UN environment programme | Global Framework on Chemicals

Chemical footprint

Toward a common understanding



Kay Williams
Head of the Global Framework of Chemicals (GFC) Secretariat

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Goethe University Frankfurt | University of South Africa | substitute ApS

In a Nutshell

What is a chemical footprint?

A chemical footprint quantifies the **potential environmental impacts** associated with **chemical usage** & **chemical emissions** along product, process and technology life cycles. Chemical footprint approaches cover the different elements of a chemical footprint assessment: usage, emissions, toxicity potential

What are chemical footprint approaches?

Chemical usage



Measured or estimated data on **chemical usage** and usage context (e.g. within a company)

Chemical emissions



Emission or **release** estimation, emission monitoring, analytical measurements, or emission databases

Toxicity characterization



Models estimating **human toxicity** and **ecotoxicity impact potentials**, or pollution, exposure, effect monitoring data

Contents

- Global Framework on Chemicals (GFC)
- Defining «Chemical footprint»
- Chemical footprint approaches: Examples & challenges
- Standardization process
- Take-home points

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- **Global Framework on Chemicals (GFC)**
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UN environment programme | Global Framework on Chemicals

THE GLOBAL FRAMEWORK ON CHEMICALS

For a Planet Free of Harm From Chemicals and Waste



KAY WILLIAMS

Head of the Global Framework on Chemicals Secretariat

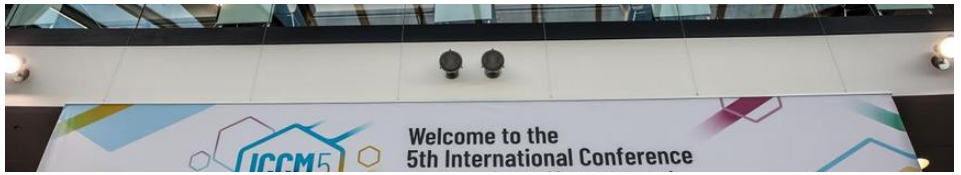


The Global Framework on Chemicals – For a planet free of harm from chemicals and waste

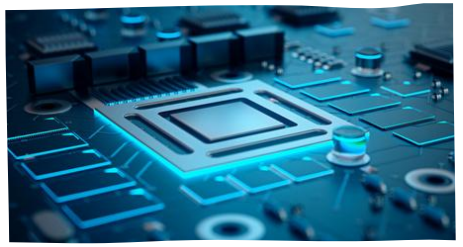
Multisectoral and **multistakeholder framework f**or safe and sustainable management of chemicals and waste adopted at the Fifth meeting of International Conference on Chemicals Management in Bonn, Germany in September 2023.

5 Strategic objectives

28 Targets















Five Strategic Objectives and Twenty-Eight Targets

Strategic objective A. (7 targets)

Legal frameworks, institutional mechanisms and capacities are in place to support and achieve the safe and sustainable management of chemicals throughout their life cycle.

Strategic objective B. (7 targets)

Comprehensive and sufficient knowledge, data and information are generated, available and accessible to all to enable informed decisions and actions.

Strategic objective C. (1 target)

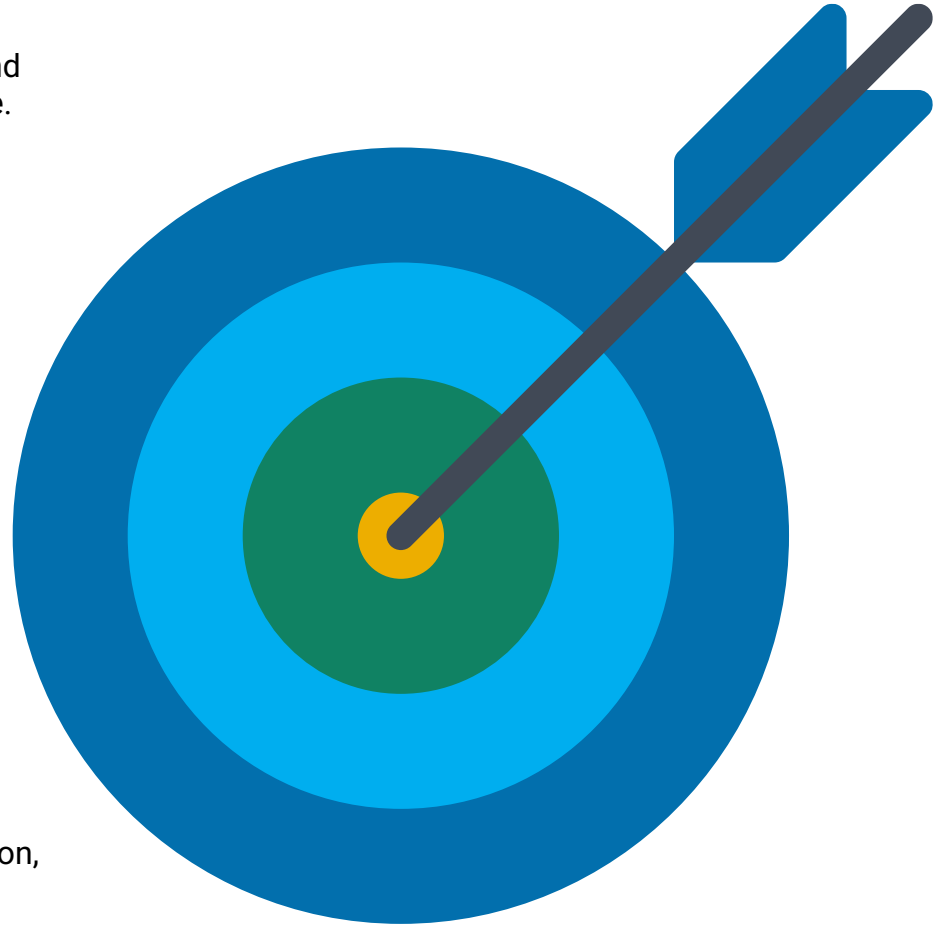
Issues of concern are identified, prioritized, and addressed.

Strategic objective D. (7 targets)

Safer alternatives and innovative and sustainable solutions in product value chains are in place so that benefits to human health and the environment are maximized and risks are prevented or, where prevention is not feasible, minimized.

Strategic objective E. (6 targets)

Enhanced implementation occurs through increased and effective resource mobilization, partnerships, cooperation, capacity-building, and integration into all relevant decision-making processes.

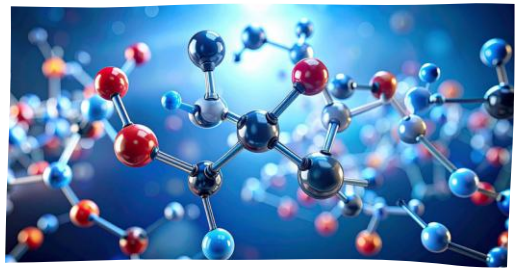


Specific Objective and Target

Strategic objective D. (7 targets)

Safer alternatives and innovative and sustainable solutions in product value chains are in place so that benefits to human health and the environment are maximized and risks are prevented or, where prevention is not feasible, minimized.





Target D6

By 2030, sustainable chemical and waste management strategies have been developed and implemented for major economic and industry sectors that identify priority chemicals of concern and standards and measures, such as the **chemical footprint approach,** to reduce their impact and, where feasible, their input along the value chain.



