"Capacity Building and Strengthening Institutional Arrangement"

Workshop: "Hazardous Substances and Wastes"

Ecological Risk Assessment Concepts and Modelling

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APAT

Agency for Environmental Protection and Technical Services

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1. Definitions

Some definitions

1. **Risk = PROBABILITY × DAMAGE**

2. **Risk = HAZARD × VULNERABILITY**

Some disciplines consider exposure, referring to the physical aspects of vulnerability

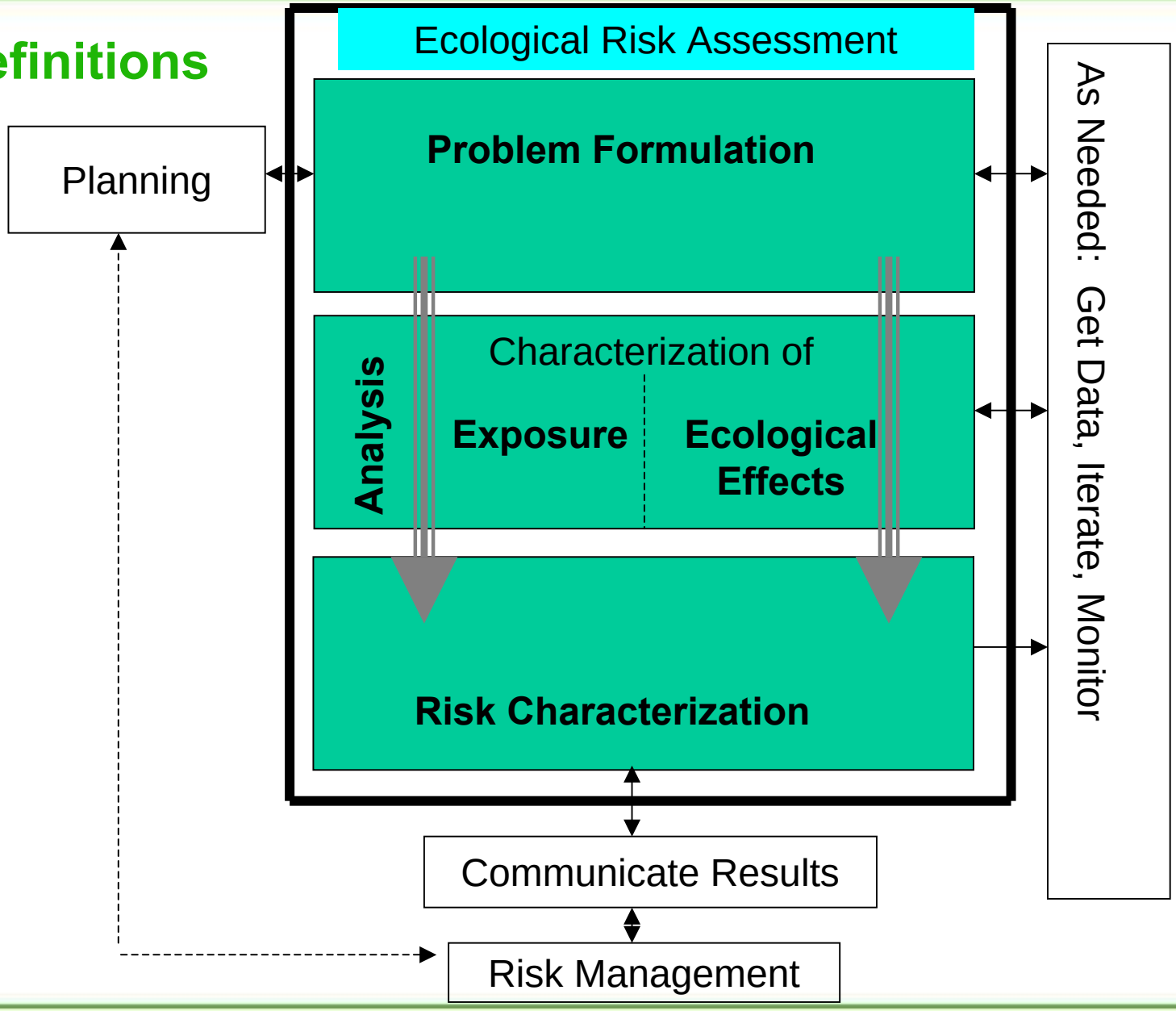
United Nations - International strategy for Disaster Reduction. Terminology of disaster risk reduction

Risk assessment method defined to evaluate the probability of occurrence of an event with adverse ecological effects, related to the exposure to one or more stressors

USEPA. Guidelines for Ecological Risk Assessment. US-EPA/630/R-95/002F, 1998 and later revisions

