	1.03–3.06	0.37–0.30	Tenax, single point	24	2	Shor et al. (2003)
Canal sediment from Indiana, USA; basic research on desorption	10.2	26.7	1.76	XAD, desorption curve[b]	20	1	Birdwell and Thibodeaux (2009)

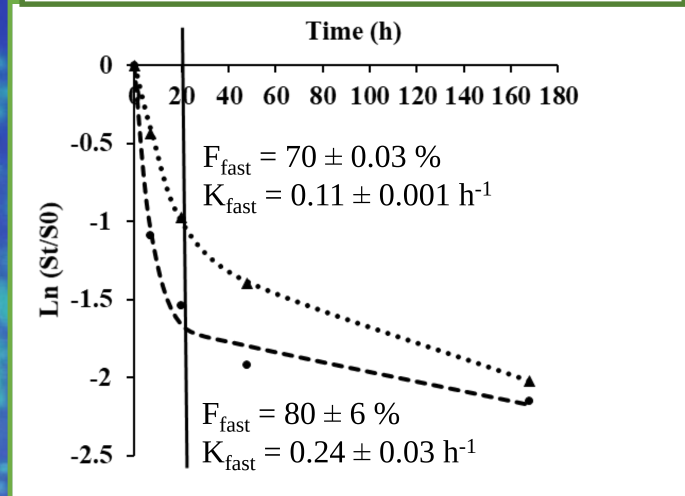
DESORPTION EXTRACTION

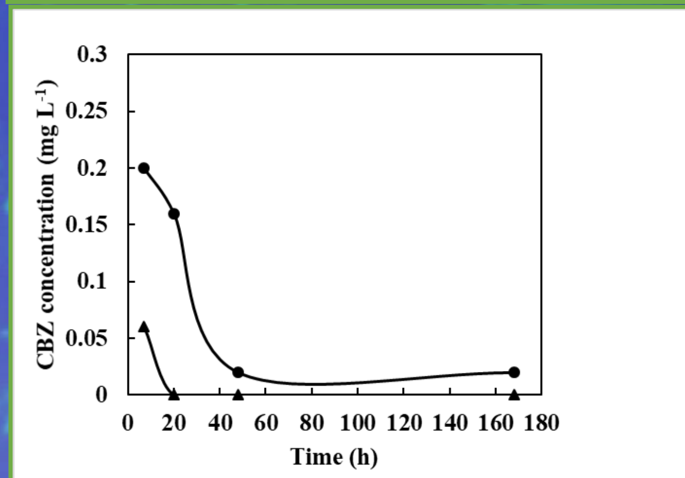
UPDATE

CARBAMAZEPINE **LOG K_{OW} = 2,7**

- 1 g spiked soil
- 35 mL. of Mili-Q water
- Biocide (sodium azide)
- 1,5 gr. of Tenax® (60-80 mesh) by Buchem BV