Framework Implementation Programmes

Programmes under development in partnership with Inter-Organization Programme for the Sound Management of Chemicals

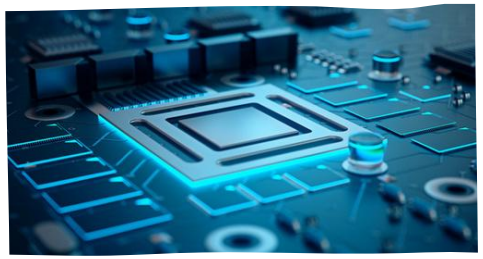
Global implementation programmes (IPs)

IP1: Legal frameworks and institutional capacities for chemicals management

IP2: Economic and industry sector engagement and action for the safe and sustainable chemicals management

- Electronics
- Textiles
- Healthcare
- Construction

IP3: Integrating Chemicals and Waste Issues in Sustainable Development Decision-making





Sectoral Implementation Programmes

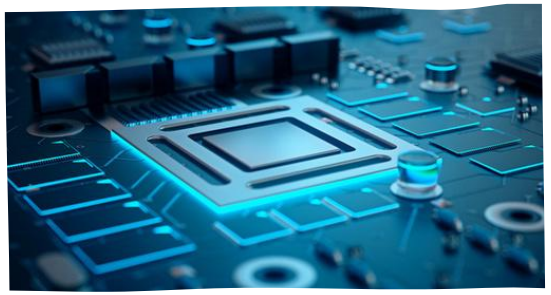
Programmes under development in partnership with Inter-Organization Programme for the Sound Management of Chemicals

Electronics

Relevant sector segments include:

- Semiconductors and electronic
- components
- Consumer electronics (e.g. smart phones)
- Industrial electronics (e.g. cloud servers)

Telecommunications (e.g. cell towers)







Sectoral Implementation Programmes

Programmes under development in partnership with Inter-Organization Programme for the Sound Management of Chemicals



Textiles

Relevant sector segments include:

- Fashion and apparel (e.g. footwear,
- accessories)
- Household and home textiles (e.g. bed sheets)
- Technical textiles (e.g. fire-resistant suits)

Industrial textiles (e.g. filtration fabrics)







Sectoral Implementation Programmes

Programmes under development in partnership with Inter-Organization Programme for the Sound Management of Chemicals

Healthcare

Relevant sector segments include:

- Pharmaceuticals and therapeutic
- biotechnology
- Healthcare services & facilities (e.g. hospitals)
- Medical technology (e.g. surgical equipment)

Personal healthcare (e.g. diet supplements)







Sectoral Implementation Programmes

Programmes under development in partnership with Inter-Organization Programme for the Sound Management of Chemicals



Construction

Relevant sector segments include:

- Residential building materials and
- construction
- Industrial facilities (e.g. manufacturing plants)
- Commercial construction (e.g. retail centres)

Infrastructure construction (e.g. railways)







UN environment programme | Global Framework on Chemicals

Chemical footprint

Definition and methodological guidance



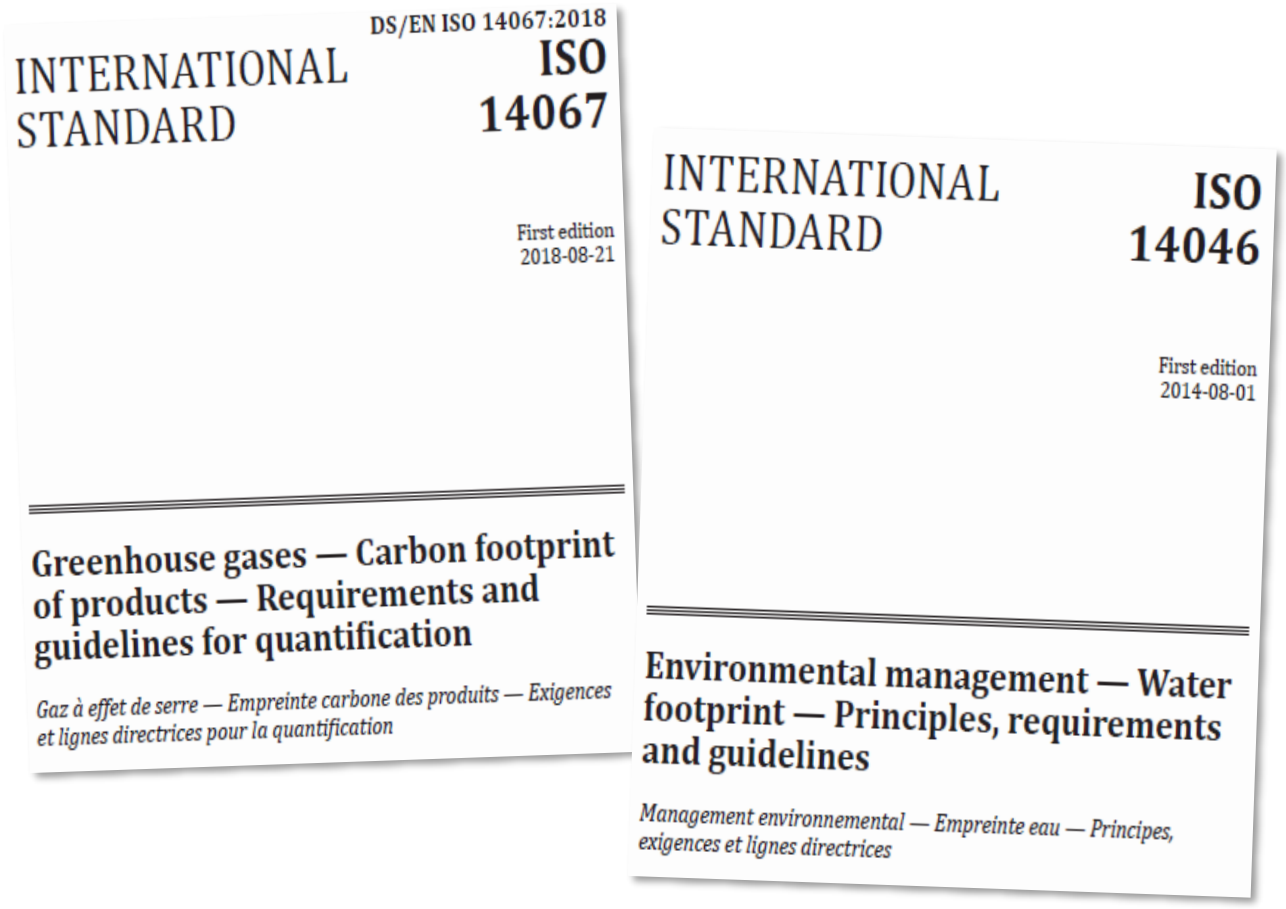
Peter Fantke
Goethe University Frankfurt, Honorary Professor
University of South Africa, Extraordinary Professor
USEtox Team, Managing Director
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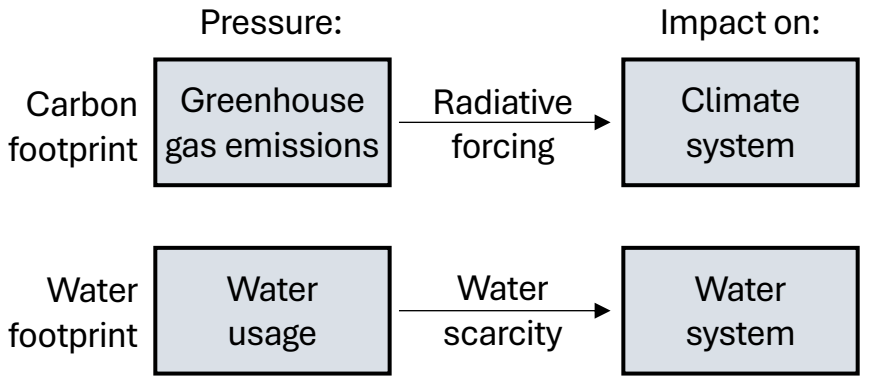
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- Take-home points

Why Defining «Chemical Footprint»?