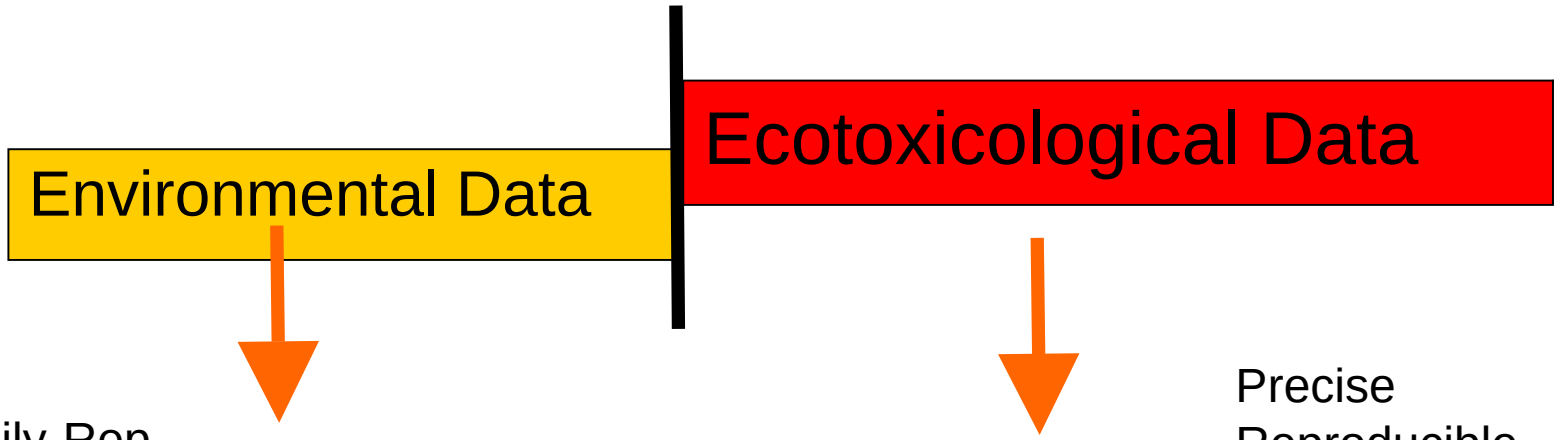
Not an exact science, but an applied methodology to support decisions on the basis of controlled experiments …

1. Definitions



1. Definitions

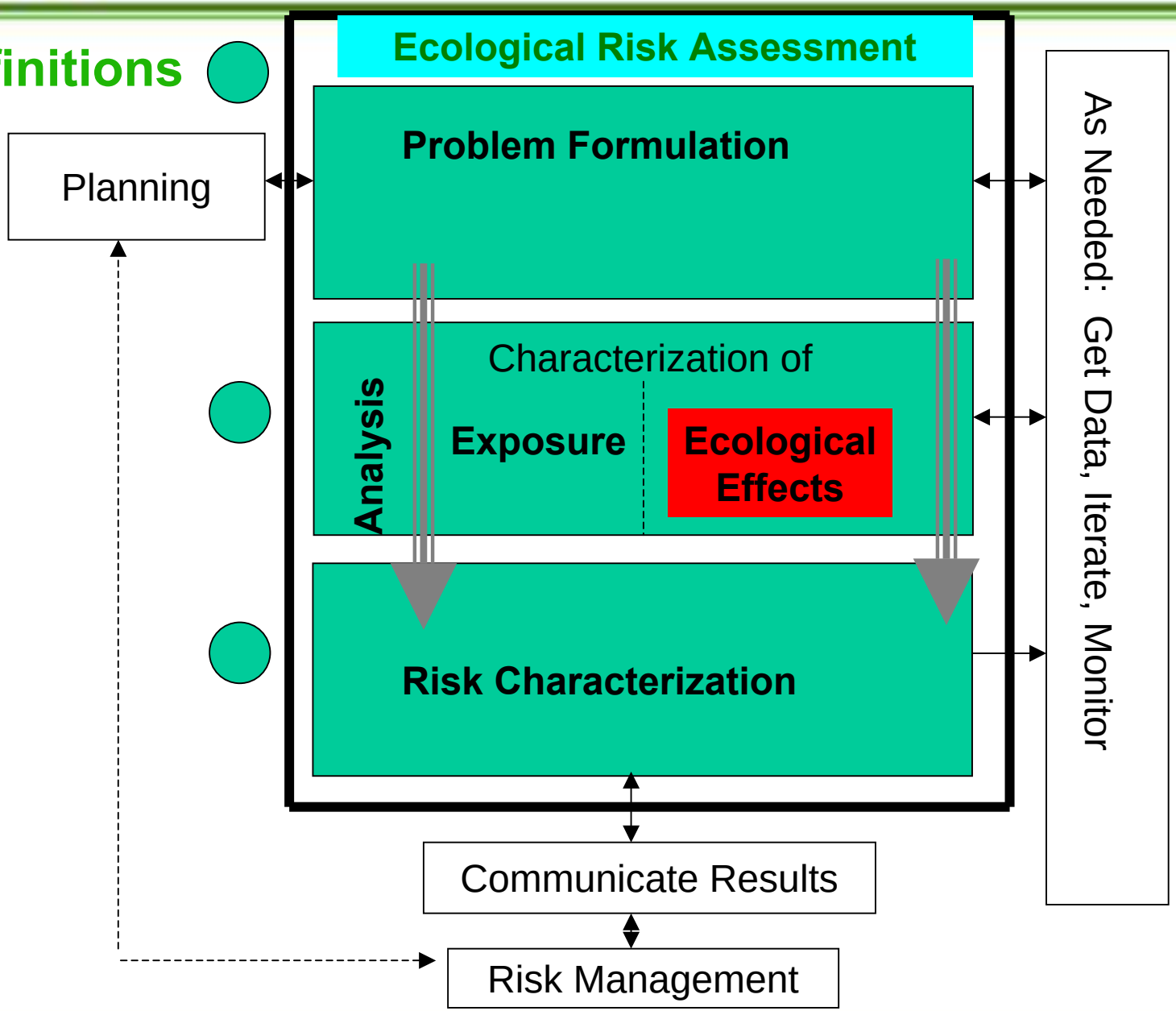
Why ERA?



