Government of Canada / Gouvernement du Canada

Ecological Risk Assessment

Chile-Canada Webinar

November 15, 2018

CHEMICALS MANAGEMENT PLAN

PLAN DE GESTION DES PRODUITS CHIMIQUES

Canada

Outline

- Ecological Assessments Under CEPA
- Ecological Prioritization Approaches
  - Ecological Risk Classification (ERC) for organic substances
- Ecological Risk Assessment
  - Hazard Assessment
  - Exposure Assessment
  - Risk Characterization and Uncertainties
  - Consultation and Review Process

Ecological Risk Assessments under CEPA

- CEPA requires the assessment to determine if a substance is entering or may enter the environment in a quantity or concentration or under conditions that:
  - a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity
  - b) constitute or may constitute a danger to the environment on which life dependsand/or
  - c) constitute or may constitute a danger to human life or health in Canada

- CEPA also stipulates that substances assessed to be harmful to human health and/or the environment are risk managed.

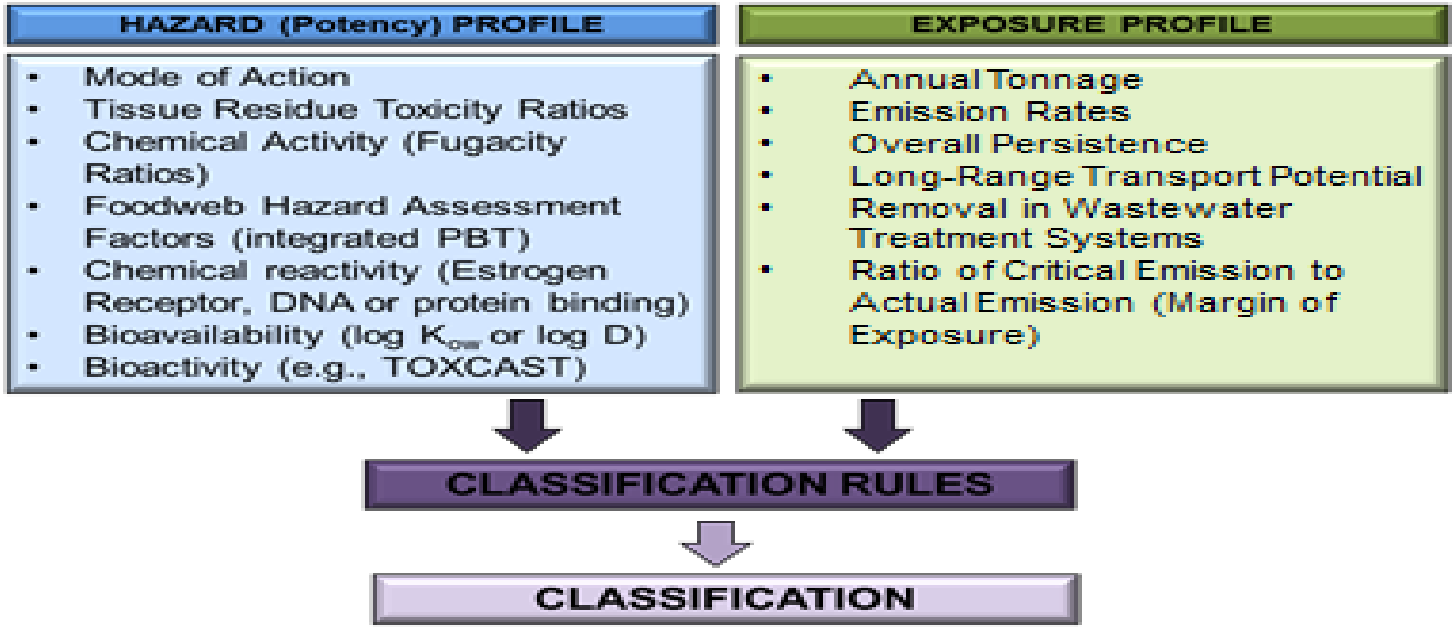
Ecological Prioritization Approaches

Ecological Risk Classification (ERC)

- ERC applies a weight-of-evidence for determining risk classification, including multiple descriptors as lines of evidence for both hazard and exposure
- The various lines of evidence are combined using classification rules to prioritize chemicals based on their potency (Hazard Class 1-3) and potential for exposure (Exposure Class 1-3) according to a risk classification matrix
- ERC2 is being developed for use in prioritization activities post- 2020