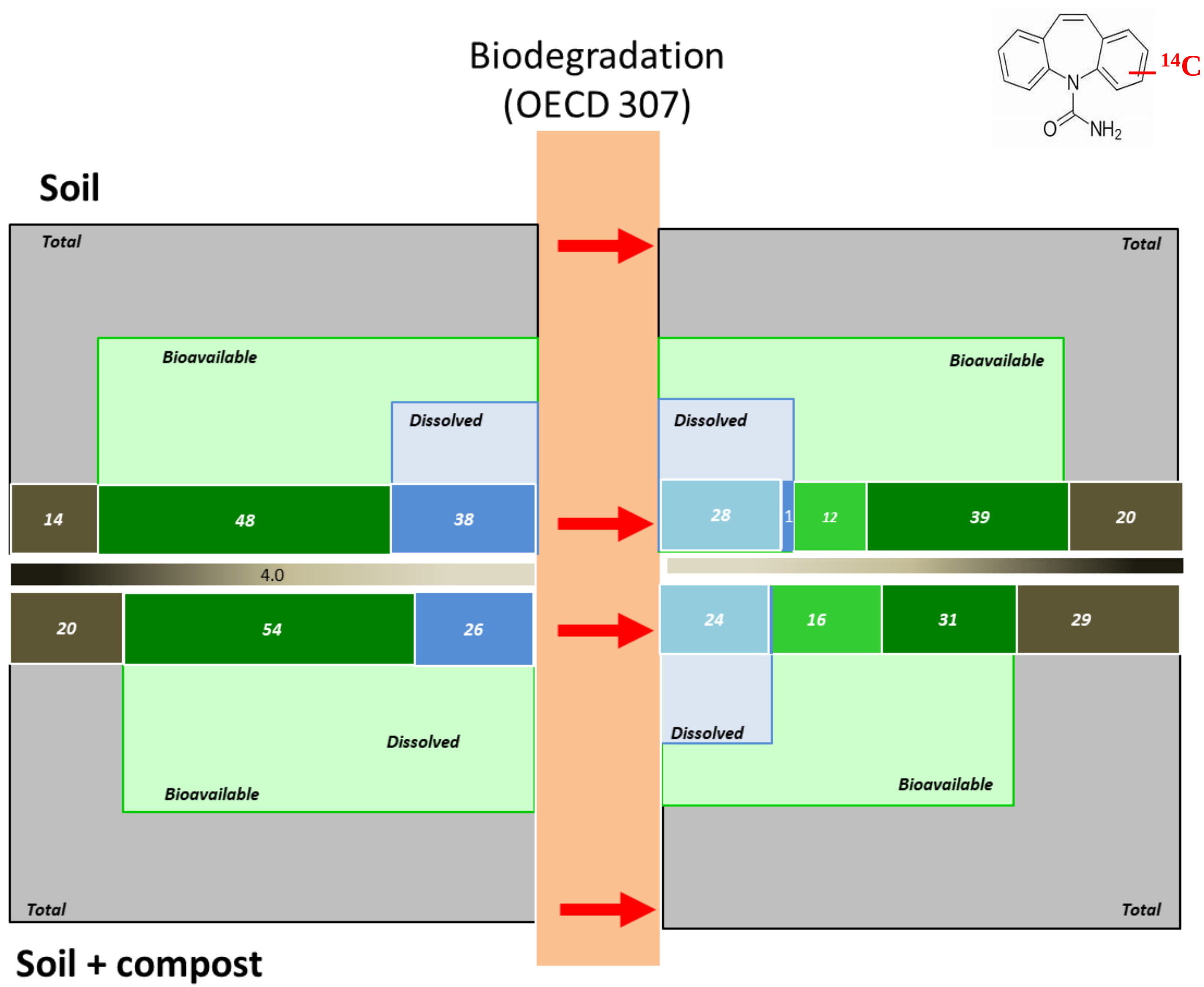






Posada-Baquero et al. *Sci. Total Environ.*, in prep.

DESORPTION EXTRACTION UPDATE



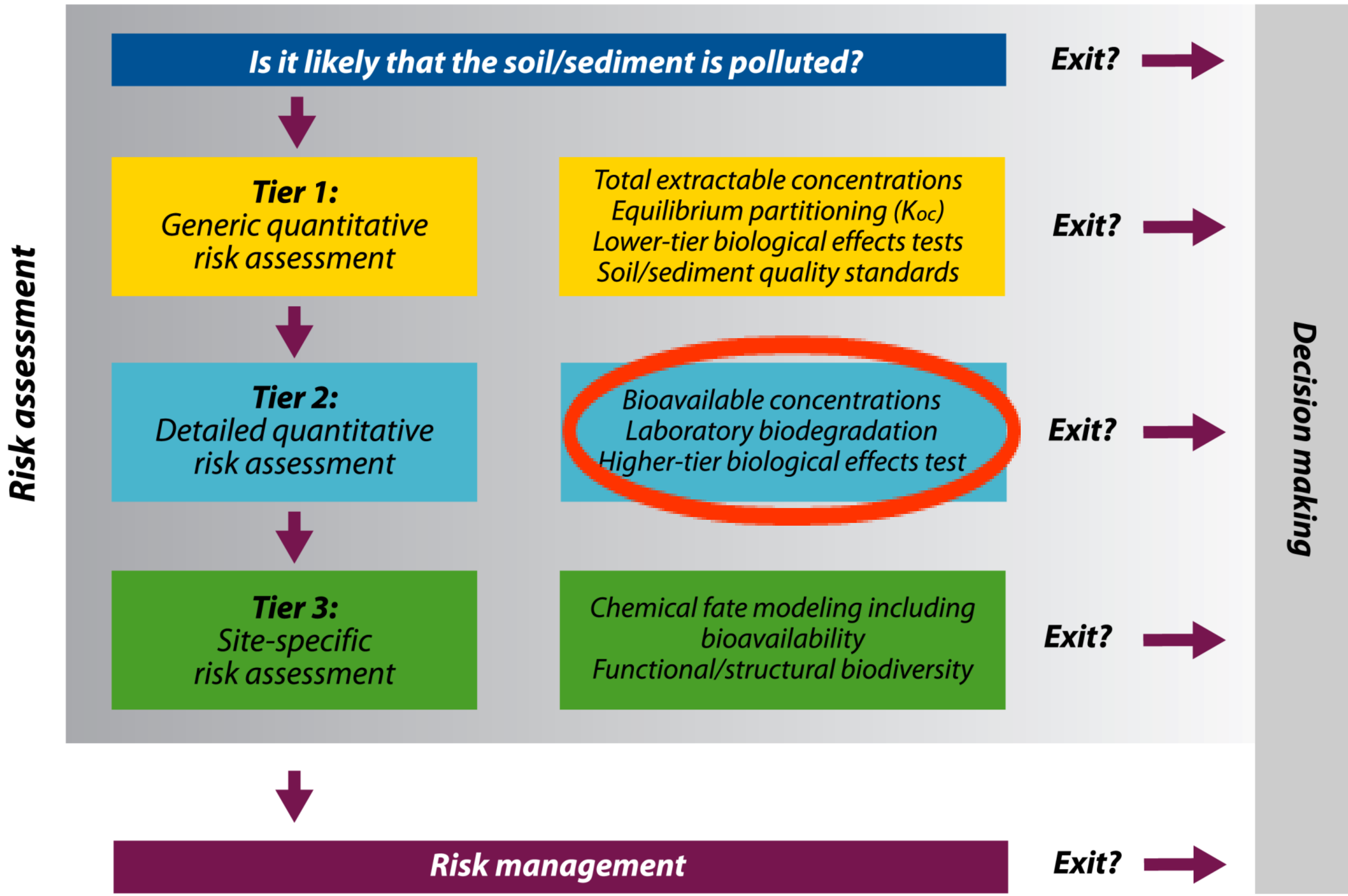
Posada-Baquero et al. *Sci. Total Environ.*, in prep.