Rough
Not-easily-Rep.
Complex
Multiple
Cannot be easily m.
…

Precise
Reproducible
Simple
Discrete
Can be modelled
…

1. Definitions



1. Definitions

ERA investigation levels

– Rationale and objectives of the definition of different ERA investigation levels

- *scoping*: collect and organise available information and define a preliminary ecosystem conceptual model describing potential exposure pathways

- *screening*: define a method to derive “screening values”

- *site-specific assessment*:
  – analytical levels of increasing detail (TIER)
  – implementation of the TRIAD approach and other WOEs

2. Scoping, screening, site-specific assessment

Scoping: Checklists and conceptual models

- Development of the checklists (proposed as appendices of the ANPA Manual n. 11/2002)
- Criteria for a standardised development of a conceptual model

2. Scoping, screening, site-specific assessment

Screening: making things manageable:

- Always begin with screening
  - Screening is not just poor quality (expertise, reasoning…)
  - Many cases can be resolved by categorization, without estimation

- Screening in ERA: quotients and factors
  - In biological surveys: “squat and peek”
  - In causal analyses: elimination of impossible causes
  - Use of benchmark data

2. Scoping, screening, site-specific assessment

Site-specific assessment

- Bioavailability
- Bioaccumulation
- Environmental background assessment
- Toxic Pressure method (Posthuma et al., 2002) identification of sampling points onto which apply the TRIAD approach
- Weight of Evidence

SCOPING

2. Scoping, screening, site-specific assessment

APAT

Check list

Standardised information gathering for the build-up of a conceptual model (ad es., US-EPA, 1997)

→ **PRELIMINARY CONCEPTUAL MODEL**

SCREENING

Defining landuse category

→ **Definition of primary ecological properties relevant for ecosystem functioning**