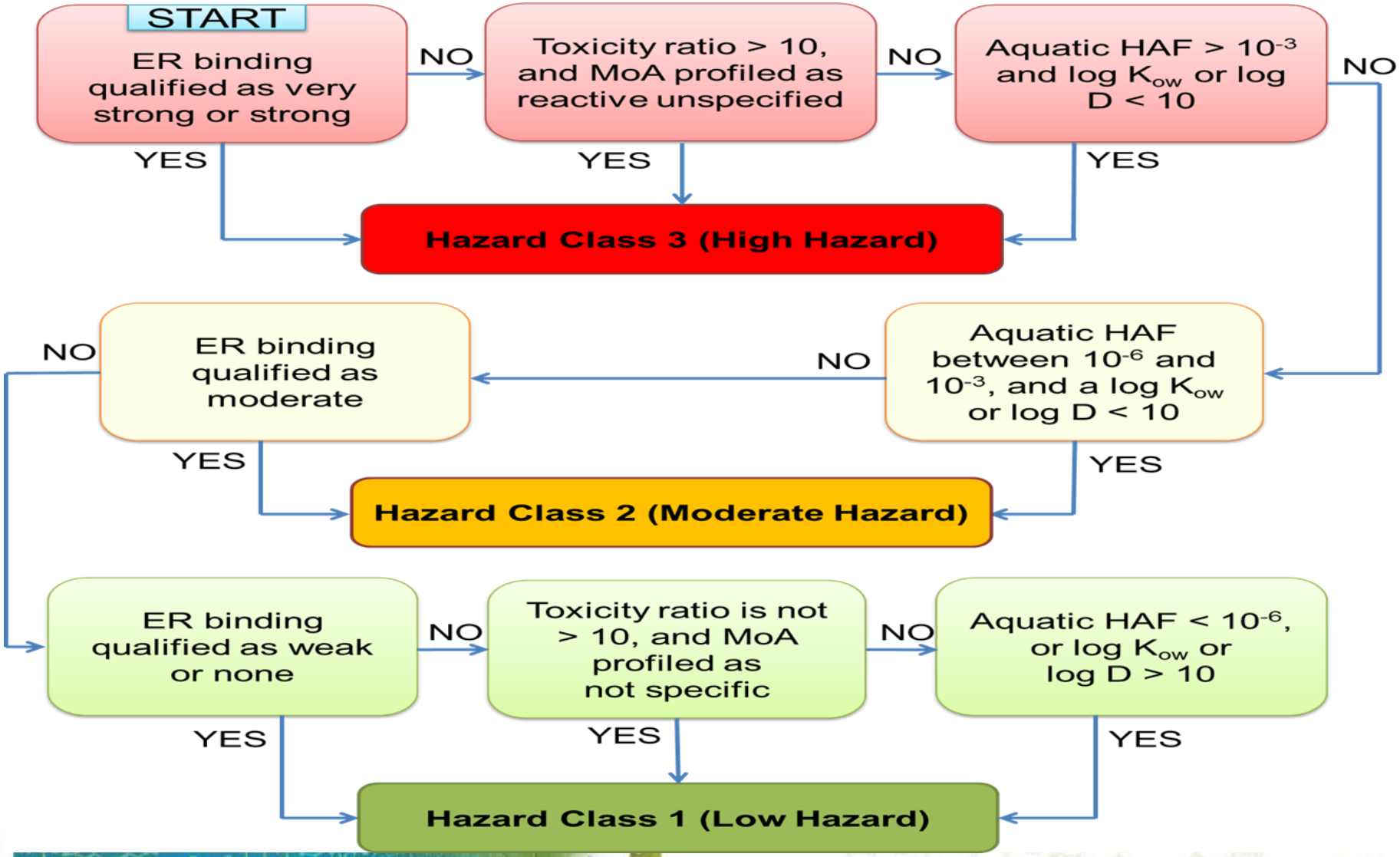
	Hazard Class 1	Hazard Class 2	Hazard Class 3
Exposure Class 1	Low	Low	Moderate
Exposure Class 2	Low	Moderate	High
Exposure Class 3	Low	Moderate	High

Ecological Risk Classification (cont')



- [ECCC] Environment and Climate Change Canada. 2016. Science approach document: ecological risk classification of organic substances. Gatineau (QC): ECCC. http://www.ec.gc.ca/ese-ees/A96E2E98-2A04-40C8-9EDC-08A6DFF235F7/CMP3%20ERC_EN.pdf
- OECD Integrated Approaches to Testing and Assessment (IATA) Case Studies Project (http://www.oecd.org/chemicalsafety/risk-assessment/iata-integrated-approaches-to-testing-and-assessment.htm

