Achievement of a good chemical and ecological status:
Existing challenges and a way forward to improve the risk assessment strategies

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What is the problem?
several regulations of chemicals in waters: a paradox.

- REACH and 94/414 regulate the use of chemicals
- WFD/chemical quality: prohibits that 33 substances being over water quality standards
- WFD/ecological status: prohibits that water bodies might be lower than good status
- Effluent release in the environment is controlled, using chemical analyses and whole effluent toxicity tests in several EU countries
- How can any chemical survive such a hunt?
However reality is quite sad!

- Many chemicals are present in waters in toxic concentrations
- Exemple: Pesticides in France (75% of waters contaminated)
- Nitrate and phosphorus remains high in many water bodies
- Sexual modifications can be recorded in fish
- In 2007 a new list of 8 substances was added to the initial 33 substances list
  - And other will come
2004: 75% contaminated
Trends in nitrate concentration in Europe
• What are the right markers?
• Which substances are responsible?

Histological view of a gonad from a chub downstream Lyons (Flammarion et Al.)
Threatened fish in EU waters

Share of globally threatened species in native freshwater fish
- %
  - 0–7
  - 8–15
  - 16–30
  - 31–44

Number of species
- 0–25
- 26–50
- 51–100
- 101–344

Introduced species
- %
  - 0–11
  - 12–20
  - 21–29
  - 30–69

Outside report coverage
### Polluted Seas

**Major Bodies of Water/Areas with Serious Water Pollution Problems**

<table>
<thead>
<tr>
<th>Body of Water</th>
<th>Microbiological</th>
<th>Eutrophication</th>
<th>Chemical</th>
<th>Suspended solids</th>
<th>Solid wastes</th>
<th>Thermal</th>
<th>Radioelements</th>
<th>Spills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gulf of Mexico</td>
<td>Severe Impact</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>No known impact</td>
<td>No known impact</td>
<td>Slight Impact</td>
</tr>
<tr>
<td>Caribbean Sea</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>Severe Impact</td>
<td>Moderate Impact</td>
<td>Slight Impact</td>
<td>Slight Impact</td>
<td>Severe Impact</td>
</tr>
<tr>
<td>Baltic Sea</td>
<td>Slight Impact</td>
<td>Severe Impact</td>
<td>Moderate Impact</td>
<td>Slight Impact</td>
<td>Slight Impact</td>
<td>No known impact</td>
<td>Slight Impact</td>
<td>Moderate Impact</td>
</tr>
<tr>
<td>Yellow Sea</td>
<td>Moderate Impact</td>
<td>Severe Impact</td>
<td>Slight Impact</td>
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<td>Moderate Impact</td>
<td>Slight Impact</td>
<td>No known impact</td>
<td>Moderate Impact</td>
</tr>
<tr>
<td>Bohai Sea</td>
<td>Moderate Impact</td>
<td>Severe Impact</td>
<td>Moderate Impact</td>
<td>Slight Impact</td>
<td>Moderate Impact</td>
<td>Slight Impact</td>
<td>No known impact</td>
<td>Severe Impact</td>
</tr>
<tr>
<td>Congo Basin</td>
<td>Moderate Impact</td>
<td>Severe Impact</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>Slight Impact</td>
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<td>Moderate Impact</td>
</tr>
<tr>
<td>Benguela Current</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>Severe Impact</td>
<td>Moderate Impact</td>
<td>Moderate Impact</td>
<td>Slight Impact</td>
<td>Severe Impact</td>
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</tr>
<tr>
<td>Lake Victoria</td>
<td>Severe Impact</td>
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<td>Moderate Impact</td>
<td>Moderate Impact</td>
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</tbody>
</table>

**Source:** Adapted from UNEP SEO Report, 2004-2005
Some scientific issues
• PNEC is not based on a reasonable excess risk value: build on NOECs that are close to 10% effect
• No assessment at the community level, apart from studies on some pesticides
• Variability only addressed using safety factors
• Most statistics are disputable (Hypothesis testing at low power)
• Fate of chemicals is not georeferenced
• Degradation processes are weakly known
• And all uncertainty and variability is confounded within arbitrary safety factors
How is PNEC determined?

Safety factors are still a relevant « explanation » for PNEC!

Based on 440 freshwater PNECs from INERIS database
What needs to be clarified on the exposure side?

- **Sources of pollution**
  - That is where scientists should insist on PMs to get data, without any belief in confidentiality argument

- **Fate of chemicals**
  - Transformations
  - Degradation
  - Change of compartment (volatilisation, precipitation…)

- **Localisation of chemicals in the environment**
  - From an ecosystem point of view
  - From a human health point of view with focus on sensitive populations
• Interactions between chemicals
  • Reactivity of chemicals interacting within biotopes
  • Joint effects at organism or sub-organism level
  • Interaction of effects of different chemicals with different species within communities
• The number of possible combinations is terrific
  • No a priori statistical solution
  • Science needs to understand mechanisms at those levels and to model them
• Interaction between anthropogenic pressures
  • Pathology of stressed species, Immuno-depression
  • Multiple stresses on major physiological functions
  • Microbial, algal, fungal or viral blooms
• **Mechanisms**
  • Need to understand what happens at different levels from microscopic to macroscopic
  • Globally increase toxicological knowledge
  • Specifically increase knowledge of cancer and reproduction