→ **Generic concentration levels arranged by landuse category**

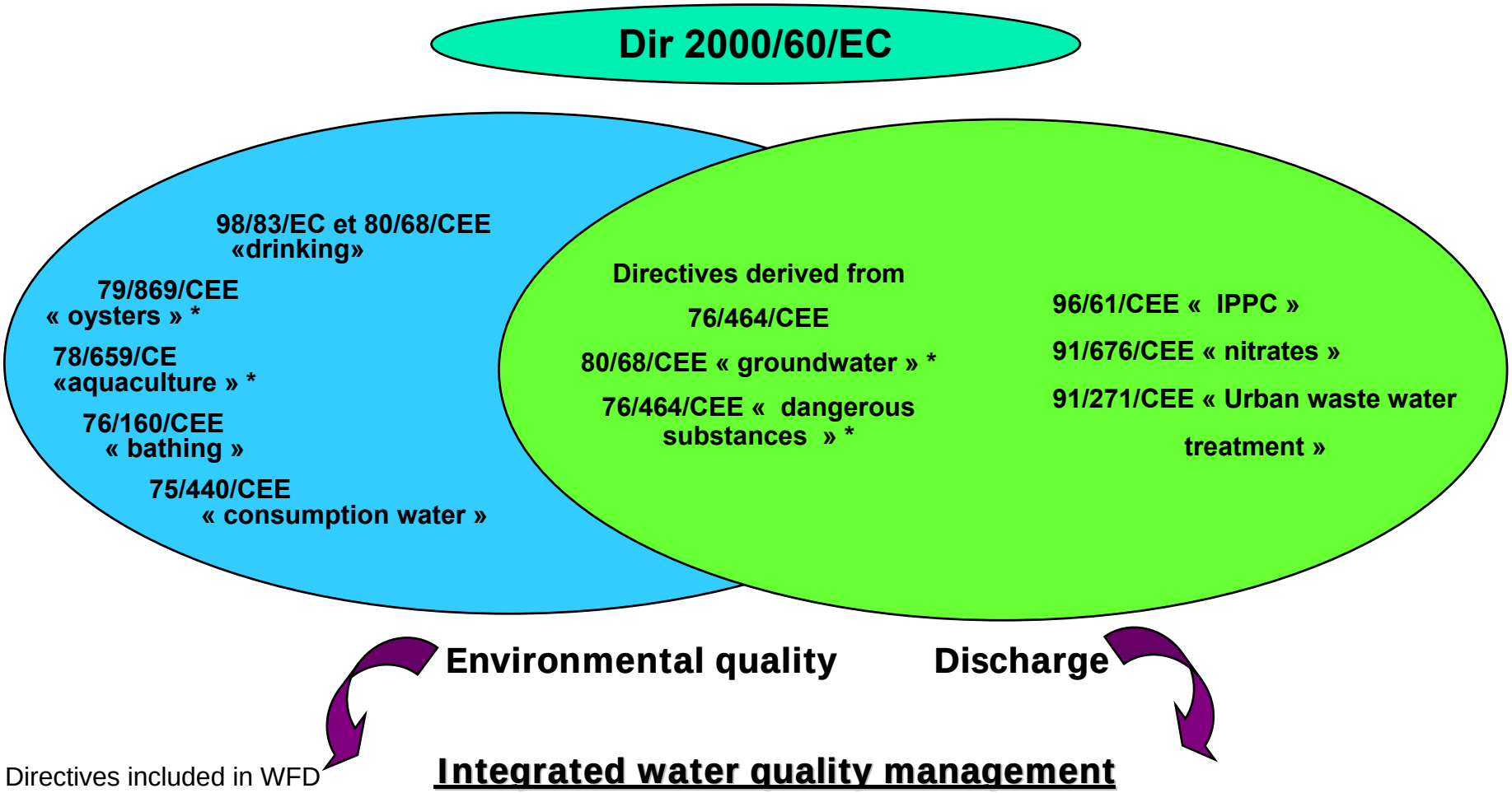
Is the extant concentration greater?

- No → END
- Si → **SITE-SPECIFIC RISK ASSESSMENT**

TRIAD

- Chemistry
- Ecotoxicology
- Ecology

3. Risk and the Water Framework Directive



* Directives included in WFD

3. Risk and the Water Framework Directive

Risk?

- Risk = chance of failing the ***objectives*** indicated by the Directive (Art.4)

3. Risk and the Water Framework Directive

Risk Assessment for River Basin Management and the Water Framework Directive

- Risk Assessment to target specific issues (contaminated sites, human health, brownfields,…)

WFD-Risk

- to conduct a review of the impact of human activity on the status of surface water and on groundwater (Article 5)
- to provide a guideline for the **monitoring of water body status** (Article 8)
- to help in designing a **Programme of measures** (Article 11)

Risk Assessment strategy to interpret, at the river basin level, the significance of environmental risks due to the combination of:

1. natural vulnerability
2. the presence of stressors generated by human activities

3. Risk and the Water Framework Directive

Environmental Objectives (Article 4):

a $_{i)}$ **Prevent deterioration** of the status of all bodies of surface water

a $_{ii)}$ **Protect, enhance and restore**... with the aim of achieving good surface water status at least 15 years after the entry into force of the Directive

a $_{iii)}$ **Protect and enhance** all artificial and heavily modified bodies of water with the aim of achieving good ecological potential and good surface water chemical status at least 15 years after the entry into force of the Directive

a $_{iv)}$ **Reduce pollution** from priority substances by ceasing/phasing out priority hazardous substances

b $_{i)}$ **Limit** the input of pollutants into groundwater and prevent their deterioration

b $_{ii)}$ **Protect, enhance and restore** all bodies of groundwater, ensure a balance between abstraction and recharge, achieve good groundwater status by 2015

b $_{iii)}$ **Reverse any sustained upward trend** in the concentration of any pollutant resulting from the impact o human activity

c **Achieve compliance** with any *Protected Area* standards and objectives by 2015

4. Risk and Water management

Directive 2006/7/EC of 15 February 2006
'Management of bathing water quality'

Bathing water profile (Article 6, Annexe III)