We know carbon footprint and water footprint scope, elements, methods, and approaches





https://iso.org/standard/71206.html | https://iso.org/standard/43263.html

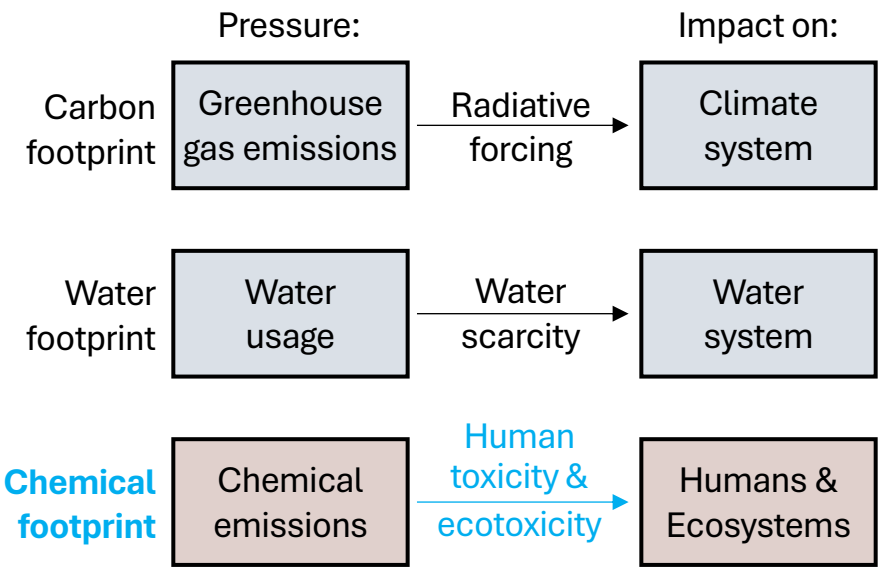
Why Defining «Chemical Footprint»?

Scope, elements, methods, and approaches for chemical footprint currently missing

UN environment programme | Global Framework on Chemicals

Requirements for defining Chemical Footprint under GFC

- Alignment with Carbon Footprint and Water Footprint concepts
- Considering entire life cycle as per GFC strategic objectives
- Covering usage, emissions and impact
- Enables aggregation of results
- Supports management decisions



https://iso.org/standard/71206.html | https://iso.org/standard/43263.html

GFC Definition | «Chemical Footprint»

Definition proposed by Working Group 1 of the GFC ‘Chemical Footprint Workstream’:

Metric that quantifies the potential environmental impacts associated with human toxicity and ecotoxicity related to chemical usage and chemical emissions

Potential environmental impacts refer to the impact categories of human toxicity and ecotoxicity representing specific environmental issues of concern associated with chemical emissions in life cycle assessment

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Characteristics

- Fully **aligned** with definitions of Carbon Footprint (ISO 14067) and Water Footprint (ISO 14046)
- Follows **standardized** Life Cycle Assessment (LCA) methodology (ISO 14040, ISO 14044)
- **Impact-level** metric with elements covering usage, emissions, and impact potential
- **Cumulative** metric covering elements along chemical source-to-impact pathway
- Enables **aggregation** of results (e.g. chemicals, life cycle stages)



GFC Definition | «Chemical Footprint Assessment»

Definition proposed by Working Group 1 of the GFC 'Chemical Footprint Workstream':

Compilation and evaluation of the inputs, outputs and associated potential environmental impacts associated with human toxicity and/or ecotoxicity related to chemical usage or chemical emissions affected by products, processes or organizations' activities

If a chemical footprint assessment does not comprehensively evaluate potential environmental impacts, it needs to be associated with a **qualifier** that describes objectively what has been assessed

All chemicals are by default within the scope of a chemical footprint assessment

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All chemicals are by default within the scope of a chemical footprint assessment

- Chemical usage assessment → informs on usage hotspots
- Chemical emission assessment → informs on emission hotspots & compliance
- Chemical footprint assessment → informs comprehensively on impact hotspots & reduction

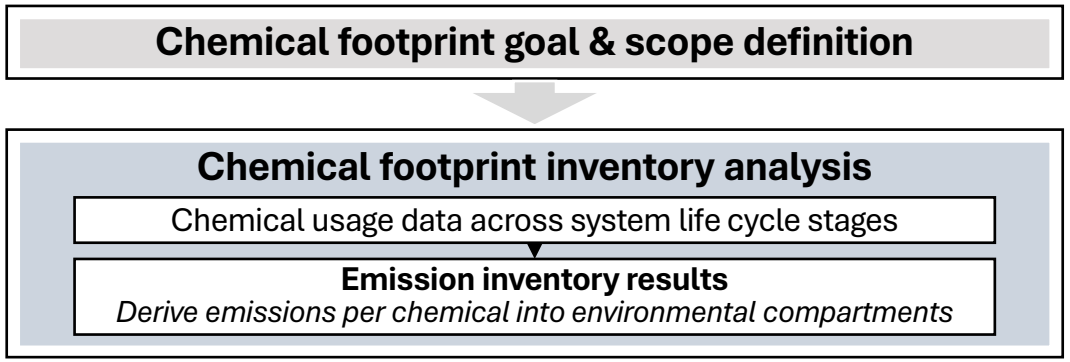


«Chemical Footprint Assessment» Phases

Chemical footprint goal & scope definition

— Defining **system boundaries**, decision context, etc.