Residue

ARE C_{free} AND F_{fast} METHODS COMPLEMENTARY?

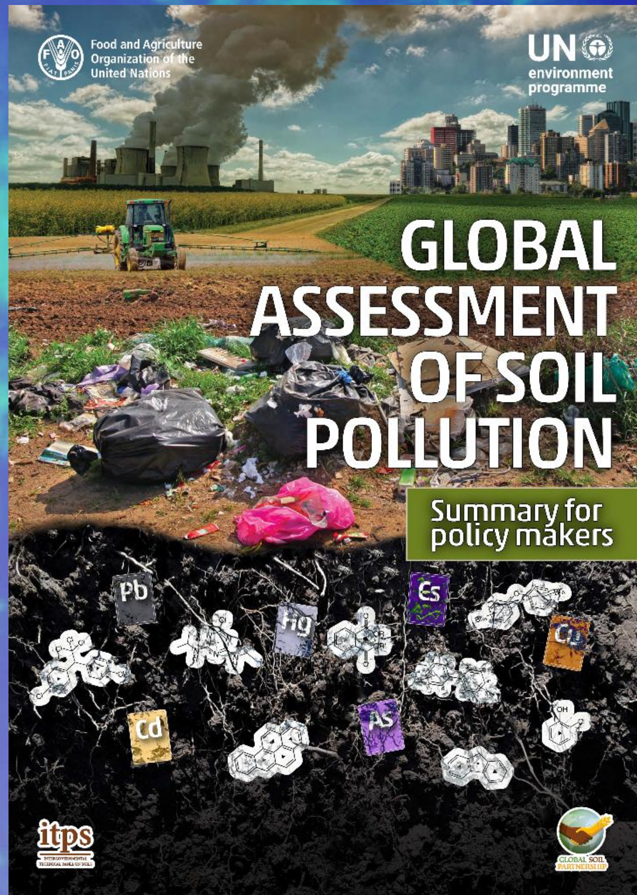
	C_{free}	F_{fast}
Time for performance	weeks	hours
Preferable scenario	sediment	soil (?)
Theoretical support	+++	++
Applicability	in/ex-situ	ex-situ
Output	ng/L	mg/kg
Standard method	No	Yes
Included in regulation	Yes	No

Tiered Risk Assessment-Management Framework



Ortega-Calvo et al. ES&T, 2015. 49, 10255-1026

FAO GLOBAL SOIL PARTNERSHIP



Glossary

Bioavailability. The portion of the total quantity of a chemical/substance that is 'freely available' to cross an organism's cellular membrane from the medium the organism inhabits at a given time (Semple *et al.*, 2004), and which can be metabolically active in a living organism (Klaassen, Casarett and Doull, 2013). 'Freely available' is defined operationally by different methods. Bioassays on plants or animals (Ng *et al.*, 2015) are often time and resource-consuming and may comprise ethical issues. Indirect single-step or sequential chemical extractions using reagent(s) simulating the interaction of plant or human fluids/exudates with the contaminant(s) of interest are also employed (Cipullo *et al.*, 2018). Some of these extractions have been standardized and taken into consideration in the legislation of some countries. Other extractions are undergoing standardization, a process necessary to make bioavailability a concept that can be included in legislation and policies for soil protection, and as a tool for risk assessment (Harmsen, 2007; Kim *et al.*, 2015). In soil, contaminant bioavailability can be affected by soil properties (e.g., pH, redox potential, clay content, organic matter content, etc.) (Gupta *et al.*, 2019; Sinche *et al.*, 2018), contaminant chemical properties (e.g., polarity, oxidation states, acidity, etc.), and/or environmental factors (e.g., moisture content, temperature, etc.). These properties are not static in time or place, thus it is important to understand the limitations of operationally-defined determinations of bioavailability when evaluating actual bioavailability at a given site temporally and spatially.

FAO and UNEP, 2021, https://doi.org/10.4060/cb4827en
Main report at: https://doi.org/10.4060/cb4894en