- A system of b.w.p., appropriate to provide a better understanding of risks as a basis for management measures (point 10 INTRO)
- Establishing and maintaining a b.w.p., is among the main management measures (Article 2)
- Monitoring point shall be the location where the greatest risk of pollution is expected according to the b.w.p. (Article 3)
- Alerting and informing the public… on the basis of the b.w.p. (Article 5)
- It should indicate cyanobacterial risk (Article 8) and other parameters (Article 9)
- It should trigger further investigations to determine health risk (Article 9)
- It should provide a basis for informing the public (Article 12)

4. Risk and Water management

…by 24 March 2011

Annex III:

- Detailed description of the catchment
- Identification/assessment of causes of pollution
- Assessment of cyanobacterial potential
- Assessment of macro-algae or phytoplankton
- If pollution, then: nature, frequency, duration, causes, measures, remediation schedule, responsibility
- Review monitoring

4. Risk and Water management

Habitat Directive Dir 92/43/EEC

- **Article 2**
- 1. Aim: ensure bio-diversity through the conservation of natural habitats and of wild fauna and flora …

- 2. … maintain and restore, at **favourable conservation status**, natural habitats and species…

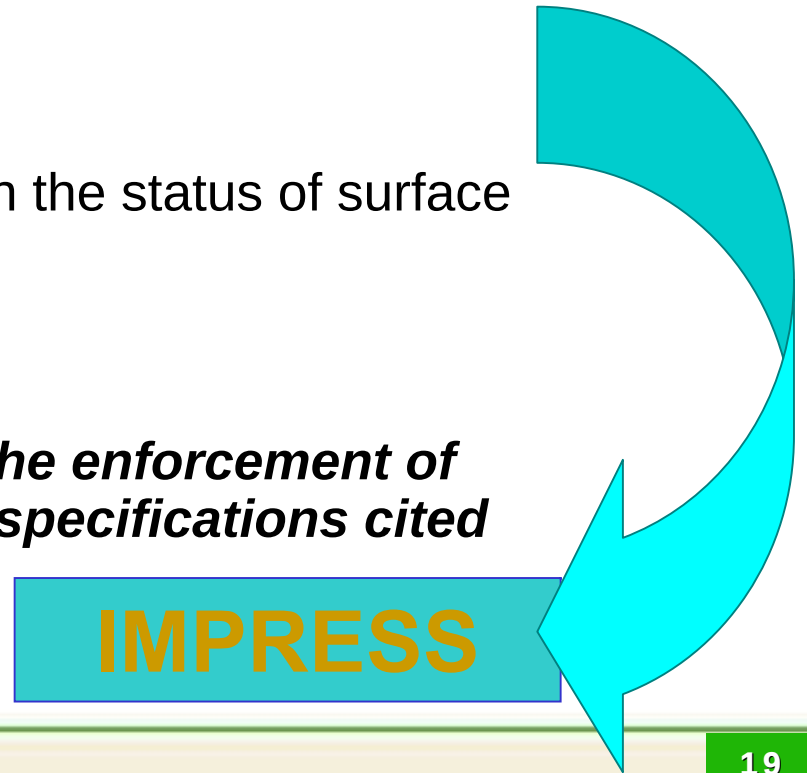
4. Risk and Water management

Article V

"*Characteristics of the river basin district, review of the environmental impact of human activity and economic analysis of water use*"

- analysis of river basin characteristics
- review of the impact of human activity on the status of surface waters and on groundwater
- economic analysis of water use

to be completed within 4 years after the enforcement of the Directive, following the technical specifications cited in Annex II and III



European Commission, DG Environment
Unit D.2: Water & Marine

CIS Achievements

Fourteen Guidance Documents

1) Economics and the Environment
2) Identification of Water Bodies
3) Analysis of Pressures and Impacts
4) Artificial and Heavily Modified Water Bodies
5) Transitional and Coastal Waters –Typology, Reference Conditions
6) Intercalibration Network and the Intercalibration Process
7) Monitoring
8) Public Participation
9) GIS and the WFD
10) Rivers and Lakes Typology
11) Planning Process
12) Wetlands
13) Classification
14) Intercalibration process

4. Risk and Water management

WFD-Risk characteristics:

- Easily understandable by non-specialists and open to participation initiatives and inputs coming from stakeholders.

- Able to establish causal relationships between:
  - 1. the ***biological indicators*** (considered as first priority by the Directive)
  - 2. ***physical and chemical indicators*** (supporting the first-ones)
  - ***3. stressors*** causing impacts within the river basin

- Iterations which will allow an in-depth assessment and a progressive refining of the analytical tools adopted. Starting from a first conceptual model, progressively more quantitative and more specific tools will be proposed, designed to portray more closely the characteristics of the hazard identified during the former steps.

- Include a well-defined **decision support system** which should provide the option to proceed towards further analyses (Human Health Risk Assessment, Ecological Risk Assessment-TRIAD).

