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# DEVELOPMENT OF GUIDELINES FOR ECOLOGICAL RISK ASSESSMENT

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## **Ecological and Health Risk Assessment**

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# Agenda

- evaluation of existing guidelines
- develop a robust approach
- evaluate the risk results

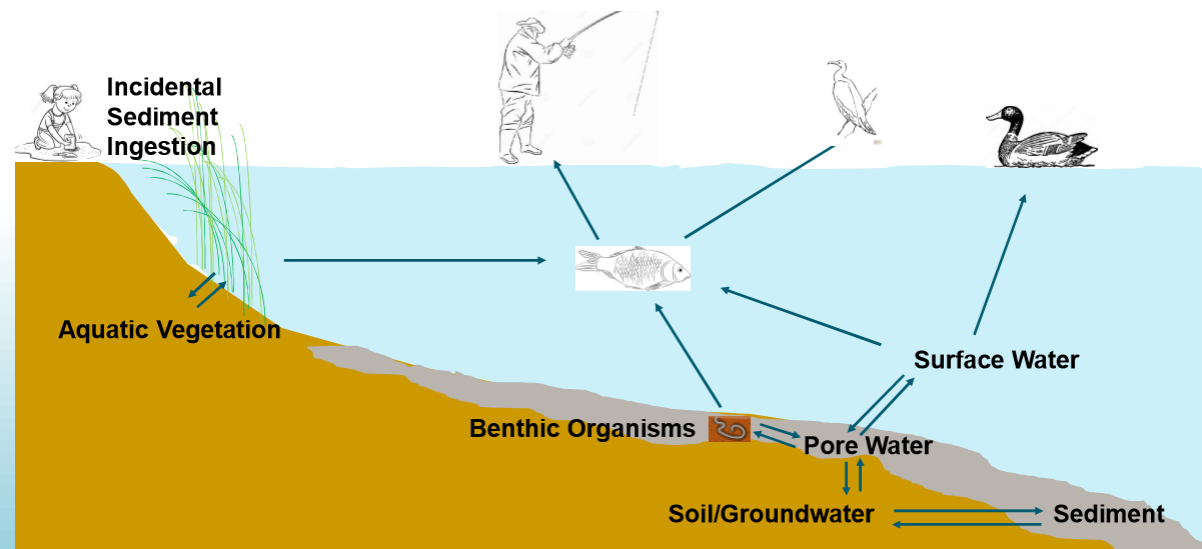


# Objectives and Methodology

- Ecological Risk Assessment - ERA is defined by US Environmental Protection Agency as "*the process that estimates the likelihood of adverse ecological effects occurring as a result of exposure to one or more stressors*".
- The ecological risk assessment procedure is not currently regulated in Italy, nor guidelines for the elaboration of the ERA are defined.
- A common approach is not defined even at European level with particular reference to the soil environmental matrix, therefore the remediation of contaminated sites is regulated independently in individual States.
- Goals that all EU countries must achieve for water bodies are set by the Water Framework Directive (2000/60 / EC) and subsequent directives.

# Content

- Step 1: evaluation of existing guidelines
- Step 2: develop a tiered approach
  - Comparison with trigger values
  - Refined CSM, LoEs, TRVs
- Technical specifications to be used as a reference for the development of Tier I and Tier II ERA in Italy were based on international and national guidelines, references and standards, and integrating the approach with the existing law enforced in Italy.



# Step 1 – Selection of reference documents to define the approach to be adopted in Italian sites

ASTM	E2205 – 2002: Risk-Based Corrective Action for Protection of Ecological Resources E1391 -2002. Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing. 1994. Standard Guide for Designing Biological Tests With Sediments. ASTM E1525: 22 pp.
Canada	Factsheet 2: Chemical-specific sediment quality guidelines. Environment Canada, National Guidelines and Standards Office, Ottawa, ON., 2004 Government of Canada. Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance, 2012
US EPA	Framework for Ecological Risk Assessment, 1992 Guidelines for Ecological Risk Assessment, April 1998 Guidance for Developing Ecological Soil Screening Levels, revised 2005 Generic Ecological Assessment Endpoints (GEAEs) for Ecological Risk Assessment: Second Edition With Generic Ecosystem Services Endpoints Added, 2016 Ecological Soil Screening Levels, 2003-2007 Region 4, Ecological Risk Assessment Supplemental Guidance, 2018

