

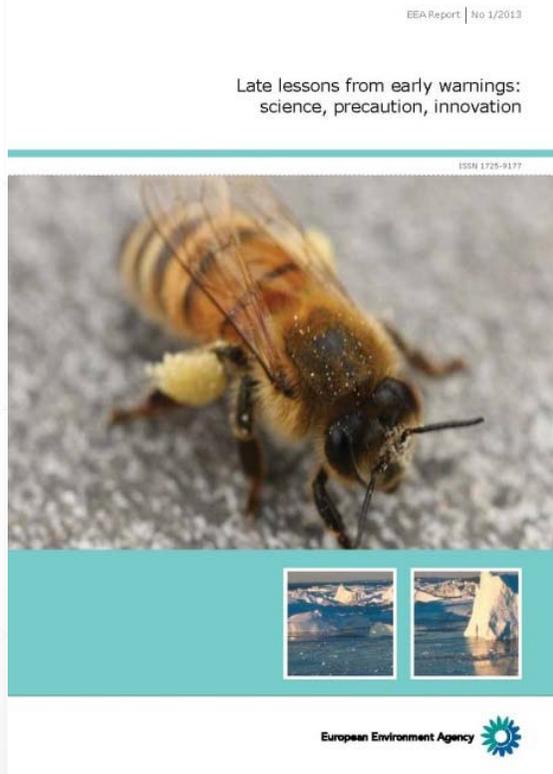
Innovation and Precaution

Some framing reflections

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Precaution



*'The precautionary principle provides justification for public policy and other actions in situations of scientific **complexity, uncertainty and ignorance**, where there may be a need to act in order to avoid, or reduce, **potentially serious or irreversible** threats to health and/or the environment, using an appropriate strength of scientific evidence, and taking into account the **pros and cons of action and inaction** and their **distribution**.'*

Source: EEA 2013

Why is precaution a key principle?

- Complex issues in complex social-ecological systems: often the realm of ignorance and ambiguity
- Potential irreversibility
 - e.g. altering genome, self replicating technologies, biodiversity loss, climate change, nuclear contamination, ...
- We live on a finite planet
 - ⇒ Necessity of upstreaming: being proactive rather than reactive: avoid harm as much as possible
 - e.g. 'benign by design', avoid, substitute, reduce at source, ...

Asymmetry in error types

Type I error False positive	Accept a false hypothesis ($H=$ there is an effect)	Excessive credulity	In science: avoid them because you want to provide explanations of the world
Type II error False negative	Reject a true hypothesis ($H=$ there is an effect)	Excessive scepticism	Maybe these should be avoided when stakes are high and damages irreversible and/or exposure widespread

- Asymmetry between competing policy and scientific options of avoiding false negatives and avoiding false positives
 - Stems from irreversibility and high stakes
 - Calls for precautionary approaches
- ⇒ Reflect on pros and cons of being wrong

Inspiration: EEA 2001 & 2013 & Andy Stirling's work

Weighing pros and cons



Asymmetries in how we account for the pros and cons, costs and benefits of an action / a technology / a product

- Emphasis on the short term one-dimensional (vested) benefits & risks vs. long-term and systemic (societal) risks & benefits
- More emphasis on costs of preventative or precautionary action than on benefits (and co-benefits, spillover effects)
- Negative externalisation goes one way: from private interests to society &/or environment

Business and precaution?