Preliminary Hazard Classification Criteria



ERC Hazard Profile Example

Hazard Profile Descriptors		CAS RN 98-54-4 Phenol, 4-(1,1-dimethylethyl)-	Notes
Mode of action	OASIS MoA profiler	Phenols and anilines	Bins chemical based on MoA (OECD Toolbox)
	MoATox database by US EPA	Narcosis	When available used as supporting info to provide insight into empirical MoA
	Toxicity ratio	3.8	Ratio baseline to specific tox; >10 =↑ potency
	Chemical activity	0.01	LC50/WS; narcosis (0.01-0.1), ↑ potency <<0.01
HAF	Aquatic food web	$>10^{-6}$	=conc in most sensitive foodweb organism/CBR
Chemical Reactivity (OECD Toolbox)	ER binding	Weak binder	ER binding Profiler
	DNA binding	No alert	Structural & Mutagenicity Profilers
	Protein binding	No alert	Structural & Reactivity Profilers
	AR binding	Active	AR binding Profiler
Bioavailability	log Kow or log D	3.3 (Bioavailable)	log Kow or log D > 10 indicates ↓bioavailability
Bioactivity	ToxCast, Tox 21	Bioactive	In vitro alerts used as supporting info

Moderate hazard classification under ERC

Risk Assessment Toolbox

Type 1 Approach

- Addresses the substance/group with a science-based policy response
- Used when regulatory assessment conclusion under s.64 of CEPA 1999 is not suitable
- Examples include: Referring to a better placed program (e.g., foods); documentation of previous action under *CEPA 1999*

Type 2 Approach

- Addresses substances using a broad-based approach, often based **on low potential for exposure and conservative scenarios**
- Substances do not meet criteria under s.64
- Examples include: Rapid Screening; Threshold of Toxicological Concern type approaches

Type 3 Approach

Low

Level of Complexity

High

Type 3-1

- Addresses the substance/group with a reduced amount of effort for streamlined hazard and/or exposure analysis
- Examples include: Use of international hazard characterizations; use of biomonitoring data; qualitative assessment

Type 3-2

- Substance/group requires de novo risk assessment

Type 3-3

- A complex assessment is required for the substance/group that may require cumulative assessment approaches

RM actions for those meeting s.64; additional information gathering and source attribution may be required to inform risk management

Ecological Risk Assessment

Ecological Risk Assessment Objectives

- **Hazard assessment**
  - Considers environmental fate (persistence, environmental partitioning and bioaccumulation) and effects data (including the potential for endocrine disruption) and the mode of action
  - Multiple toxicity endpoints are evaluated to establish the predicted no effect concentration (PNEC) in the most sensitive species or based on a species sensitivity distribution
- **Exposure assessment**
  - Realistic worst-case estimates of exposure expressed as predicted environmental concentration (PEC) in various environmental media
  - PECs can be based on environmental monitoring data and/or estimated based on environmental emissions
- **Risk characterization**
  - Comparison of PEC to PNEC
  - Consideration of key lines of evidence and uncertainties

Hazard Assessment

Hazard Assessment Approach

- Considers environmental fate (persistence, environmental partitioning and bioaccumulation) and effects data (including the potential for endocrine disruption) and the mode of action:

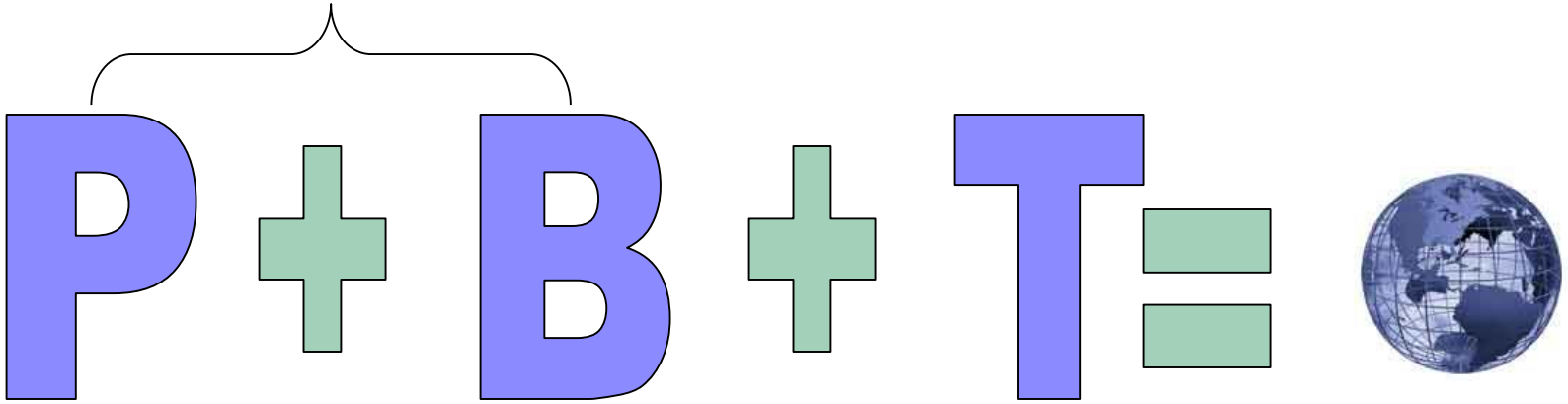
  - Toxicity data for aquatic, benthic (sediment), terrestrial (plants / soil-dwelling) and wildlife organisms