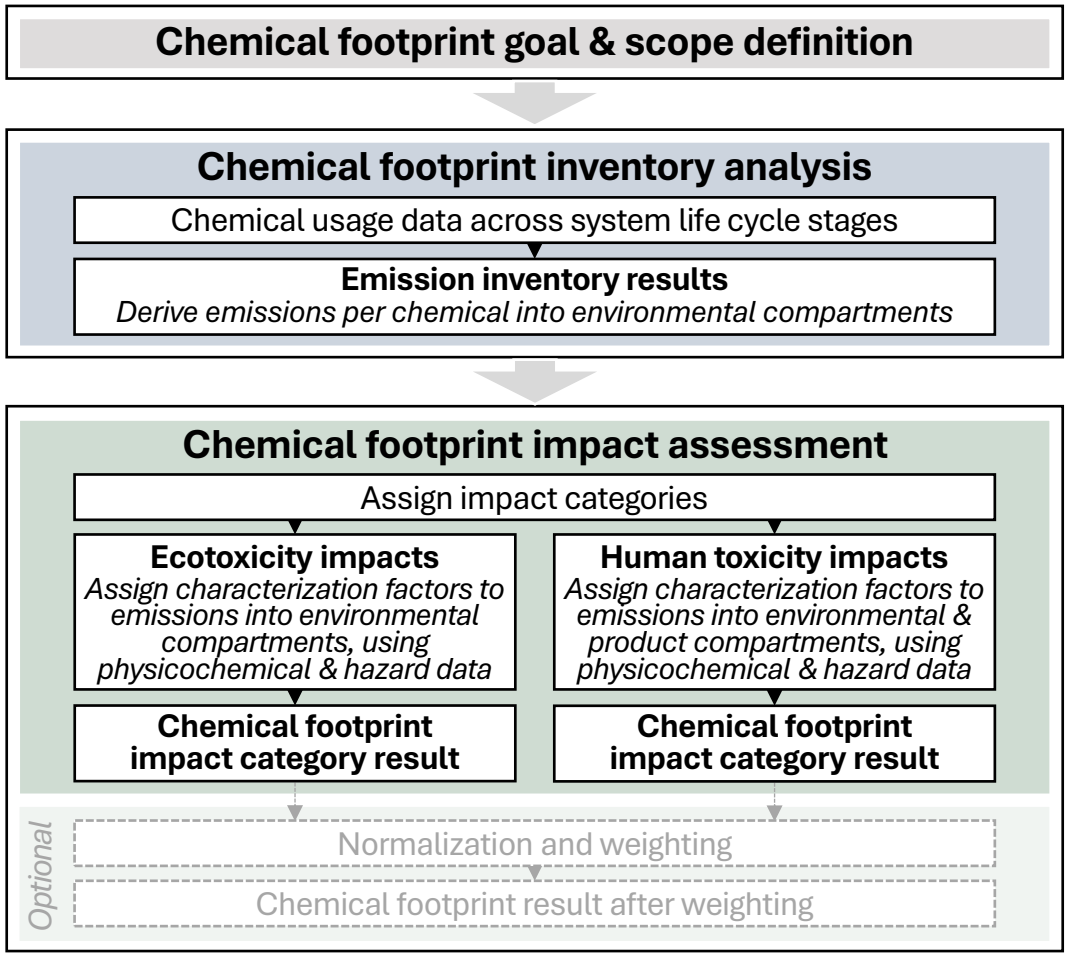
«Chemical Footprint Assessment» Phases



— Defining **system boundaries**, decision context, etc.

— Generating or gathering data on life cycle **inputs** from the environment and **outputs** to the environment (e.g. chemical emissions)

«Chemical Footprint Assessment» Phases

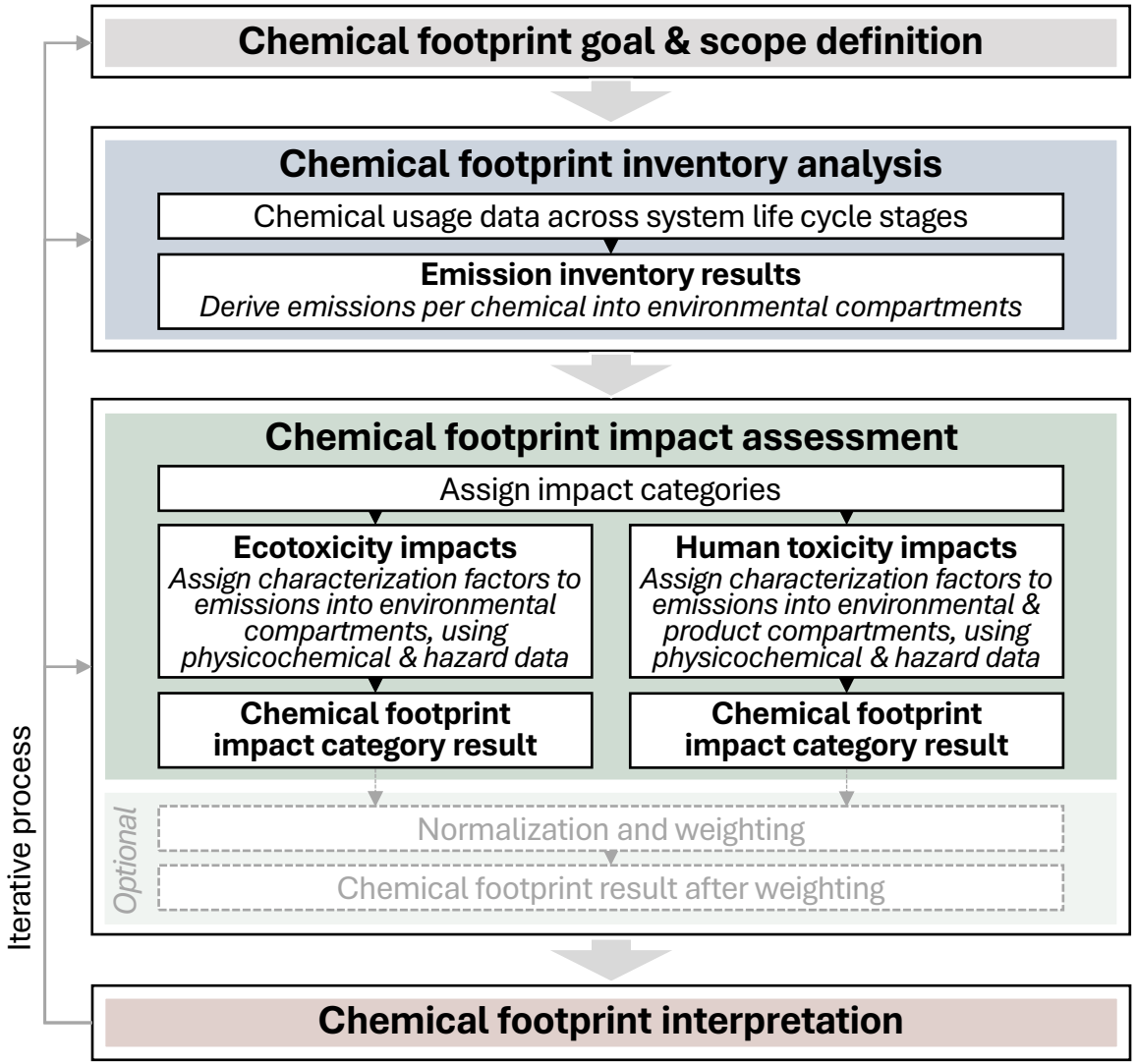


— Defining **system boundaries**, decision context, etc.

— Generating or gathering data on life cycle **inputs** from the environment and **outputs** to the environment (e.g. chemical emissions)

— Translating life cycle inputs and outputs into potential environmental impacts on humans and ecosystems (e.g. toxicity models providing impact **characterization factors** that consider *fate & persistence, bioaccumulation & mobility, and (eco-)toxicological effect potencies*), and combining inventory analysis with impact assessment results into **impact scores** as indicator results

«Chemical Footprint Assessment» Phases



— Defining **system boundaries**, decision context, etc.

— Generating or gathering data on life cycle **inputs** from the environment and **outputs** to the environment (e.g. chemical emissions)

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— Results **interpretation** (e.g. visualisation, decision support)

GFC Definition | «Chemical Footprint Approach»

Definition proposed by Working Group 1 of the GFC 'Chemical Footprint Workstream':

Data and methods that provide relevant contributions to a chemical footprint assessment for deriving a chemical footprint or one or more of its elements, that is chemical usage, and/or chemical emissions, and/or associated impact characterization factors

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Measured or estimated data on **chemical usage** and usage context (e.g. within a company)



Emission or release estimation, emission monitoring, analytical measurements, or emission databases



Models estimating **human toxicity & ecotoxicity impact potentials**, or pollution, exposure, effect monitoring data

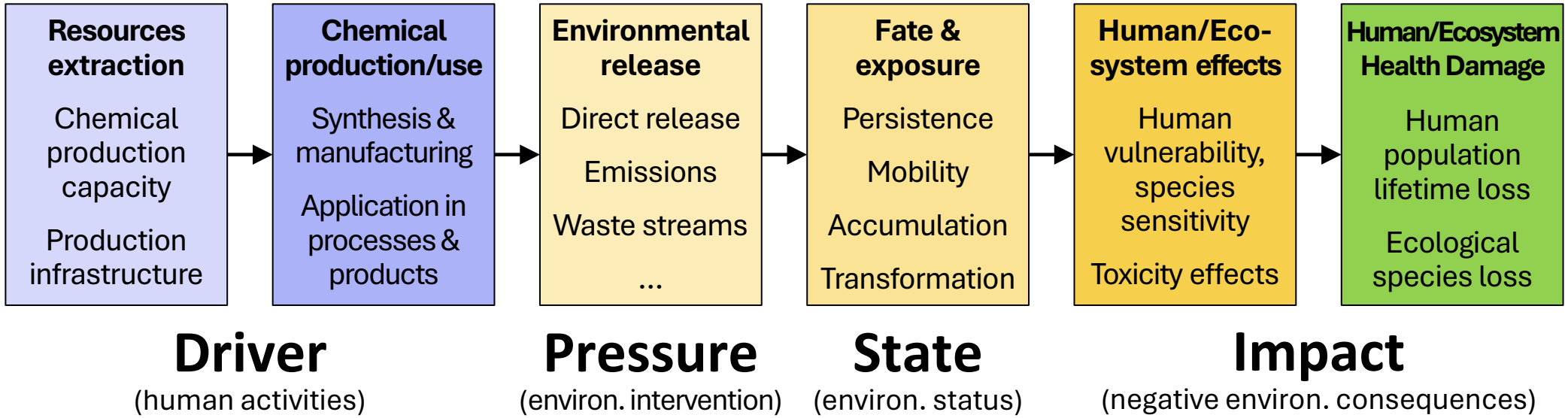
Chemical footprint approaches

(covering one or more elements related to chemical usage, chemical emissions or (eco-)toxicity impact)