# Step 1 – Selection of reference documents to define the approach to be adopted in Italian sites

Italy	<p>ICRAM: Manuale per la movimentazione dei sedimenti marini, 2002</p> <p>ISPRA, Nuovo indice dello stato ecologico delle comunità ittiche (NISECI), 2017</p> <p>ISPRA: Batterie di saggi ecotossicologici per sedimenti e acque interne, 2013.</p> <p>ISPRA: Batterie di saggi ecotossicologici per sedimenti di acque salate e salmastre, 2011</p>
Netherland	RIVM – Ecological Risk Assessment in Contaminated Land, 2006
European Commission	<p>Common Implementation Strategy for the Water Framework Directive (2000/60/EC) Technical Report - 2011 – 055 Guidance Document No. 27</p> <p>Technical Guidance For Deriving Environmental Quality Standards, 2011.</p>
UK	<p>An ecological risk assessment framework for contaminants in soil, 2008</p> <p>Derivation and use of soil screening values for assessing ecological risks, 2017</p>

*Integration of US EPA Guidelines, ASTM Standard, ISPRA manuals, EEC Water Framework Directive*

# ERA - Definition of applicable **AECOM** guidelines

- Items evaluated during comparison:
  - Framework type?
  - Trigger values used?
  - Tiered approach?
  - Toxicity testing?
  - Evaluation of results?



# ERA- Definition of applicable guidelines **AECOM**

- The guidance documents
  - Tiered approach
    - Comparison to trigger values;
    - Evaluation of ecological toxicity;
    - Bioaccumulation;
    - Physical characteristics;
    - Sediment and pore water chemistry evaluations.
  - Recommendations / suggestions on how the evaluation can be done, not necessarily tiered.



# ERA- Definition of applicable **AECOM** guidelines

- Toxicity testing:
  - toxicity testing is recommended in most guidance documents;
  - Based on lessons learned there is a risk related to the use of the results of these tests as single LoE (biased results); –There is a wide variety of tests available (different organisms + substrate), and techniques alter continuously, how to select the right test for a specific site?



*Hyalella azteca*



*Chironomus dilutus*



*Lumbriculus variegatus*



*Thamnocephalus platyurus*

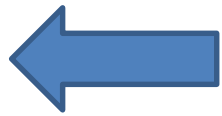
# Tier I

- Tier I evaluation procedure consists of the initial site assessment and the problem formulation, during which ERA objectives are established and the system is examined, is included for the definition of exposure pathways and potential ecological effects.
- Tier I evaluation is based on the development of the Preliminary Site Conceptual Model aimed at the identification of the Contaminants Of Potential Ecological Concern (COPEC).
  - Environmental setting and contaminants known or suspected at the site;
  - Contaminant fate and transport mechanisms that may exist;
  - Likely affected receptors;
  - Identification of complete exposure pathways;
  - Selection of endpoints to screen for ecological risk; and
  - A preliminary ecological effects evaluation that should include screening ecotoxicity values based on conservative thresholds such as chronic no-observed adverse-effect-levels (NOAELs).