Logical Risk Assessment pathway for river basin assessment

Initial description of the **vulnerability** and the pressures which insist upon the river basin

Identification of **risk factors**

Thematic mapping portraying the **distribution** of: vulnerabilities, risk factors (sources) and potential on-site impacts (targets)

Validation of the relative strength and internal coherence of the identified **causal relationships** (source/pathway/target)

Quantification of specific risk pathways

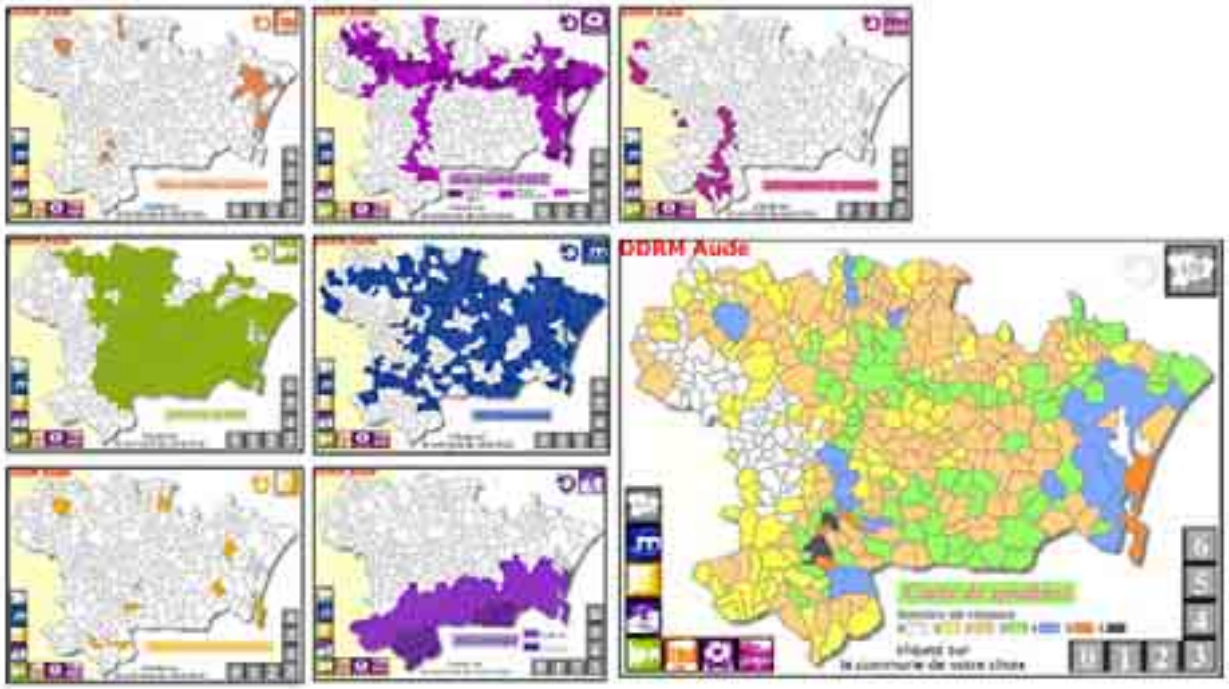
Indication of the need of further specific **investigations**

Programme of measures

Second Risk Assessment phase: validation of the ***Programme of measures***

4. Risk and Water management

multi hazard



4. Risk and Water management

Risk assessment methodology for determining impacts in surface freshwater bodies

UK Environment Agency, June 2005

- Assessing the risk of failing WFD objectives based on predicted impacts on the most sensitive quality elements
- The **LINE OF EVIDENCE**: In lentic ecosystems risk posed by nutrient pressures is assessed by phytoplankton; in-lake nutrient concentrations is the most appropriate supporting physico-chemical element)

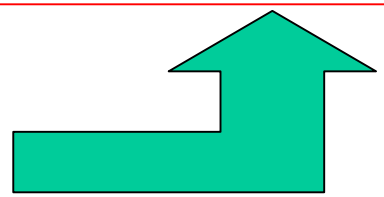
Reference conditions

Screening values

Status classification

Priority sites

Programme of measures



4. Risk and Water management

Tier 1 **Risk assessment steps**

- Point source nutrient pressures – STWs, septic tanks, etc. estimated by p.c. export of 0.4 kg TP a
- Diffuse nutrient pressures – land-use coefficients and animal stocking data
- TP load summed from above and converted to in-lake nutrient concentration (OECD 1982)
- Comparing modelled in-lake[TP] with observed [ref-TP], to derive EQR and risk/status prediction

Tier 2 (50 study lakes)

- Point source nutrient pressures – Detailed estimates of STWs, level of treatment, septic tanks and fish farms
- Diffuse nutrient pressures – land-use coefficients and animal stocking data
- Comparing modelled in-lake[TP] with ecotype-specific and site-specific [ref-TP]
- Comparing measured in-lake[TP] with site-specific [ref-TP], to derive EQR and risk/status prediction