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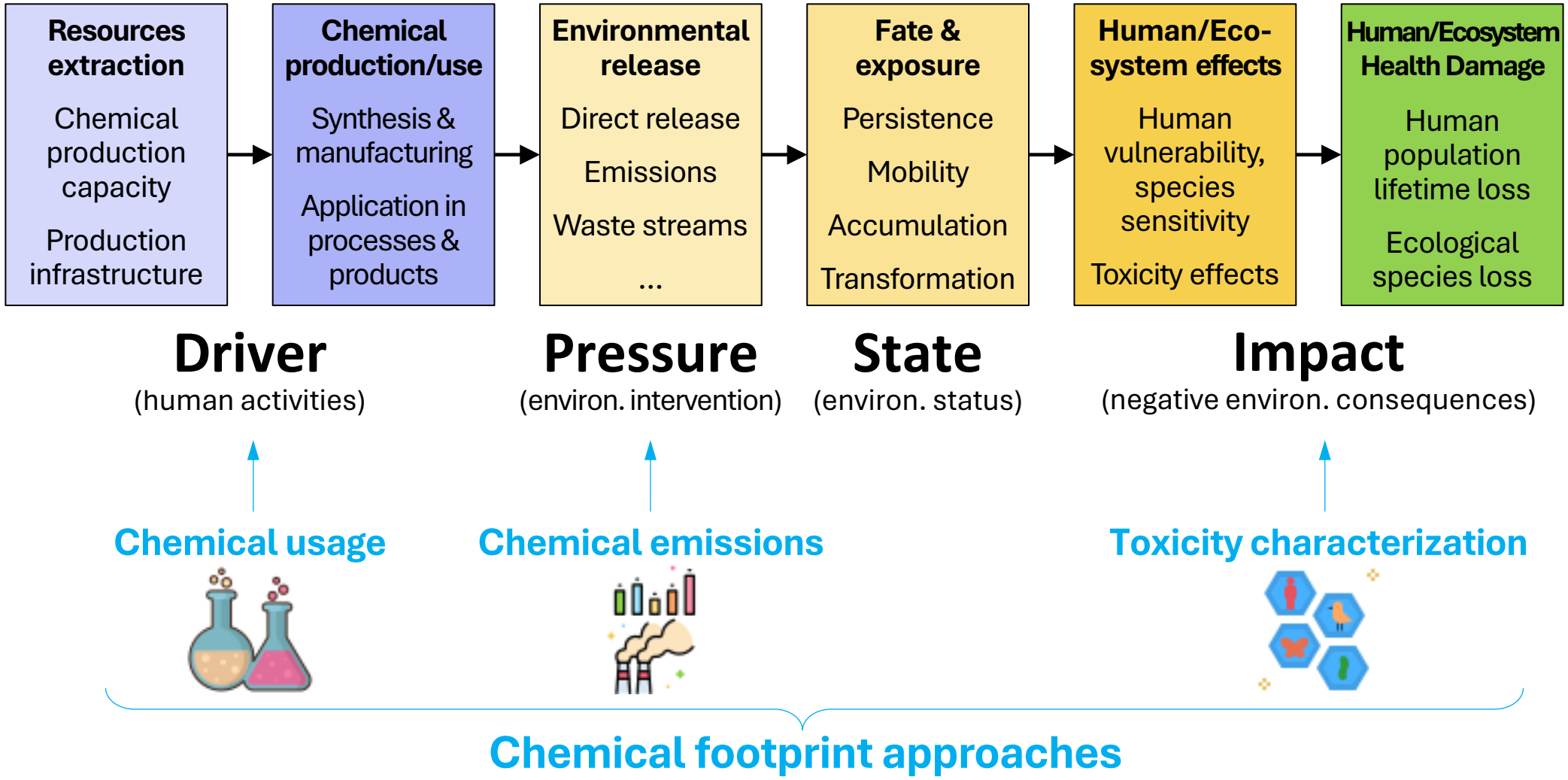
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Source-to-Impact | Chemical Footprint Elements



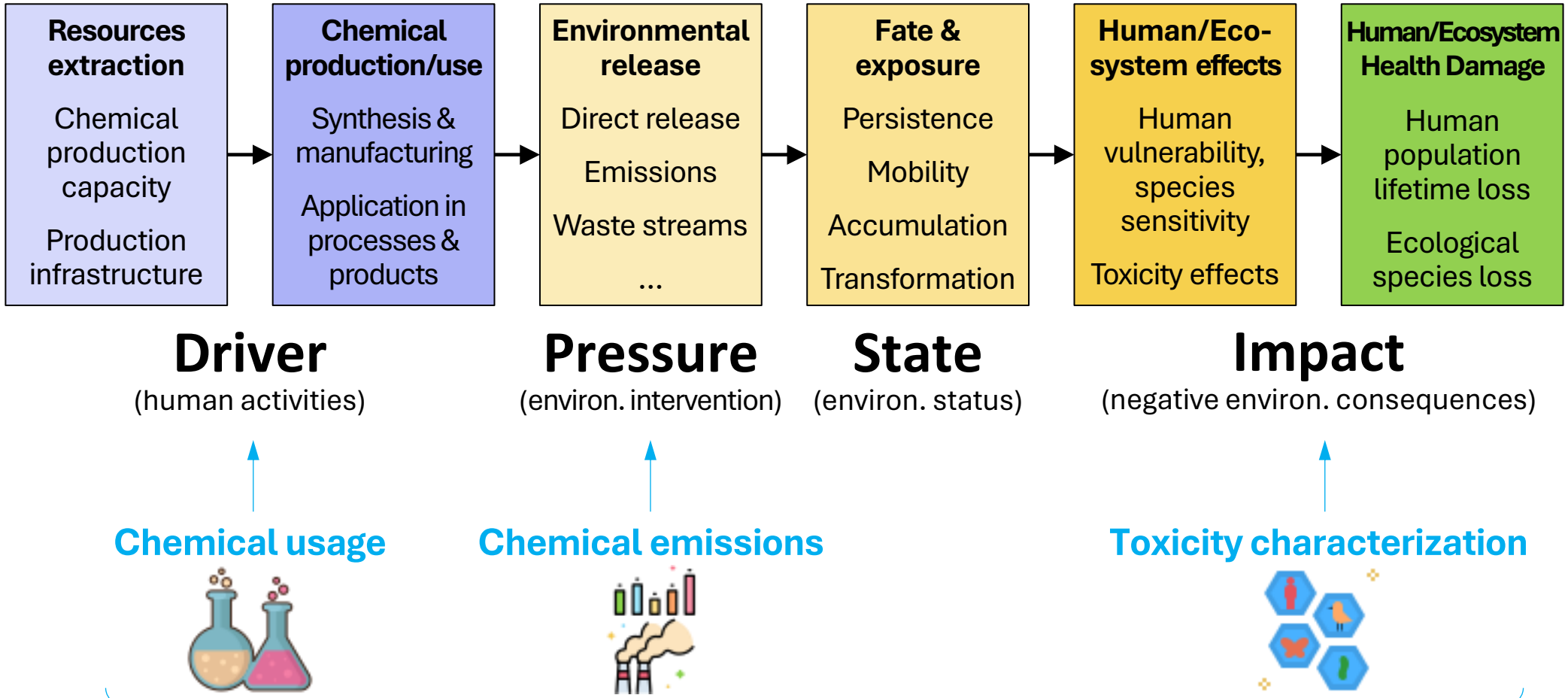
Adapted from Persson et al. 2022 · https://doi.org/10.1021/acs.est.1c04158