# Tier II

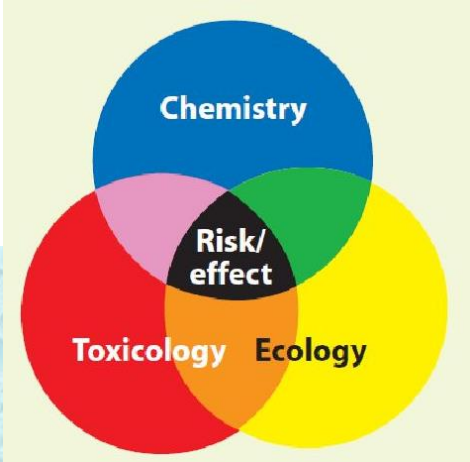
**WEIGHT OF EVIDENCE APPROACH**  
combines information from multiple lines of evidence



**TRIAD APPROACH**  
Integrated use of chemical, toxicological and ecological Lines of evidence



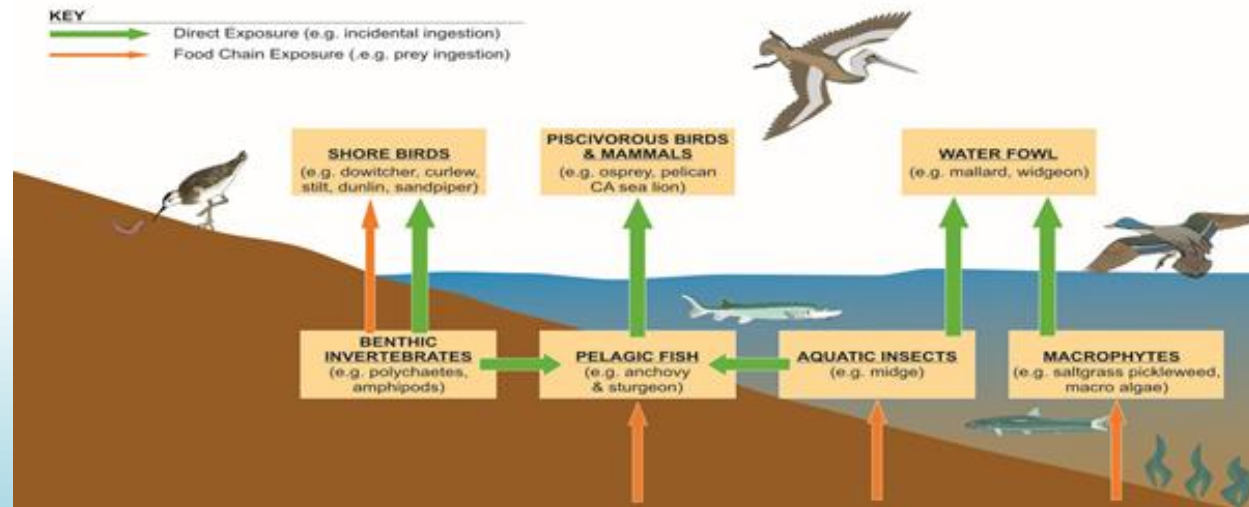
**DECISION SUPPORT MATRIX**  
combines information from multiple lines of evidence:  
Aggregation of data and uncertainty assessment based on ecological relevance



# Tier II

- Objective of Tier II: estimate the risk for ecological receptors based on site-specific data, using exposure models, ecotoxicological data, and ecological data.
- Tier II evaluation does not estimate the risk of adverse effects on the ecological target induced by the contaminants identified in Tier I through a modeling approach but **using laboratory and field data**.
- A procedure was set for selecting **TRV - Toxicity Reference Values**, based on the selected assessment endpoint, and to develop the Final Conceptual Site Model.

- Data evaluation: provide lines of evidence based on chemistry, toxicity and ecology.



# Tier II - LoE: Chemistry

- Selection of compounds that could potentially bioaccumulate
- Chemical analyses on environmental matrices, filling in gaps of Tier I.
- Position and collection of background samples (US EPA “*Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*” and “*Role of Background in the CERCLA Program*”).
- Calculation of exposure point concentration (EPCs) .
- Bioaccumulation tests (on tissues) – Selection of tests on 3 different species of different taxa.
- **Calculation of daily doses** through food chain as referenced by US EPA «*Guidance for Developing Ecological Soil Screening Levels (Eco- SSLs)*»
- **Effect Assessment: Selection of TRVs**