TARGETS RELEVANT TO SOIL POLLUTION

FAO and UNEP, 2021, https://doi.org/10.4060/cb4827en

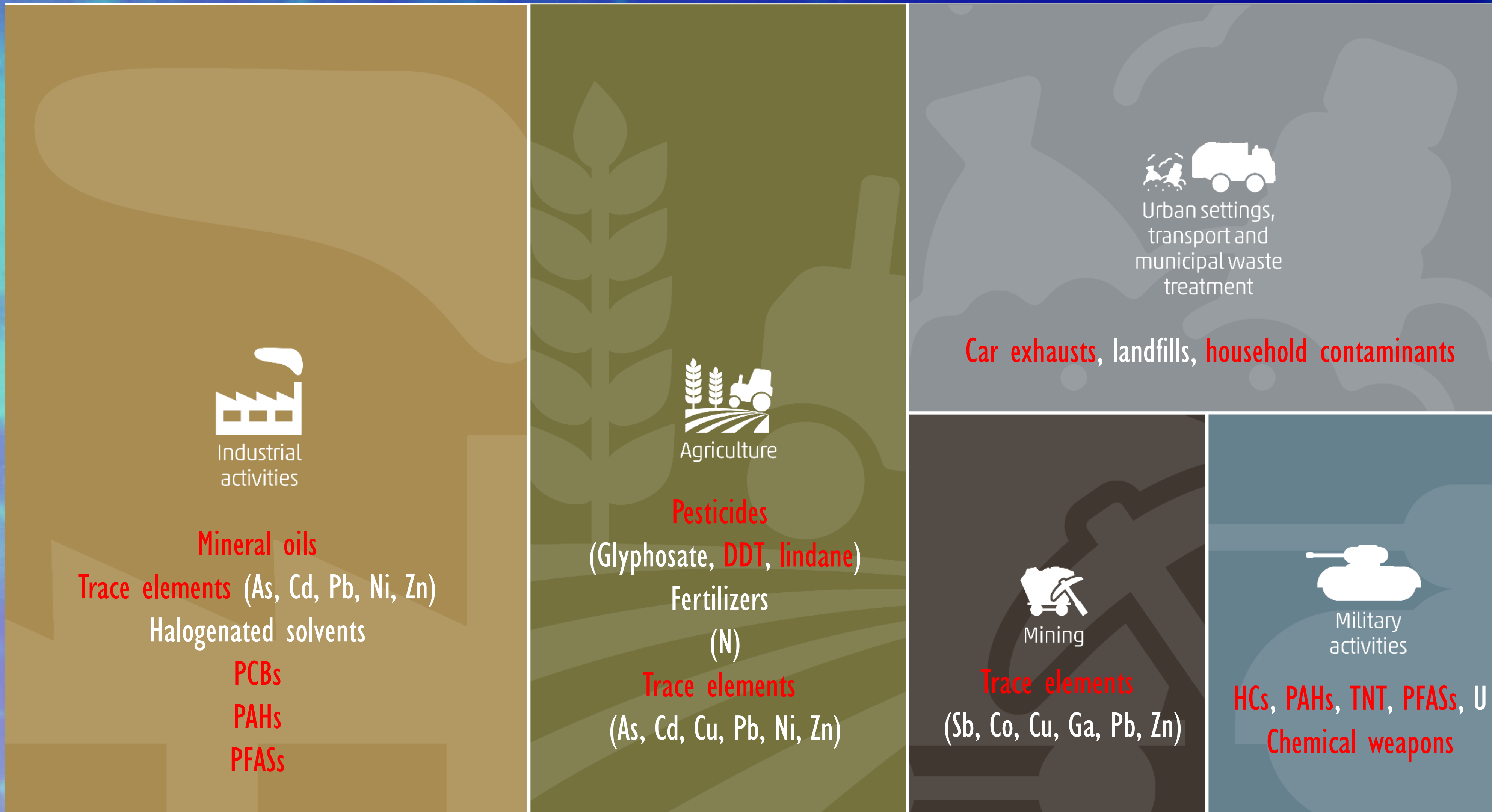


Figure 12. Hierarchical chart showing the main sources of soil pollution in Europe

The boxes represent an estimate of the relative importance of each source as perceived by regional experts, and their size is related to their relative importance. The larger the size, the greater the relative importance

FAO and UNEP, 2021
https://doi.org/10.4060/cb4827en

https://doi.org/10.1016/j.scitotenv.2022.157007

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Review

Nature-based approaches to reducing the environmental risk of organic contaminants resulting from military activities

Carmen Fernandez-Lopez [a], Rosa Posada-Baquero [b], Jose-Julio Ortega-Calvo [b,*]

[a] University Centre of Defense at the Spanish Air Force Academy (CUD-AGA), Santiago de la Ribera, Spain
[b] Instituto de Recursos Naturales y Agrobiología de Sevilla (IRNAS-CSIC), Seville, Spain