Source-to-Impact | Chemical Footprint Elements



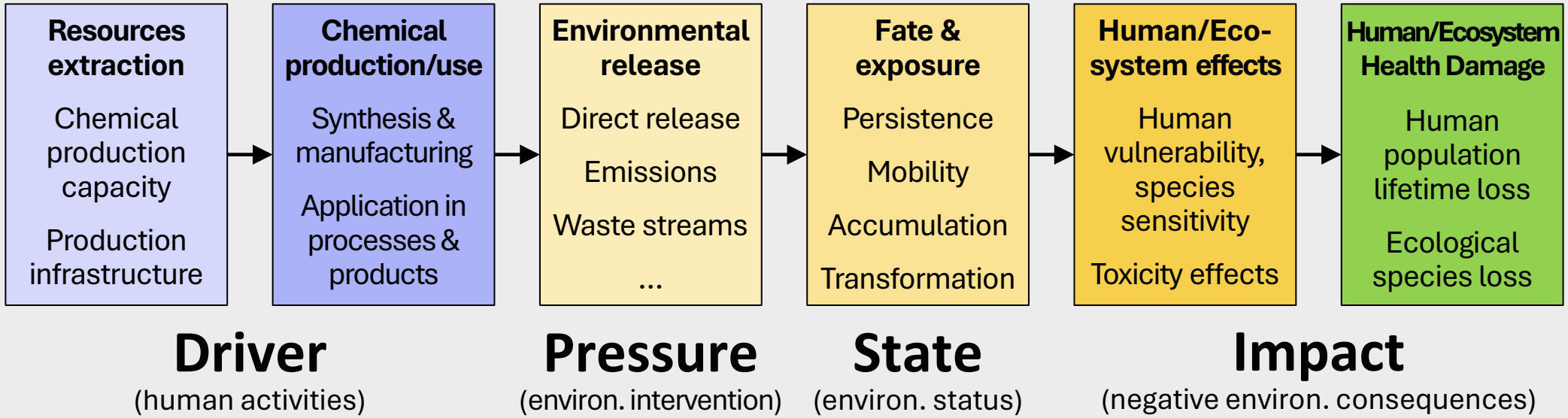
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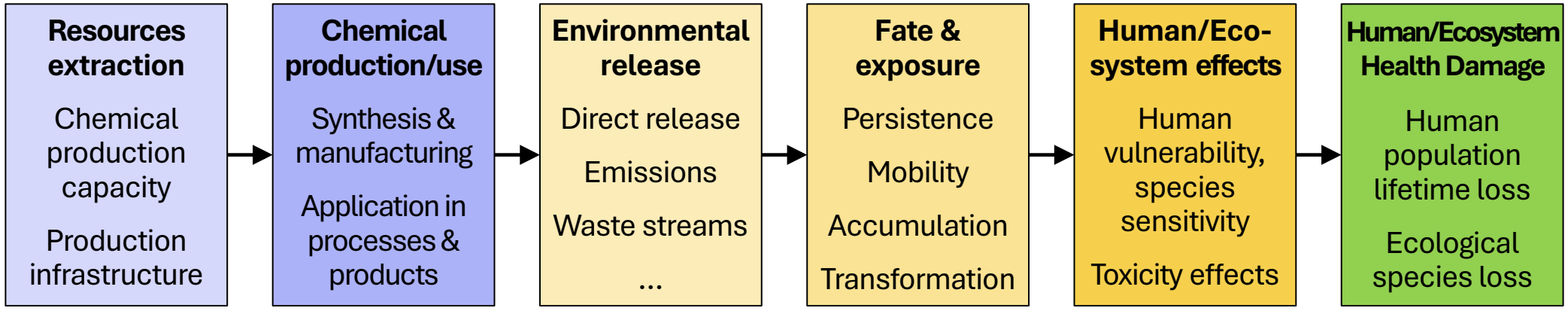


Chemical Footprint = Chemical Pressure × Impact Potential

→ Builds on combining chemical footprint approaches for usage, emissions & toxicity characterization

Adapted from Persson et al. 2022 · https://doi.org/10.1021/acs.est.1c04158

Source-to-Impact | Relation to Life Cycle Assessment



Driver (human activities)

Pressure (environ. intervention)

State (environ. status)

Impact (negative environ. consequences)

Environmental half-lives, bioconcentration factors, (eco-)toxicological effect data, ...

Hazard properties

(e.g. data used for GHS Classification)

Inventory Analysis

Life cycle input & output results

Impact Assessment

Human toxicity & ecotoxicity characterization factors

Adapted from Persson et al. 2022 · https://doi.org/10.1021/acs.est.1c04158

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Chemical Footprint Approaches

Chemical usage



Measured or estimated data on **chemical usage** and usage context (e.g. within a company)

--Example--

Danish national geospatial agricultural pesticide usage data

Chemical emissions



Emission or release estimation, emission monitoring, analytical measurements, or emission databases

--Example--

Environmental Genome Initiative™ supply chain emission data

Toxicity characterization



Models estimating **human toxicity & ecotoxicity impact potentials**, or pollution, exposure, effect monitoring data

--Example--

UNEP/SETAC USEtox® scientific consensus model human toxicity/ ecotoxicity impact characterization factors

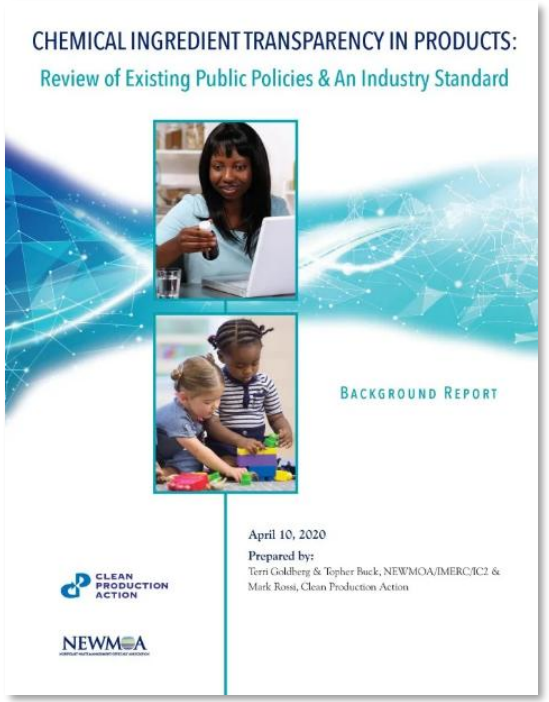
Chemical Footprint Approaches | Chemical Usage

What can it inform?