# Tier II - LoE: Toxicity

- Criteria for the selection of toxicity tests;
- Site-specific toxicity tests are considered more useful than indirect toxicity information for the following reasons
  - The site-specific bioavailability of the contaminants is considered;
  - The form of the contaminant is realistic;
  - Interactions among contaminants are simultaneously addressed;
  - Spatial distribution of toxicity can be determined; and
  - Remedial goals may be determined with higher confidence
- Reference to:
  - ISPRA Manuale di Ecotossicologia 88/2013 (sedimenti e le acque interne);
  - ISPRA Manuale di Ecotossicologia 67/2011] (acque salate e salmastre).
  - APAT 2004, GUIDA TECNICA SU METODI DI ANALISI PER IL SUOLO E I SITI CONTAMINATI UTILIZZO DI INDICATORI BIOLOGICI ED ECOTOSSICOLOGICI

# Tier II/Tier III - LoE: Ecology

- Ecological surveys:
  - Site-specific biological studies that can target a range of attributes for individuals (e.g., growth, reproductive success, survival), populations (e.g., biomass, abundance, density, age structure) or communities (e.g., diversity, species composition, abundance, density, biomass), making it possible to directly estimate the assessment endpoint . Comparisons should be made to reference conditions or along gradients in exposure. For surface waters: ecological status can be assessed making reference to D.lgs. 152/06 smi, Parte Terza, Allegato 1, Capitolo 2 *“Modalità per la classificazione dello stato di qualità dei corpi idrici”*.
  - Indirect biological information: transference of appropriate biological studies from other sites (e.g., published in the literature) that could be used to help inform a response profile for the site of interest.



# Tier II – ERA - Conclusions

- Once individual LOEs have been characterized, the findings must be evaluated separately for each assessment endpoints, coupled with uncertainty assessment. – Ref. Canada Ecological Risk Assessment Guidance
- LOEs that are highly ecologically relevant should be given more emphasis, provided that uncertainties are comparable.

Table 5-2. Example summary table of WOE (terrestrial ecosystem) by assessment endpoint

	Assessment Endpoint	LOE Group	Magnitude	Spatial Scale	Uncertainty about magnitude	Evidence for causal relationship between exposure and effects <sup>a</sup>	Uncertainty about causality	Ecological relevance	Overall Assessment
Plants	Ecological function and food and cover and wildlife	Soil chemistry	Above Benchmarks	1000 m <sup>2</sup>	Moderate	No evidence of links between benchmarks and site-specific effects to plants, because benchmarks for site-specific COPCs are based on invertebrate data only.	High	Low	Low effects, high uncertainty - Soil and chemistry benchmarks for site-specific COPCs are not based on plants but rather are based on invertebrates. The community survey indicates there are low effects, but the cause may be fungal infection rather than site-related COPCs, and uncertainty is high.
		Community survey	Low	n/a	High	No evidence of relationships between biomass / richness and soil chemistry. Leaf spots and shoot blights that are evident on a few species are believed to be related to fungal infection, not contaminants.	High	High	
Soil Invertebrates	Diverse and abundant invertebrate community, and ecological function as food for wildlife	Soil chemistry	Above Benchmarks	1000 m <sup>2</sup>	Moderate	Weak evidence (from literature) of links between benchmarks and effects to soil invertebrates, but application to specific sites limited by variation in toxicity modifying factors	High	Low	Low effects, moderate to high uncertainty - Although tissue concentrations of COPCs in earthworms are elevated and there is some site-specific toxicity observed, the toxicity results are not correlated with COPCs. Furthermore, the most ecologically relevant line of evidence (invertebrate abundance and richness) indicates no effects.
		Earthworm tissue bioaccumulation	Moderate	300 m <sup>2</sup>	High	Weak evidence (from literature) that observed contaminant concentrations could be causing toxicity	Moderate	Moderate	
		Earthworm ( <i>Eisenia foetida</i> ) survival in laboratory toxicity test	Low	30 m <sup>2</sup>	Moderate	No evidence of a concentration-response relationship. One sample yielded significant toxicity, but not at high contaminant concentration.	Moderate	Moderate	

Table 5-2 continues on next page.

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