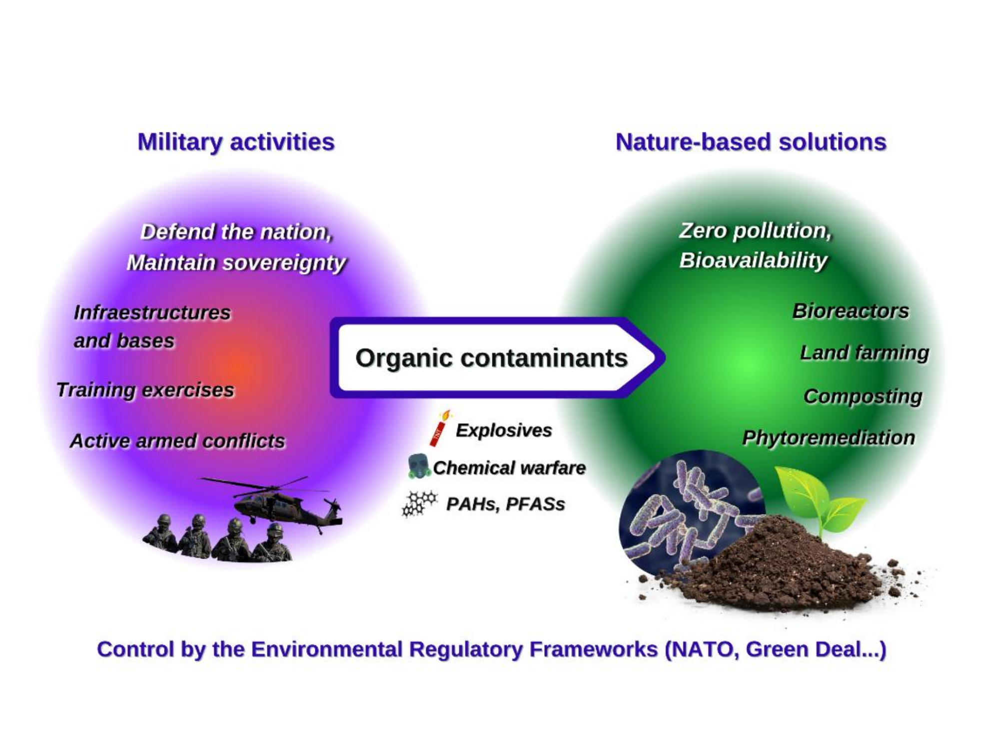
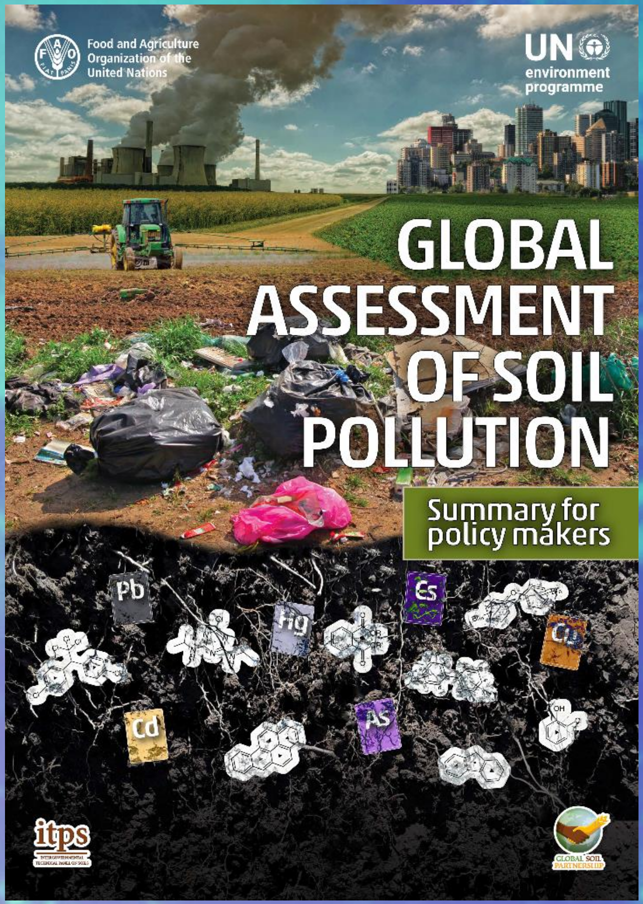


Table 2
Examples of nature-based technologies for military activity contamination.

Nature-based technology	Description	Organic contamination site	Example
Natural attenuation	Spontaneous pollutant removal, continuous monitoring	Hydrocarbon-contaminated soils	Siles and Margesin, 2018
Land farming	In situ periodical fertilization with inorganic nitrogen phosphorous and potassium (NPK)	Hydrocarbon-contaminated and explosive-contaminated soils	Siles and Margesin, 2018; Clark and Boopathy, 2007; Raschman and Vanek, 2008
Composting	Amendment with biodegradable organic materials, fertilization, and pile maintenance under controlled humidity and aeration	Explosive-contaminated soils	Kalderis et al., 2011; Payne et al., 2013
Composting + bioaugmentation	In situ amendment with biodegradable organic materials following bioaugmentation	Explosives-contaminated soils, sediments, and groundwater	Michalsen et al., 2016; Jugnia et al., 2017; Jugnia et al., 2018
Prepared-bed bioreactor	Ex situ treatment with recirculation of irrigated water and nutrients	Hydrocarbon-contaminated soils	Kołwzan et al., 2008
Soil slurry reactor	Mechanical mixing with liquid phase, controlled aeration	Explosives-contaminated soils	Clark and Boopathy, 2007
Phytoremediation	Use of plants to mobilize the contaminant into plant biomass	Explosives and PFAS-contaminated soils and groundwater	Lee et al., 2007; Rylott et al., 2011; Hannink et al., 2001; Hannink et al., 2002
Phytoremediation and bioremediation	Use of plants and soil bacterial diversity	Explosive and vomiting agents-contaminated soils and waters	Cary et al., 2021; Lamichhane et al., 2012; Thijs et al., 2018; Teng et al., 2017



PRIORITY ACTIONS

to prevent and halt soil pollution an to remediate polluted soils

- **Knowledge gaps**
  - Harmonise SOP analysis, standardization thresholds
  - Soil surveys, data & info soil pollution
  - Emerging contaminants (pharma, µplastics, NMs)
  - Nature-based management & (bio)remediation
- **Global awareness-raising and communication**
  - Citizen based, early warning systems for soil pollution
  - Public & 4R (reduce, reuse, recycle, recover)
- **Regional cooperation**
  - Transfer scientific & technology knowledge
  - Open access pubs.

