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A new risk-based prioritisation strategy of Contaminants of Emerging Concerns (CECs) in soils

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BACKGROUND

- Many **not yet regulated substances** used across various sectors in Europe (flame retardants, pharmaceuticals, per- and polyfluoroalkyl substances (PFAS), etc.) gain significant attention owing to their suspected/recognised harmful effects on the ecosystem and human health.
- Identifying and prioritising the contaminants of emerging concern (CECs)** based on their potential to be released and accumulated in soils, transferred to other compartments (such as water and air), and to pose threats to terrestrial ecosystems and human health will **support mitigation regulatory and future monitoring efforts at both the European and national levels.**

AIM & METHODS

This study introduces a **multi-criteria risk-based procedure using a Source (S) –Pathways (P) –Receptors (R)** approach combined with uncertainty analysis to **prioritise for soils** the 969 organic and non-metallic inorganic pollutants CECs listed in the NORMAN list of emerging substances for the aquatic compartment (NORMAN, 2017).

To contribute to the **development of an EU priority list for soil (CECs)**, this prioritisation strategy aims to:

- Propose a straightforward, reproducible, and easily updatable procedure** that utilises available data to evaluate the current understanding of CECs sources, transfer pathways, and toxicity.
- Integrate and **assess the uncertainty** associated with the proposed prioritisation due to knowledge gaps and data inconsistencies about CECs and recommend actions to address these uncertainties.

MAIN CHALLENGES

- No list of contaminants** considered to be emerging in soils exists
- Different countries consider different substances** due to their specific national contexts and regulations.
- Significant discrepancies often exist in the available dataset** used to assess the risk due to **incomplete or non-existent knowledge.**

RESULTS

- An **Excel file** for risk-based prioritising CECs for soils.
- A **priority list of soil CECs.**
- Recommendations for actions to be taken** to improve knowledge of each CEC for which the confidence level for the prioritisation is insufficient.

1. CECs preselection

Exclusion of metals and metalloids (their fate in the environment is governed by different properties not considered here: pH, Redox potential, etc.)

To be considered in another version of the tool?

Identification and preselection of CECs likely to be soil contaminants

Data collection on environmental fate (data predicted by the EPI Suite (US EPA, 2025): Koc, log Kow, fugacity) and use in industry (REACH data)

Can be a soil pollutant?

872 CECs preselected

Clusterisation (fuzzy clusterisation) of the 872 CECs according to their predicted environmental fate

Grouping CECs into 50 groups

Parameters used: Koc, log Kow, fugacity, solubility, molar mass, BIOWIN 3 (US EPA) biodegradability indicator

Selection of the most used and most toxic CECs (for health and the environment) in each group for the final prioritisation

74 CECs prioritized in 1st approach

Then, gradually extend the CECs to be prioritised to all substances, starting with the CECs of the groups whose representative obtain the highest risk score.

METHODOLOGY

Source-S

Soil emission risk score (S): Probability of the CEC reaching the soil

Which uses? Which sources?

How much? (REACH tonnage)

What is the probability of occurrence in soil?

Pathways-P

Mobility risk score (P): Risk of soil CEC reaching receptors, impacting environments ubiquitously over the long term

What is the environmental fate? The mobility? The persistence? Soil contaminant?

Solubility? Bioaccumulation factors? Volatility? Soil half-life? Partitioning coefficient?

What are the risks of transfer to other compartments of reaching potential targets?

Receptor-R

Toxicity score (R): Probability of CEC creating environmental and health issues

What is the toxicity to humans and the environment?

Endocrine disrupting potential? CMR properties? Environmental toxicity?

Classified as PBT? What's the risk to create environmental or health issues? Are there any targets to protect?

Semi-automatic prioritisation and uncertainty assessment in the Excel tool

Calculation of the final risk scores

Risk-based prioritisation: Production of a soil CEC priority list

Final priority score = S score * P score * R score

Are the available data sufficient to estimate the risk (missing or inconsistent data, etc.)?

Prioritisation result confidence level calculations: Identification of actions to be taken to improve the prioritisation result

At least two parameters from different sources (predictive models, field or experimental data) are systematically searched and compared to evaluate the data consistency and assess the properties used for calculating each score.

Contains only CECs with a high confidence risk score

The latest version of the Top 10 priority soil CECs (version 1.2 dated 14th May 2025)

rank	CECs	CAS_RN	Risk score (/1)	Level of confidence
1	Octamethylcyclotetrasiloxane (D4)	556-67-2	0.77	Medium
2	Tetrabromobisphenol A	79-94-7	0.70	Medium
3	Galaxolide	1222-05-5	0.54	Medium
4	Dibutyl phthalate	84-74-2	0.48	Medium
5	Tris(4-isopropylphenyl) phosphate (TIPPP)	68937-41-7	0.42	Medium
6	Hexamethyldisiloxane (HM or HMDS)	107-46-0	0.33	Medium
7	Diisopropylphthalene (DIPN)	38640-62-9	0.30	Medium
8	Decahydronaphthalene (Dekalin)	91-17-8	0.28	Medium
9	1,4-Dichlorobenzene	106-46-7	0.28	High
10	Homosalate	118-56-9	0.25	Medium

RESULTS

Example of the top 10 most-at-risk soil CECs for which data are still insufficient for a reliable prioritisation (low confidence level for the risk score) and recommended actions

CECs	CAS_RN	Risk score (/1)	Missing/ inconsistent data to be investigated further
Butyl methoxydibenzoylmethane (Avobenzone)	87075-14-7 / 70356-09-1	0.37	Persistence, bioaccumulation
Drometrizole	2440-22-4	0.30	Persistence, bioaccumulation, mobility
Methyl-1H-benzotriazole (Tolytriazole)	29385-43-1	0.15	Persistence, bioaccumulation, mobility
Abamectin (Avermectin B1A)	65195-55-3	0.05	Use, persistence, soil mobility
Perfluorononanoic acid (PFNA)	375-95-1	0.05	Use, persistence, bioaccumulation
Tetrabutyl tin ion	1461-25-2	0.05	Use, persistence, soil mobility
Doxepine	1668-19-5	0.04	Use, toxicity, persistence, bioaccumulation, soil mobility
Acide perfluorooctanoïque (PFOA)	335-67-1	0.04	Use, mobility
Amitriptiline	50-48-6	0.04	Use, bioaccumulation
Difethialone	104653-34-1	0.03	Use, bioaccumulation

PERSPECTIVES

- Call for contributions to compile a soil-specific list of emerging substances that need to be added to the prioritisation process,
- Progressive updating of the soil CEC priority list taking account of new substances, regulations and knowledge acquired about substances.
- Expansion of the dataset considered for prioritisation?

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