- Narrow understanding of business and its purpose leads to fears that the precautionary principle (PP) would be hindering business activities and innovation (fear stemming from dominance of vested interests)
- Yet this all comes from a major confusion between means and ends
- From a vision where profit is an end in itself to a vision where profit is a means towards a higher business end: providing a (useful) service to society
- Time to re-think the role and purpose of business in society
- In such context, the PP can be a starting point and a useful compass for business
- Importantly, precaution can be upstreamed in the research and development processes

Contributing to '*an economy with a human purpose*'
(une économie à finalité humaine)
René Passet (2001)



Purposeful and responsible innovation

- Avoiding harm as a starting point in a research and development process
- *'Benign by design'*
(Paul Anastas)



The 12 Principles of GREEN CHEMISTRY

Green chemistry is an approach to chemistry that aims to maximize efficiency and minimize hazardous effects on human health and the environment. While no reaction can be perfectly 'green', the overall negative impact of chemistry research and the chemical industry can be reduced by implementing the 12 Principles of Green Chemistry wherever possible.

- 1. WASTE PREVENTION**
 Prioritize the prevention of waste, rather than cleaning up and treating waste after it has been created. Plan ahead to minimize waste at every step.
- 2. ATOM ECONOMY**
 Reduce waste at the molecular level by maximizing the number of atoms from all reagents that are incorporated into the final product. Use atom economy to evaluate reaction efficiency.
- 3. LESS HAZARDOUS CHEMICAL SYNTHESIS**
 Design chemical reactions and synthetic routes to be as safe as possible. Consider the hazards of all substances handled during the reaction, including waste.
- 4. DESIGNING SAFER CHEMICALS**
 Minimize toxicity directly by molecular design. Predict and evaluate aspects such as physical properties, toxicity, and environmental fate throughout the design process.
- 5. SAFER SOLVENTS & AUXILIARIES**
 Choose the safest solvent available for any given step. Minimize the total amount of solvents and auxiliary substances used, as these make up a large percentage of the total waste created.
- 6. DESIGN FOR ENERGY EFFICIENCY**
 Choose the least energy-intensive chemical route. Avoid heating and cooling, as well as pressurized and vacuum conditions (i.e. ambient temperature & pressure are optimal).
- 7. USE OF RENEWABLE FEEDSTOCKS**
 Use chemicals which are made from renewable (i.e. plant-based) sources, rather than other, equivalent chemicals originating from petrochemical sources.
- 8. REDUCE DERIVATIVES**
 Minimize the use of temporary derivatives such as protecting groups. Avoid derivatives to reduce reaction steps, resources required, and waste created.
- 9. CATALYSIS**
 Use catalytic instead of stoichiometric reagents in reactions. Choose catalysts to help increase selectivity, minimize waste, and reduce reaction times and energy demands.
- 10. DESIGN FOR DEGRADATION**
 Design chemicals that degrade and can be discarded easily. Ensure that both chemicals and their degradation products are not toxic, bioaccumulative, or environmentally persistent.
- 11. REAL-TIME POLLUTION PREVENTION**
 Monitor chemical reactions in real-time as they occur to prevent the formation and release of any potentially hazardous and polluting substances.
- 12. SAFER CHEMISTRY FOR ACCIDENT PREVENTION**
 Choose and develop chemical procedures that are safer and inherently minimize the risk of accidents. Know the possible risks and assess them beforehand.

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Elements for the governance of innovation

- Reflect on consequences over time, and on their effects on quality of life, well-being and sustainability ⇒ Gauge an innovation against societal goals/visions
- Be transparent and dynamic (there are unknowns, knowledge evolves)
- Apply the precautionary principle when stakes are high, uncertainty and ignorance prevail
- Consider irreversibility of potential negative consequences
- Upstream: adopt a precautionary mindset in research and innovation
- Cherish diversity of solutions to build resilience
- Acknowledge the possibility of surprises
- Be adaptive, allow to revisit decisions and choices
- Keep options open, yet accept to close down inappropriate paths...

Inspiration: A. Stirling & EEA 2001, 2013

Conclusion

- The precautionary principle is a key tool if we are serious about aiming to thrive in an *"ecologically safe and socially just space for humanity"* (Raworth 2017).
- Precaution is not anti-innovation, it fosters innovation with a human purpose
- Reflexivity, open-mindedness and humility are de rigueur



Source: Kate Raworth 2017