4. Risk and Water management

Cycleau

UK Environment Agency

4. Risk and Water management

Conclusions

- A number of recent initiatives underlines the general interest of a broader implementation of risk assessment principles and methodologies
- A concerted initiative in this sense is becoming urgent and required by the EU Commission
- There is need of a closer analysis of the interactions between ERA, HHRA and Risk Assessment for RBM
- Aquatic habitats are ideal sites for testing the relation existing between the different methods and the relevance of each

5. International Experience

RISK BASE

Open
1st General Assembly:

Towards Risk Based Management of European River Basins

Invitation for participation

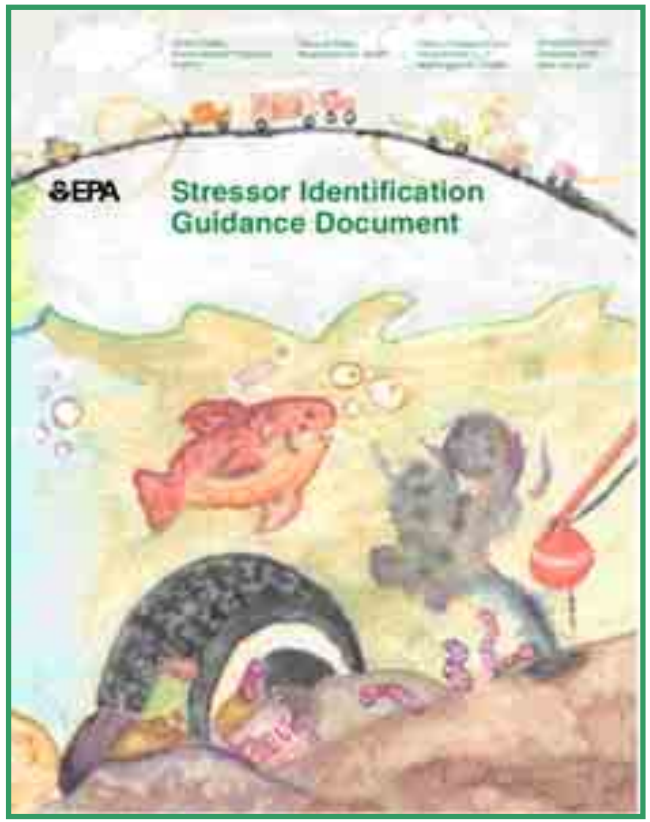
January 24 – 26, 2007
Seville, Spain

http://www.riskbase.info

5. International Experience

Stressor Identification Guidance (U.S. EPA 2000)

- A decision framework for investigating causes
  - when unknown causes of biological impairment are encountered
  - to convince a skeptical audience



- Provides a logical method for
  - analysing evidence
  - making a case
  - identifying useful information

- Available as PDF:
  http://www.epa.gov/waterscience/biocriteria/stressors/stressorid.html

5. International Experience

Causal Analysis/Diagnosis Decision Information System (CADDIS)

- A web based system providing guidance, examples, and links to information
- Helps investigators in States and Tribes identify causes of biological impairments