Can inform on chemical usage hotspots and on **GFC Target D6** in its intention “to reduce the[ir] … input [of chemicals of concern] along the value chain”

Example: BIZNGO overview of U.S. state policies for product transparency

- Health Product Declaration (HPD) Open Standard, Version 2.2
- New York Toxic Chemicals in Children's Products
- Oregon Toxic-Free Kids Act (TFKA)
- Vermont Chemical Disclosure Program for Children's Products
- Washington State Children's Safe Products Act (CSPA)
- California Cleaning Product Right to Know Act
- New York Household Cleansing Product Information Disclosure Program
- Interstate Mercury Education and Reduction Clearinghouse (IMERC)
- California Professional Salon Product Ingredient Disclosure
- California Safe Cosmetics Program
- New York Menstrual Product Labelling



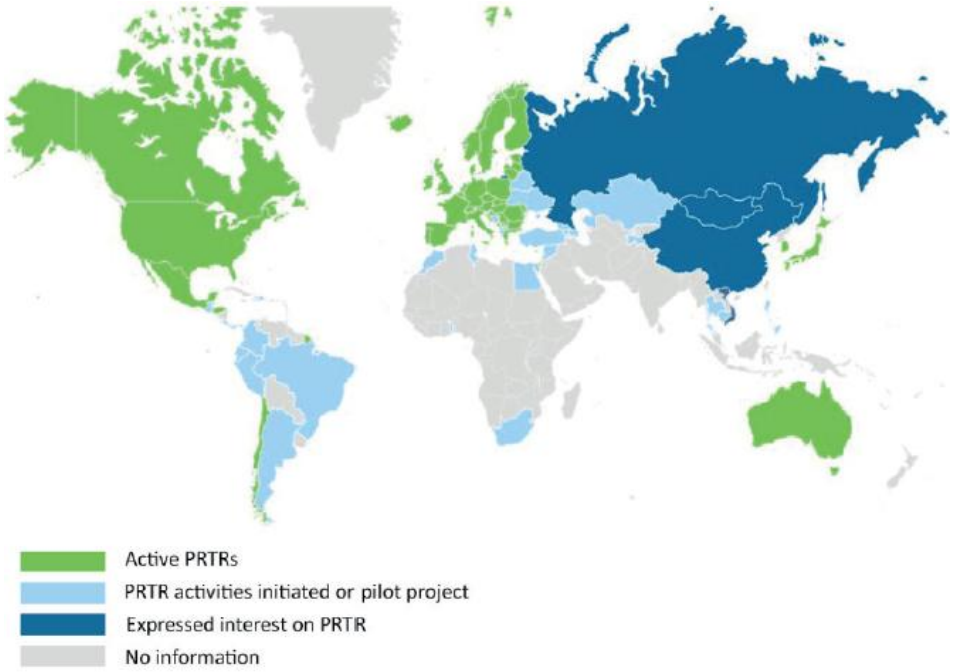
https://bizngo.org/resources/entry/chemical-ingredient-transparency-in-products

Chemical Footprint Approaches | Chemical Emissions

What can it inform?

Can inform on chemical usage hotspots and emission reporting compliance of industry sectors and nations, specifically for industrial facilities and installations during operation

Example: Planet Tracker's footprint analysis based on PRTR data





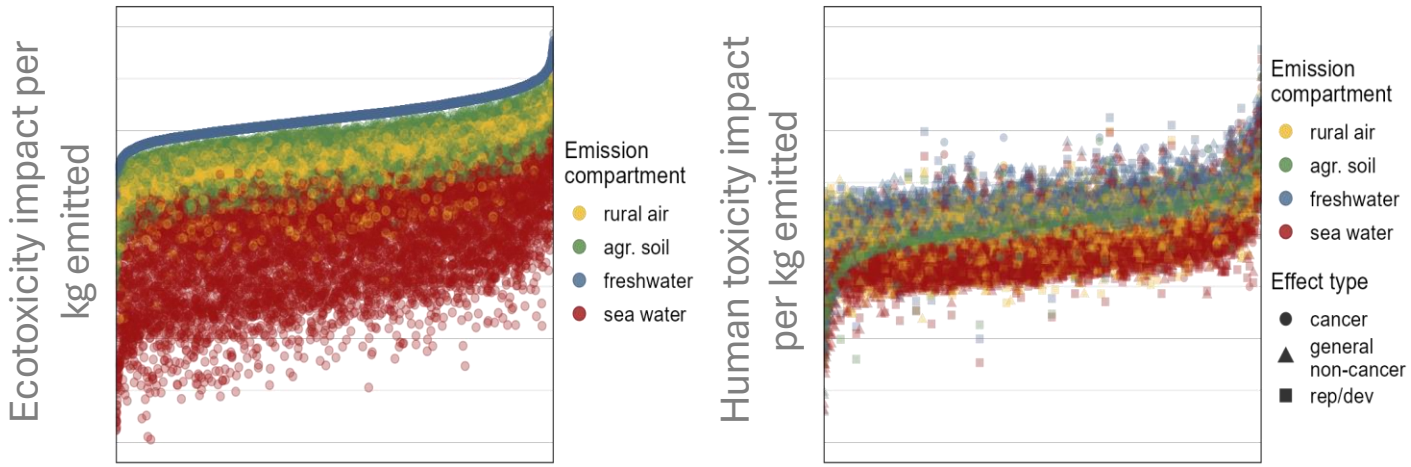
https://planet-tracker.org/toxic-footprints-europe

Chemical Footprint Approaches | Toxicity Characterization

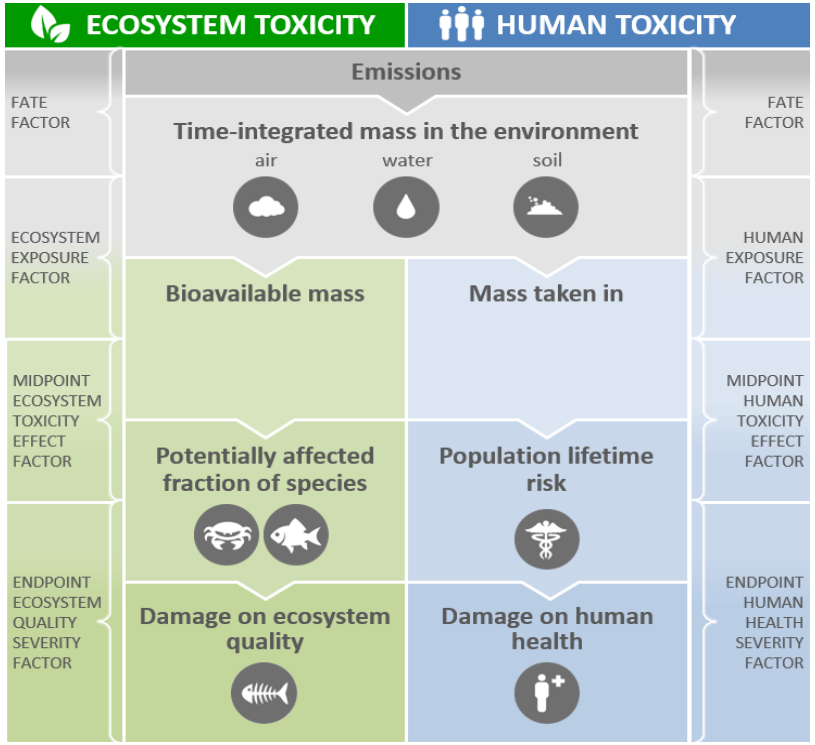
What can it inform?