FAO and UNEP, 2021, https://doi.org/10.4060/cb4827en
Main report at: https://doi.org/10.4060/cb4894en

EUROPEAN
COMMISSION

Brussels, 17.11.2021
COM(2021) 699 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

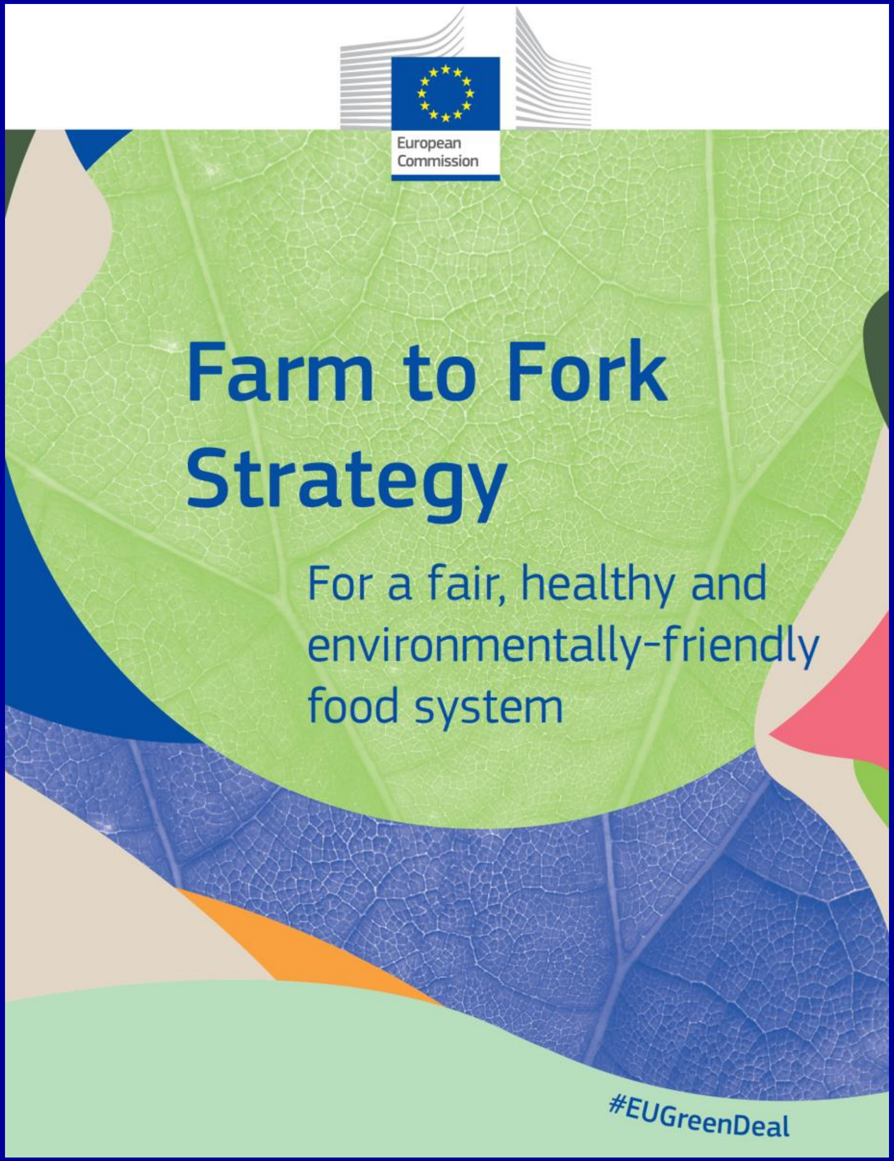
EU Soil Strategy for 2030
Reaping the benefits of healthy soils for people, food, nature and climate

{SWD(2021) 323 final}

RESTORING DEGRADED SOILS
and remediating contaminated sites - Actions

- **Legal provisions**
  - Identify contaminates sites
  - Inventory and register of sites
  - Remediate sites by 2050
- **Soil health certificate –land transaction (EU/Member States)**
- **Knowledge exchange on RA**
- **EU priority list of contaminants 2024**
- **Definition of land damage, financial security**