  - Selection of critical toxicity values for relevant groups of organisms and (deterministic approach), or use species sensitivity distributions (probabilistic approach) to derive PNECs

  - Multiple toxicity endpoints are evaluated to establish the predicted no effect concentration (PNEC) in the most sensitive species or based on a species sensitivity distribution

The Hazard Assessment Approach (cont') - PBiT

A substance that is highly persistent and bioaccumulative means it has the potential to be found in most environmental matrices including biota and will slowly increase in concentration over time



A substance that is highly persistent means it has the potential to be found in most environmental matrices and possibly remote environments

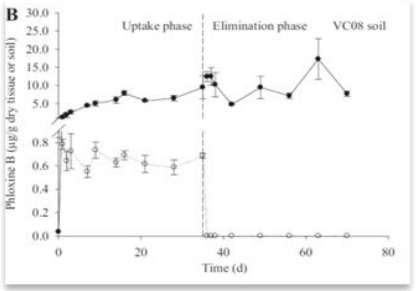
A substance that is highly bioaccumulative means it has the potential to be found in the tissues of biota and maybe transferred in foodwebs

A substance that is considered inherently toxic may cause serious effects in exposed ecological populations

A substance that is (PB)T has the potential for widespread ecological damage should it be released in sufficient quantity to the environment

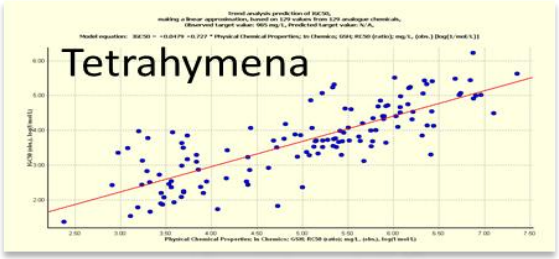
The Hazard Assessment Approach (cont') - MoA

toxicological endpoints of concern (Developmental and Reproductive Toxicology (DARTs)) and the plausible mechanisms from which the associated effects are caused

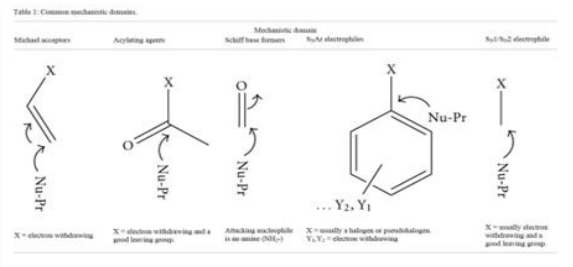


Binding Leads to Different Tissue Distribution

Dermal Effects (~sensitization)



Protein Binding Mechanism



TOXCAST Protein Damage (e.g., NCGC Assay)

Gathering of Hazard Information

Ecotoxicity data is collected and reviewed, including laboratory and field studies for from acute and chronic tests, where available:

- Chemical-specific empirical toxicity data
- *in vivo* effects related to growth and development/maturation, reproduction, neurotoxicity, and endocrine-related endpoints
- Data gaps filled with predictive tools:
  - *in silico* (computer modelling)
  - *in vitro*
  - Chemical analogues for “read-across” (endpoint information for one chemical (the source chemical) is used to predict the same endpoint for another chemical (the target chemical), which is considered to be "similar" in some way usually on the basis of structural similarity)

Data Quality and Acceptance

- The quality of empirical data is assessed using a robust study evaluation
- Only quality data are used for assessment as a rule:
  - Some exceptions to this rule may be necessary if data availability is extremely low and the data are critical for the assessment.
  - Lower data quality is then noted as a contributor to the overall uncertainty in the assessment
- Empirical data can be combined with predicted data to achieve a more robust dataset for weight of evidence considerations