Can inform on human toxicity & ecotoxicity hotspots, identify main contributors to impact and impact reduction options, and inform on **GFC Target D6** to "identify priority chemicals of concern" and "reduce their impact"

Example: UNEP USEtox scientific consensus model



Impact characterization factors for ~10,000 chemical substances

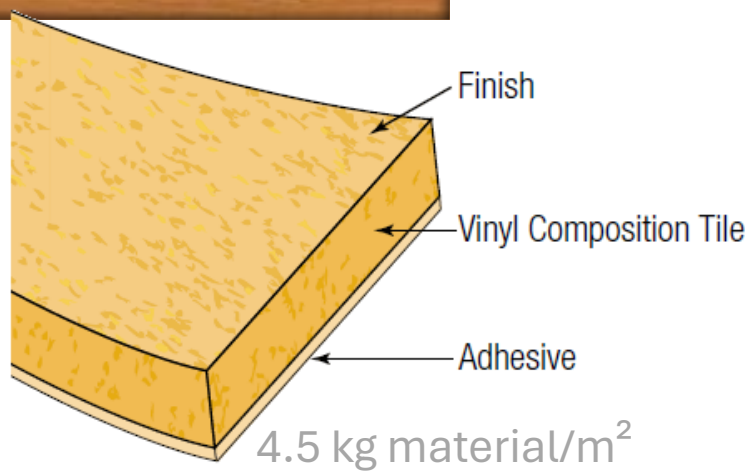


https://usetox.org

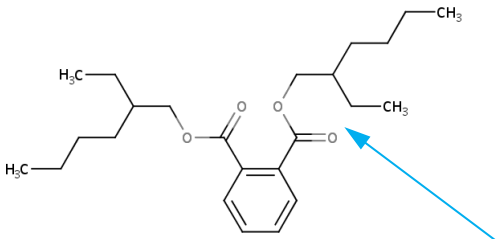
Chemical Footprint Approaches | Toxicity Characterization

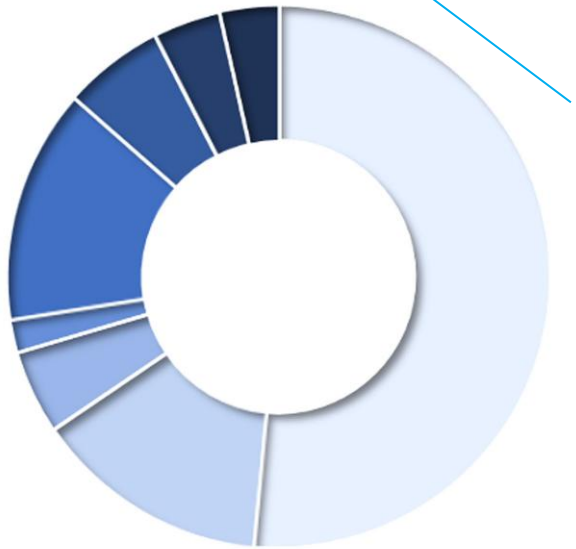
Example: substitution of hazardous plasticizer in 100 m^2 vinyl flooring/household





4.5 kg material/m^2





- 50-95% PVC polymer
- 0-50% Plasticizer
- 0.2-5% Stabilizer
- 0.1-2% Lubricant
- 1-50% Filler
- 0-10% Reinforcement
- 0-5% Pigment
- 0-5% Sundry

Chemical footprint study at impact level:

→ Di(2-ethylhexyl) phthalate (DEHP) identified as candidate for substitution

→ 2 viable alternatives identified with lower impact across entire life cycle

Fantke et al. 2020 · https://doi.org/10.1039/D0GC01544J

Remaining Challenges | Addressing Limited Capacity

— Common **challenges** for low/middle income countries (LMIC) and small/medium enterprises (SME)

- Data scarcity and missing data needed for chemical footprint assessment
- Constraints in expertise and infrastructure to apply chemical footprint approaches
- Limited human and economic resources to execute chemical footprint assessments

Remaining Challenges | Addressing Limited Capacity

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- Constraints in expertise and infrastructure to apply chemical footprint approaches
- Limited human and economic resources to execute chemical footprint assessments



— Implementation options for **progressive adoption** of chemical footprint assessments with limited capacity

- ✓ Start with covering specific chemical footprint elements (e.g. chemical usage data collection)
- ✓ Adopt existing approaches followed by companies/others (harvest expertise, methods and data used where feasible)
- ✓ Build on tools that are widely adopted and available in various software applications, and collaborate with experts generating data and providing impact factors
- ✓ Contribute to a common understanding and **standardized** chemical footprint method

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UN environment programme | Global Framework on Chemicals

Chemical footprint

Standardization process

Weijia Xia
International Department, China Association for Standardization

Actions to be Taken | Next Step

The role of **ISO standards** in global markets is to establish consistent, comparable frameworks that build trust and enable coordinated action across industries and regulators.

ISO/TC 207 and SC 5 have published carbon footprint and water footprint standards, with an active workplan extending environmental accounting across key impact categories.

Internal Implementation Benefits
Unified, risk control, quality stability, easier audits, capability

Supply Chain Positive Influence
Consistent baseline, reduced variability, transparent and traceable, alignment

International Trade Promotion Effect
Remove technical barriers, credibility and market access, reduce costs, fair trade

Reference ↑	Title
ISO/TC 207/SC 1	Environmental management systems
ISO/TC 207/SC 2	Environmental auditing and related practices
ISO/TC 207/SC 3	Environmental labelling
ISO/TC 207/SC 4	Environmental performance evaluation
ISO/TC 207/SC 5	Life cycle assessment
ISO/TC 207/SC 7	Greenhouse gas and climate change management and related activities
ISO/TC 207/SLG	Strategic Leadership Group
ISO/TC 207/STTF	Spanish translation task force
ISO/TC 207/TCG	Terminology Coordination Group
ISO/TC 207/TF 1	Communications
ISO/TC 207/TG 1	Sustainable Finance Coordination

ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification	90.92	13.020.40
ISO 14046:2014 Environmental management — Water footprint — Principles, requirements and guidelines	90.60	13.020.10 13.020.60

Actions to be Taken | Next Step

New Work Item Proposal titled on *Chemical footprint — terminology and framework*, providing a structured terminology and methodological framework for assessing chemical footprints

comments

share comments and inputs to the proposal

communication

communicate with your National Standard Body (NSB) the importance of the proposal

engagement

participate the workshop during 2026 Plenary Meeting of ISO/TC 207 in Shanghai in December

vote

vote for the NP of ISO standard in ISO/TC 207/SC5

register

participate and register as experts to the work item in ISO/TC 207/SC5

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Take-Home Points

Chemical Footprint – Toward a globally harmonized definition

- Alignment with other footprints as an LCA-based, impact-level metric
- Usage, emissions, and impact potentials are central elements
- ISO-standardization process for global acceptance needed



Take-Home Points

Chemical Footprint – Toward a globally harmonized definition

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- Usage, emissions, and impact potentials are central elements
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Chemical Footprint Approaches – Many, but still limited scope

- Chemical usage data efforts by industry ongoing, but often proprietary data
- National emission inventories, best for pesticides + selected pollutants
- Toxicity impact factors ready for use, but missing for many chemicals



Take-Home Points

Chemical Footprint – Toward a globally harmonized definition

- Alignment with other footprints as an LCA-based, impact-level metric
- Usage, emissions, and impact potentials are central elements
- ISO-standardization process for global acceptance needed

Chemical Footprint Approaches – Many, but still limited scope

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Toward viable Chemical Footprint Application in Practice

- Pilots in GFC sectors important ‘test environments’ for operationalization
- High resolution enables management decisions & viable substitution

Global collaboration, transparency & agreed approaches are success criteria!

UN environment programme | Global Framework on Chemicals

Thank you for your part in creating a planet free of harm from chemicals and waste.

Contact us at: unep-gfc.secretariat@un.org

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GFC (2026). Chemical Footprint – Terminology and Methodological Framework. Global Framework on Chemicals, UNEP. Available at https://iomcwebinars.org/chemical-footprint-approaches