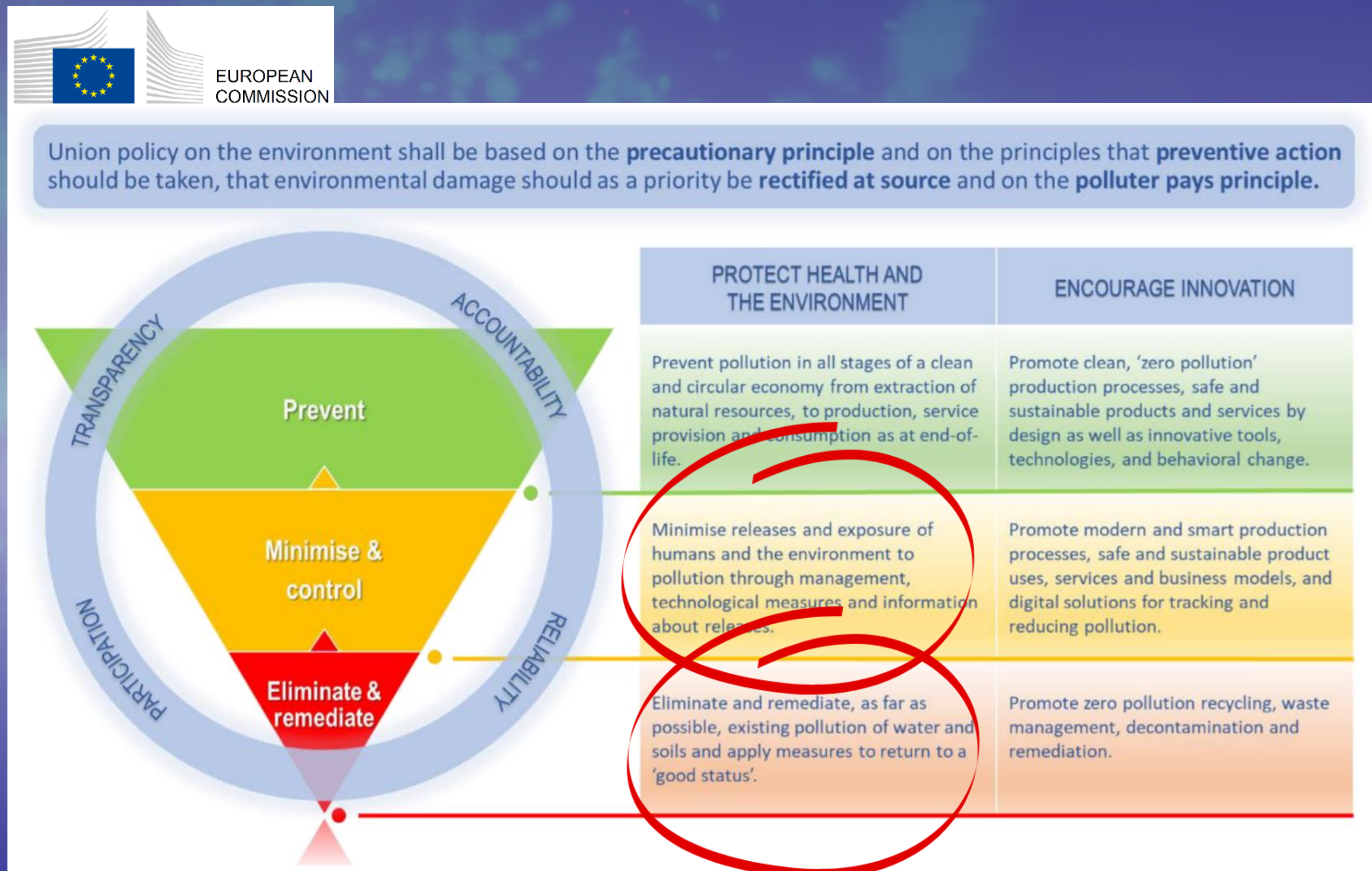
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0699&from=EN



REINFORCEMENT OF PESTICIDE RISK ASSESSMENT

- **Sustainable food production through realistic RA**
- **Ensuring food security by increasing competitiveness of farmers**

ZERO-POLLUTION ACTION PLAN



EUROPEAN
COMMISSION

Brussels, 14.10.2020
COM(2020) 667 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Chemicals Strategy for Sustainability
Towards a Toxic-Free Environment

{SWD(2020) 225 final} - {SWD(2020) 247 final} - {SWD(2020) 248 final} -
{SWD(2020) 249 final} - {SWD(2020) 250 final} - {SWD(2020) 251 final}

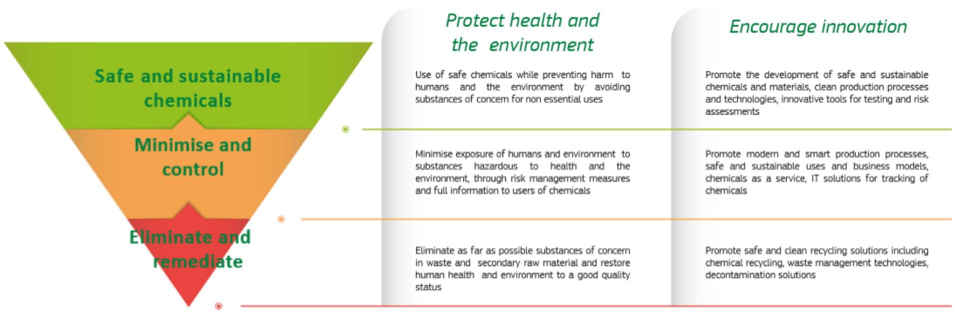


Figure: The toxic-free hierarchy – a new hierarchy in chemicals management

CHEMICAL POLLUTION in natural environment

- **New hazard classes to address**
  - **Environmental toxicity**
  - **Persistency**
  - **Mobility**
  - **bioaccumulation**
- **PMT / vP & vM as very high concern**
- **Comprehensive ERA**
- **Decontamination solutions in terrestrial & aquatic environments**
- **Pharma, food, PFASs**

https://ec.europa.eu/environment/pdf/chemicals/2020/10/Strategy.pdf

NATIONAL REGULATORY ASPECTS

potentially related with bioavailability

BOE

LEGISLACIÓN CONSOLIDADA

Real Decreto 9/2005, de 14 de enero, por el que se establece la relación de actividades potencialmente contaminantes del suelo y los criterios y estándares para la declaración de suelos contaminados.

Ministerio de la Presidencia
«BOE» núm. 15, de 18 de enero de 2005
Referencia: BOE-A-2005-895

ANEXO VI

Listado de contaminantes y niveles genéricos de referencia para protección de los ecosistemas