New Approach Methodologies (NAM)

- The application of high-throughput screening (HTS) data is being explored where there will be a paucity of empirical data

- HTS assays are used to rapidly describe concentration response curves for multiple toxicity endpoints, across a broad range of concentrations for large numbers of compounds

- There is broad international interest in using emerging technologies for regulatory risk assessment:
  - US EPA ToxCast™ and ExpoCast high-throughput projects
  - US EPA Endocrine Disruption Screening Program (EDSP)
  - OECD Adverse Outcome Pathways and Integrated Approaches to Testing and Assessment (IATA)
  - Human Genome Project (Pathways of Toxicity)
  - ILSI-HESI Framework for Intelligent Non-animal Methods for Safety Assessment
  - Accelerating the Pace of Chemical Risk Assessment (APCRA)

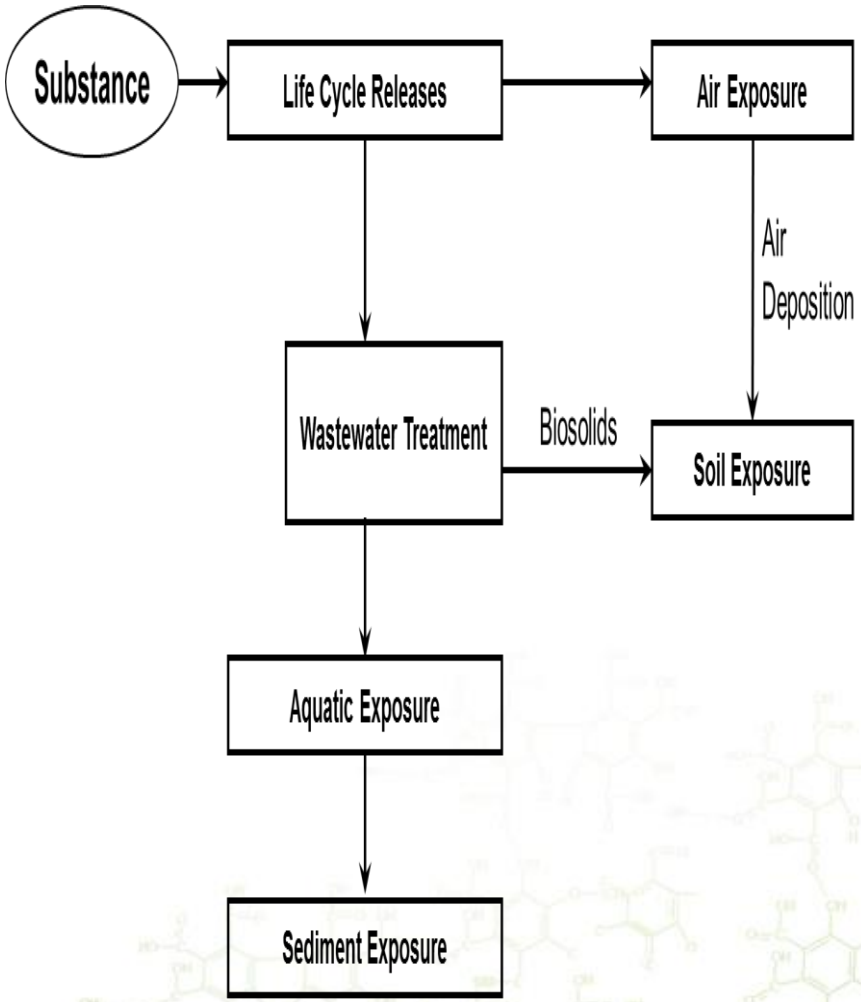
Exposure Assessment

Exposure Assessment

Exposure assessment consists of determining the entry of a substance into environmental media (i.e, air, water, sediment, soil), its fate and resulting concentrations in those media

The output of the exposure assessment is the Predicted Environmental Concentration (PEC) for different media of concern:

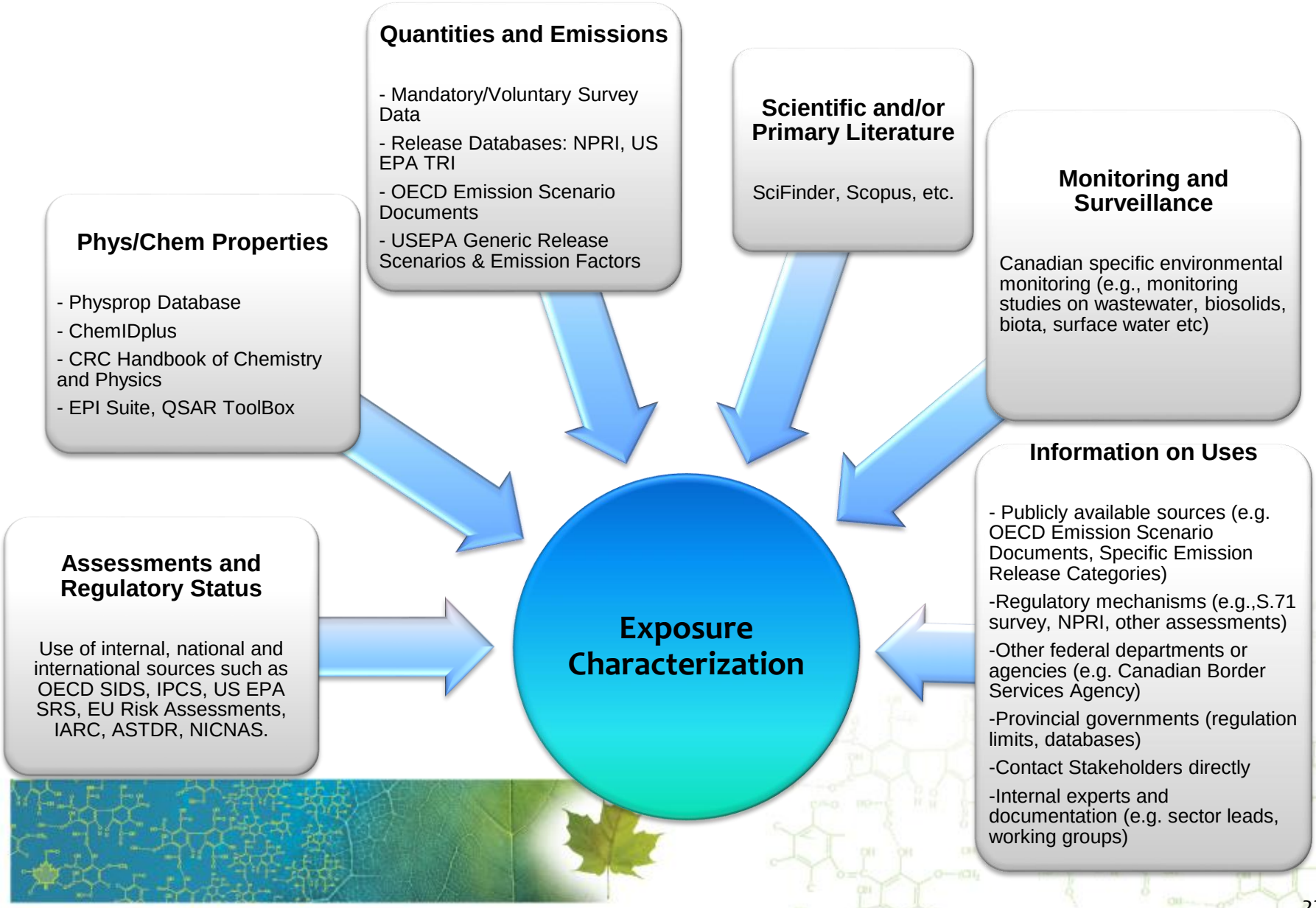
- Realistic worst-case estimates of exposure expressed as PEC in various environmental media
- PECs can be based on environmental monitoring data and/or estimated based on evaluation of environmental emissions



Exposure Assessment (cont')

- Exposure assessment uses data from industrial sectors, product use, and substance phys-chem properties:
  - Early engagement of stakeholders is beneficial
  - Lack of data results in the use of generic and typically conservative assumptions
- Exposure assessment is a iterative and tiered process - there is always room for improvement with continuous searches for new sources of information, approaches and documentation
- Exposure characterization describes potential or actual contact or co-occurrence of stressors with receptors (e.g. stressors are chemicals and receptors are organisms)

Sources of Exposure Data



Exposure Assessment Approaches (Scenarios)

Different approaches or tools may be used to characterize exposure:

- Use information from specific sites in a sector:
  - May be suitable for situations where limited number of sites are involved with no realistic expectation for substantial market change
- Selecting a few facilities as representative “realistic worst-case scenario for the sector”:
  - Representative “site” could be based on a description of the sector rather than a location
- Generic sector scenario:
  - Typically use input distributions and probabilistic approach
  - May be suitable for situation where substances are used by multiple (most) facilities within a sector