• **Medias**
  • Exposure can only be understood if the complex relationships between medias, communities and Man

• **Models**
  • The best way to integrate different observations
  • A validated model adds knowledge to data to build information
  • No modelling leads to no prediction and so no prevention
On a theoretical point of view biomarkers have several advantages:
- Integrate exposure(s) with time
- Take bioavailability in consideration
- Use biological effects rather than exposure only

Why is their use not that much developed?
- Regulators do not understand really what it means
- Identification of substances is preferred to effects
- Few labs know how to measure them

They should be seriously considered in the future
- For their own advantages
- But also since new (…omics) tools appear
• Chemical structure contains all the information that determines activity, properties, toxicity... But
  • We are lacking most of this knowledge
  • We do not know how to use the information we have!
  • In most cases knowledge about biological properties still needs to be embedded within models

• Environmental observation is also a large source of information... But:
  • It is diffuse and heterogenous
  • We not only need to observe we need to predict

• Models:
  • extract information from chemical structure,
  • create knowledge from this info,
  • Include knowledge of what happens in the real world,
  • Include this knowledge in models
Assimilation of data from different origins
- To refine exposition assessment by using local geophysical parameters
- To check the adequacy of models
- To have real time situation assessment
- To assess exposition of real populations

Knowledge of degradation products and the way they are produced

Better modelling of the fate of chemicals
- taking into account local parameters
- Including all relevant knowledge in models
- As an input to Risk Assessment models
What are the costs and benefits?
The first benefit is to avoid costs

- In France the annual budget of cancer from asbestos is 1.1M€
- Asthma and reproduction problems increase in urban/developed world, child cancer increase in some countries, the cost is very difficult to assess but might be considerable
- Some costs are not embedded in economy but are real:
  - Cost of affective lost
  - Lack of confidence in policy making and science
  - Lack of confidence in the future of humanity
The “cost” of protecting the environment

Ranking National Environmental Regulation and Performance: A Leading Indicator of Future Competitiveness?

DANIEL C. ESTY, Yale University

MICHAEL E. PORTER, Harvard Business School and Director, Institute for Strategy and Competitiveness
The cost is worth spending some money on environmental issues.

INTERVIEW - New Book Puts Cost of Saving Planet at $190 Billion

LONDON - What would it cost to wipe out world poverty, guarantee universal health care, stabilise population growth and roll back the ravages of global warming?

About $190 billion a year, or the equivalent of a third of US annual military expenditure, a prominent environmental economist says in a new book.
Everyone in the world depends on nature and ecosystem services...

Humans have made unprecedented changes to ecosystems in recent decades...

Human activities have taken the planet to the edge of a massive wave of species extinctions...

The pressures on ecosystems will increase globally in coming decades unless human attitudes and actions change.

Even today’s technology and knowledge can reduce considerably the human impact on ecosystems.

They are unlikely to be deployed fully, however, until ecosystem services cease to be perceived as free and limitless, and their full value is taken into account.
Some policy options
Why not using economical regulation instruments

• Threshold values in the environment come from a belief in threshold effects
  • It is still necessary as foolguards
  • It will last as long as water quality objectives are overpassed

• Pressures on the environment is in fact a non free use of amenities
  • It is fair to pay taxes to ensure equity towards nature
  • Pollution based taxes are good incentives for a cleaner economy
  • The income can be used for environmental restoration or social improvement (Economists evaluate the cost of restoring planetary environment by 190G$)

• It might help to reduce work based taxes
How could regulation move towards economical instruments

- Need for a quantitative assessment of the ecological and sanitary impacts of each substance
  - Models that integrate effects at several levels
  - Improvement of the evaluation of fate
- Need to evaluate the value of natural amenities
  - Willingness to pay, hedonic methods, etc should be improved since they overestimate recreation use of the environment
- Change of attitude towards environment
  - Richness of economies is explained by their efficiency in using fossil resources
  - This should be reversed towards eco-efficiency
The virtuous circle of Risk assessment

- Understand reality
- Monitor hazard
- Evaluate risk
- Regulate risk

Understand reality

Monitor hazard

Evaluate risk

Regulate risk
A new governance of environmental risks of chemicals

• First of all better data on chemicals and other stressors
• Transparency of pollution data at several scales (EU, National, local)
• Communication of relevant scientific information
• Dialogue with stakeholders to explain policies
• RA exercises driven by mixed panels including stakeholders
• Relevant use of prediction, observation and reactivity
What is a decision?

Where scientists are:

<table>
<thead>
<tr>
<th>Good situation!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad situation!</td>
</tr>
</tbody>
</table>

2 + 2 = 4

A fact:

A bet:

Are not decisions:

A choice:

Involving several stakes:

Good situation!
Thank you for listening,
have a fruitful meeting.
Remember that policy makers need you, scientists, to improve their action