Protección de los ecosistemas

Sustancia	Número CAS	Organismos del suelo	Organismos acuáticos	Vertebrados terrestres
		(mg/kg peso seco)		
1,1-Dicloroetano	75-34-3		0,06	4,18
1,2-Dicloroetano	107-06-2		0,16	0,24
1,1,2-Tricloroetano	79-00-5		0,16	0,3
1,1,2,2-Tetracloroetano	79-34-5		0,02	0,04
Tricloroetileno	79-01-6		0,21	0,45
Tetracloroetileno	127-18-4	0,01 *	0,06	0,15
1,2-Dicloropropano	78-87-5	4,24	0,07	0,43
1,3-Dicloropropeno	42-75-6		0,01 *	0,58
Acenafteno	83-32-9		0,02	4,85
Acetona	[illegible]		[illegible]	6,71
Aldrin	[illegible]	[illegible]	0,01	0,01*
Antraceno	120-12-7		0,01*	22
Benzo(a) antraceno	56-55-3	3,8	[illegible]	
Benceno	[illegible]	[illegible]	[illegible]	[illegible]
Clorobenceno	[illegible]	[illegible]	[illegible]	[illegible]
1,2-Diclorobenceno	95-50-1		0,11	3,15
1,4-Diclorobenceno	[illegible]	0,1	[illegible]	[illegible]
1,2,4-Triclorobenceno	[illegible]	[illegible]	[illegible]	[illegible]
p-Cloroanilina	[illegible]	0,14	[illegible]	[illegible]
Clordano	57-74-9	0,04	0,01*	0,01*
Cloroformo	[illegible]		[illegible]	0,01
p,p´-DDE	[illegible]	[illegible]	[illegible]	0,01*
p,p´-DDT	[illegible]		[illegible]	0,01*
Dieldrin	60-57-1	0,13	0,01*	0,01*
1,4-Dioxano	123-91-1	1,45	13,9	
Endosulfan	115-29-7	0,01	0,01*	0,04
Endrin	72-20-8		0,01*	0,01*
Estireno	100-42-5	0,68	0,25	100**
Etilbenceno	100-41-4		0,08	4,6
Decabromofenil éter	1163-19-5		2,66	59,7
Pentabromo difenil éter	32534-81-9	0,32	5,18	0,01*
Octabromo difenil éter	32536-52-0		0,51	0,24
Fenol	108-95-2	0,27	0,03	23,7
2-Clorofenol	95-57-8	0,04	0,01*	0,12
2,4-Diclorofenol	120-83-2	0,2	0,06	0,02
2,4,5-Triclorofenol	95-95-4	0,05	0,09	3,3
2,4,6-Triclorofenol	88-06-2	0,4	0,012	0,03
Pentaclorofenol	87-86-5	0,02	0,01*	0,01*
Fluoranteno	206-44-0	1	0,03	1,96
Fluoreno	86-73-7	0,22	0,02	2,84

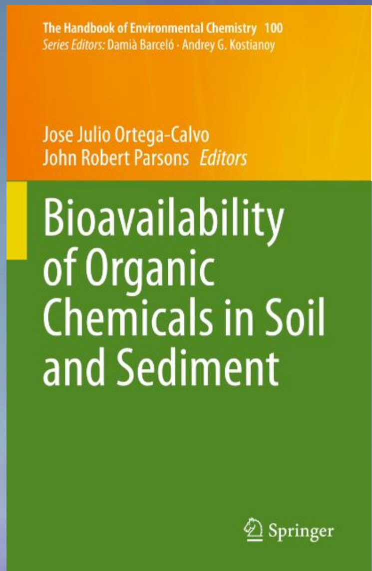
Annex VI: 70 % contaminants (36/54) in RD2005 with K_{ow} > 3 (PAHs, DDT, etc.)

- **Annex IV – conditions for risk assessment (environmental):**
  > reference values or toxicity in bioassays

- **Annex III- Contaminated soil: toxicity bioassays or "those others considered as equivalents"**

https://www.boe.es/buscar/pdf/2005/BOE-A-2005-895-consolidado.pdf

BIOAVAILABILITY UPDATE



Jose Julio Ortega-Calvo and John Robert Parsons (eds.), *Bioavailability of Organic Chemicals in Soil and Sediment*, Hdb Env Chem, DOI 10.1007/698_2020_573,

Concluding Remarks and Research Needs

J. J. Ortega-Calvo and John R. Parsons

- **Is Bioavailability Science Ready for Use in Regulation of Organic Chemicals?**
- **How Should Bioavailability of Organic Chemicals Be Measured?**
- **How Should Bioavailability Be Implemented into Regulation of Organic Chemicals?**
- **Research Needs in Bioavailability**
  - **Methodologies for measuring bioavailability**
  - **Environmental risks of non-bioavailable compounds**
  - **Bioavailability in the remediation of waters, sediments, and soils**

CONCLUSIONS

- TOTAL POLLUTANT CONCENTRATIONS LEAD TO OVERESTIMATION OF RISK, BUT MORE REALISTIC ASSESSMENTS CAN BE DONE BY INCORPORATING BIOAVAILABILITY
- BIOAVAILABILITY SCIENCE & BIOTRANSFORMATION CAN BE SUCCESSFULLY INTEGRATED INTO LOW-RISK APPROACHES FULLY IN LINE WITH UN SDG AND EU GREEN DEAL.
- SLOW POLLUTANT PHASE EXCHANGES HAVE A STRONG IMPACT ON BIOAVAILABILITY & BIODEGRADATION, BUT THIS CAN BE MODIFIED MICROBIALLY (BIO-SURFACTANTS, CHEMOTAXIS, ATTACHMENT, ETC.)
- THESE MECHANISMS CAN BE PROSPECTED IN FUTURE INNOVATION PATHWAYS FOR BIOREMEDIATION

SETAC

SETAC Europe 34th Annual Meeting
5-9 May 2024, Seville, Spain
Europe2024.setac.org

fibes Sevilla City Office Conference and Exhibition Centre

Thank you for listening
and see you next year in Seville!