Exposure Assessment Approaches (Consumer Products)

- Exposure from activities over the lifetime of a substance is considered from manufacture of substance to use in formulating products and consumer or professional use of products

- For consumer uses, focus is mainly on down-the-drain scenarios:

    - Releases and exposure in the environment are often assumed to be of lesser concern because of dispersive nature of releases

    - Very limited data available to develop these scenarios

    - When appropriate, environmental exposure resulting from large quantity uses of consumer products is considered

Exposure Modelling

- **Typical aquatic exposure**
  - Industrial facilities release equation
  - Down-the-drain consumer product use (Consumer Release Aquatic Model - CRAM)

- **Typical sediment exposure**
  - Calculation of equilibrium partitioning between water column and sediment

- **Typical air exposure**
  - SCREEN3
  - AERMOD (more refined)

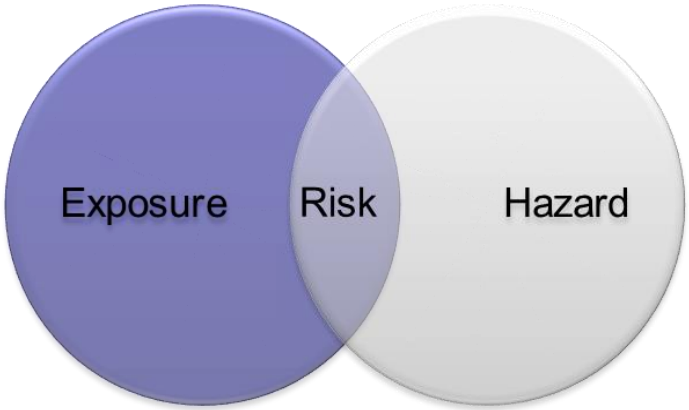
- **Typical soil exposure**
  - BASL4 or similar calculation (exposure resulting from application of biosolids)
  - AERMOD and soil spreadsheet (exposure resulting from deposition)

- **Wildlife exposure**
  - BASL4 or similar calculation for worm or shrew
  - Calculation methods for benthic organisms and fish
  - Spreadsheet model based on USEPA Wildlife Handbook considering food chain transfer

Risk Characterization

Risk Characterization

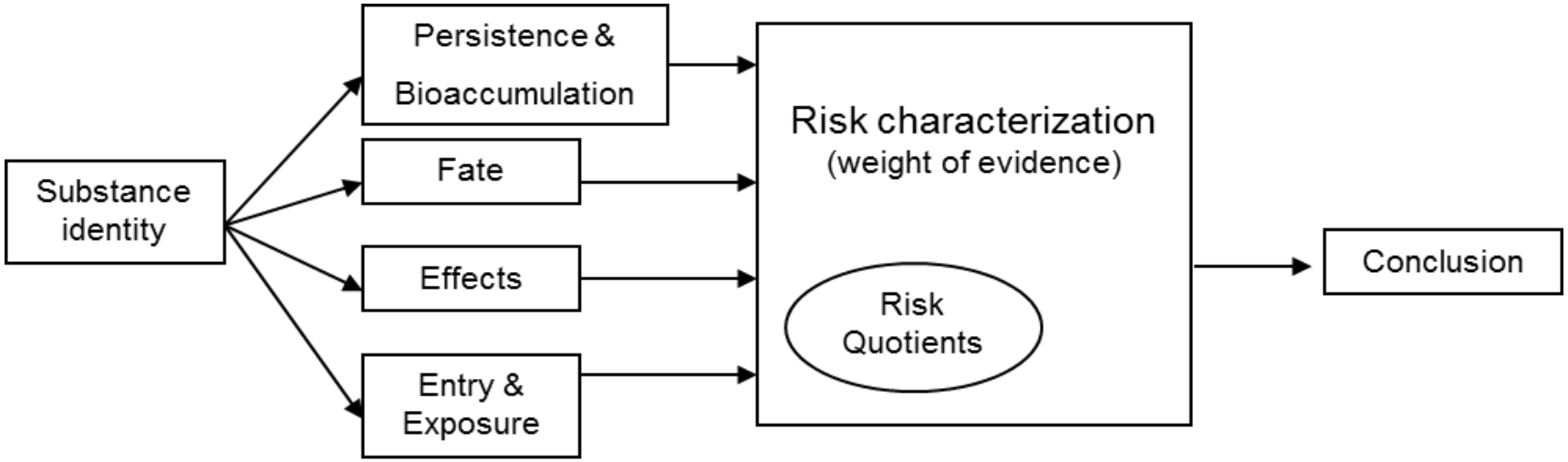
Risk characterization is a risk-based approach that considers both exposure and hazard