5. International Experience

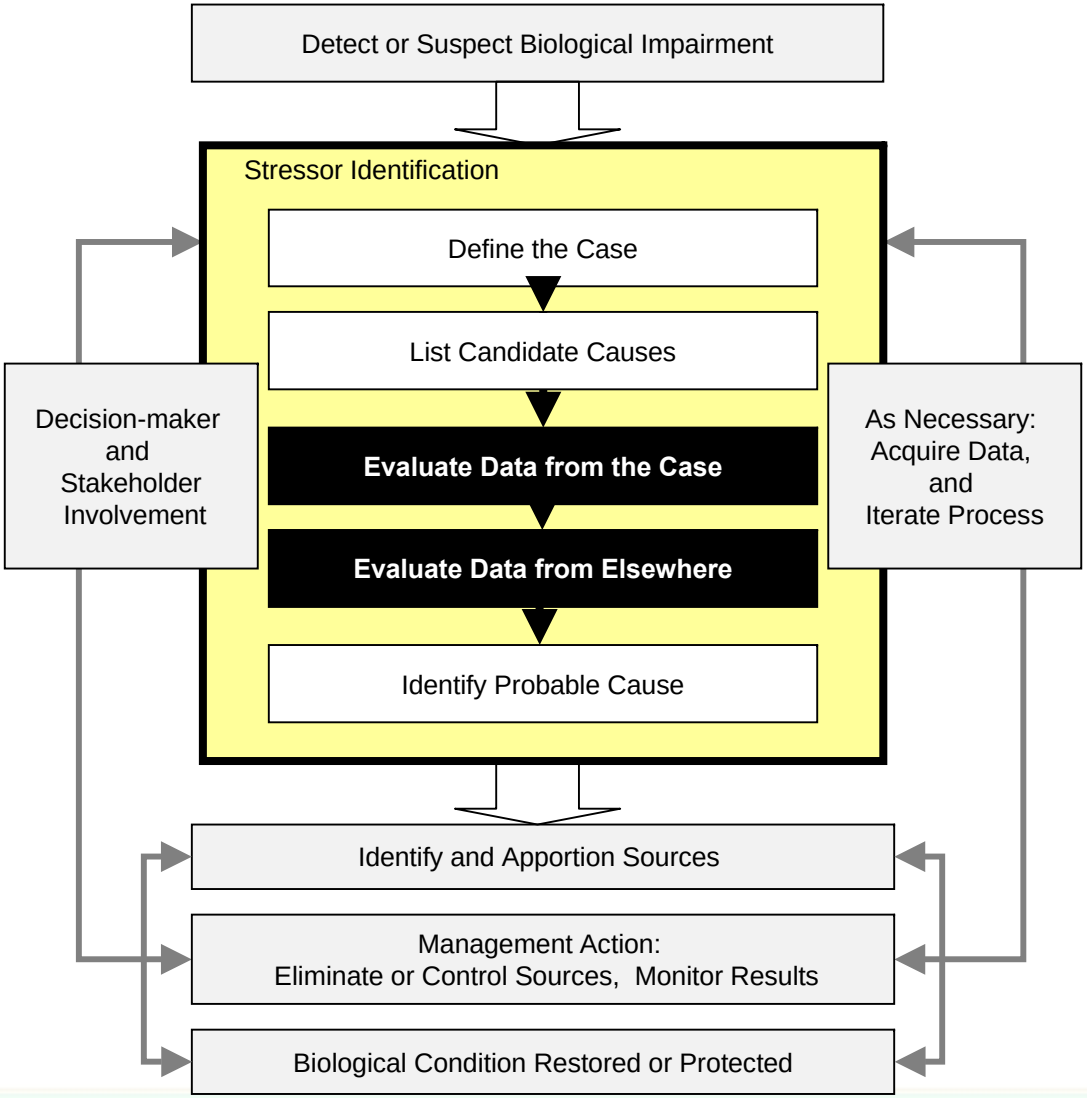
U.S. EPA - System requirements

- A mutually supporting community of practitioners
  - Direct Sharing of information
  - Continuous Quality Assessment in real time

- A **system of frameworks** for performing different assessments
  - Drawing on the same pool of information, tools and experience
    - What sediment benchmarks are available?
    - What bioaccumulation models for bivalves?
    - What SSDs for chromium?
    - What transport and fate models for estuaries?

5. International Experience

Stressor Identification Process



6. The Italian Case

The role of the APAT in Risk Assessment

D. M. 471/99 “Bonifica Siti Contaminati”(Art. 14.3; Art. 15.3; Art. 17.5)
D. Lgs. 22/97 “Rifiuti” (Art. 22.5)
New Legislation: Decree 152 of 2006

- Tri-annual planning of activities of the Agency 2003-2006
- Soil department (*contaminated site management*)
- Environmental Emergencies Department (*Settore Sistemi Integrati Ambientali, Servizio Emergenze Ambientali)*

ERA-MANIA (2003-2005)

“*Criteri metodologici per l’Analisi di Rischio Ecologico*”

6. The Italian Case

Role of Ecological Risk Assessment in contaminated sites management

To support a rigorous and transparent step-by-step decisional process

To lead a detailed risk characterization, established according to a well-established set of priorities, determined to avoid irreversible impacts

To allow an adequate selection of the sites at greatest risk, of highest remediation priority

To facilitate a communication channel accessible to ERA experts (ecologists, ecotoxicologists, chemists), environmental law experts and *stakeholder*

D.M. 471/99 (abolished):

Risk Assessment used to justify the persistence of concentrations exceeding screening values (Tab. 1), despite the implementation of best available technologies at affordable cost

6. The Italian Case

Decreto legislativo 152/2006

"Norme in materia ambientale"
Parte IV, Titolo V - Bonifica di siti contaminati
Allegati i-v

Refuse management and contaminated site remediation

Concentrazione Soglia di Contaminazione (**CSC**)
Standard concentration limit in soil

Concentrazione Soglia di Rischio (**CSR**)
Hazardous concentration level established by HHRA (RBCA approach)

6. The Italian Case

If: X > CSC → **potentially contaminated site**

Conduct HHRA (RBCA approach)

Establish **CSR**: Hazardous concentration level

If: X > CSR, CSC

Remediation

If: CSC<X>CSR

site non-contaminated

Current proposal for contaminated site classification