Characterization of ecological risk determines whether there is potential for ecological concern:

1. Calculation of risk quotients (PEC/PNEC)
2. Consideration of all lines of evidence (e.g., observed trends, persistence, bioaccumulation, risk quotients, endocrine effects, cumulative effects, etc.)
3. Uncertainties

Risk Characterization



One of the lines of evidence is the risk quotient:

$$\text{Risk Quotient (RQ)} = \frac{\text{Predicted Environmental Concentration (PEC)}}{\text{Predicted No-Effect Concentration (PNEC)}}$$

RQ > 1 indicates that exposure is above effects threshold

RQ < 1 indicates that exposure is below effects threshold

Characterization of Uncertainty

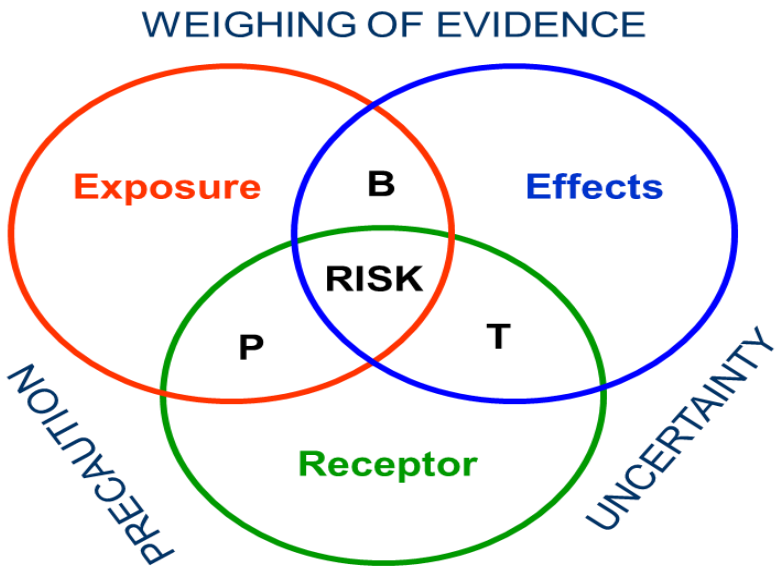
- The characterization of uncertainty is to indicate the overall confidence and uncertainty in the exposure and hazard assessment based on:
  - Quality and amount of relevant data incorporated
  - Identification of any significant data gaps in the assessment
  - Description of any important issues with studies used to estimate exposure (e.g., use of limited data from other countries) or characterize hazard (e.g., uncertainty regarding species differences in sensitivity)
  - Key assumptions inherent in models and defaults
  - Specify whether the uncertainties could result in an underestimation or overestimation of risk

Weight of Evidence

- Under Section 76.1 of *Canadian Environmental Protection Act, 1999* (CEPA), **must apply** a weight of evidence (WoE) approach and the precautionary principle when assessing substances
- ECCC is co-leading with ECHA the development of OECD guidance on WoE in Chemical Evaluation

Risk is thus encountered when exposure concentrations exceed effects concentrations for receptors we are trying to protect (i.e., "CEPA Toxic")

Exposure assessment determines the predicted environmental concentration (PEC) of a new substance which is a function of chemical release rate, chemical fate and degree of organism contact



Understanding a substance's fate in the environment helps determine where a substance will reside, for how long and how a receptor may come into contact with it

The aim of effects assessment is to determine a substance concentration that results in no observable adverse effects to ecological organisms over a long term. Called the predicted no effect concentration (PNEC)

Receptor characterization determines which ecological receptors are potentially exposed and which are sensitive species. Answers "what are we trying to protect" question

- **ECCC's factsheet on WoE is available online:** https://www.canada.ca/en/health-canada/services/chemical-substances/fact-sheets/application-weight-of-evidence-precaution-risk-assessments.html

Consultation & Review Process

- Internal:
  - ECCC Research Community
  - Several layers of ECCC management
  - Legal Services

- External:
  - International engagement on technical issues feed into assessment approach
  - Expert peer reviews of assessments and Science Approach Documents
  - Publication of assessment s and Science Approach Documents to obtain broad input
  - Science Committee input on specific issues


thank you
danke
gracias
merci
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mochchakkeram
sukriya
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謝謝
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dank je
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