Work in the nano dimension: ethics, risk and precaution

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Part 1: background reflection on ethics.

Historical highlight from the French Revolution:

- a story from more than 200 years ago ->
- Marie Jean Antoine de Condorcet

Marie Jean Antoine de Condorcet 1795:
"Sketch for a Historical Picture of the Progress of the Human Mind"

- "*Will increased welfare and improved health of man lead to largely increased populations? Will not necessarily there be a time when the number of people has outgrown the natural resources that nature can supply? Is it not reasonable to assume that when resources become scarce, then there will be fight for the resources, war between people?*"

- [**Technology Fix argument**:] Nobody could claim that such a time is imminent, Technological progress may bring the answers.
- [**Ethics argument**:] People's ethics and morality will progress alongside reason. Our moral duty is not to make sure that unborn life is born, but that those that are born are secured a life in reasonable welfare, dignity and happiness."

Condorcet believed in the power of rationality / science.

- The following is an obvious truth for him:
- The progress of science and technology cannot be conceived without at the same time assuming that human reason and ethics also will have made considerable progress!
  - **Moral progress matches the scientific progress**!

Moral Progress?
In line with scientific progress?

- **What do you think?**

[Ethics is about making good / right choices.]

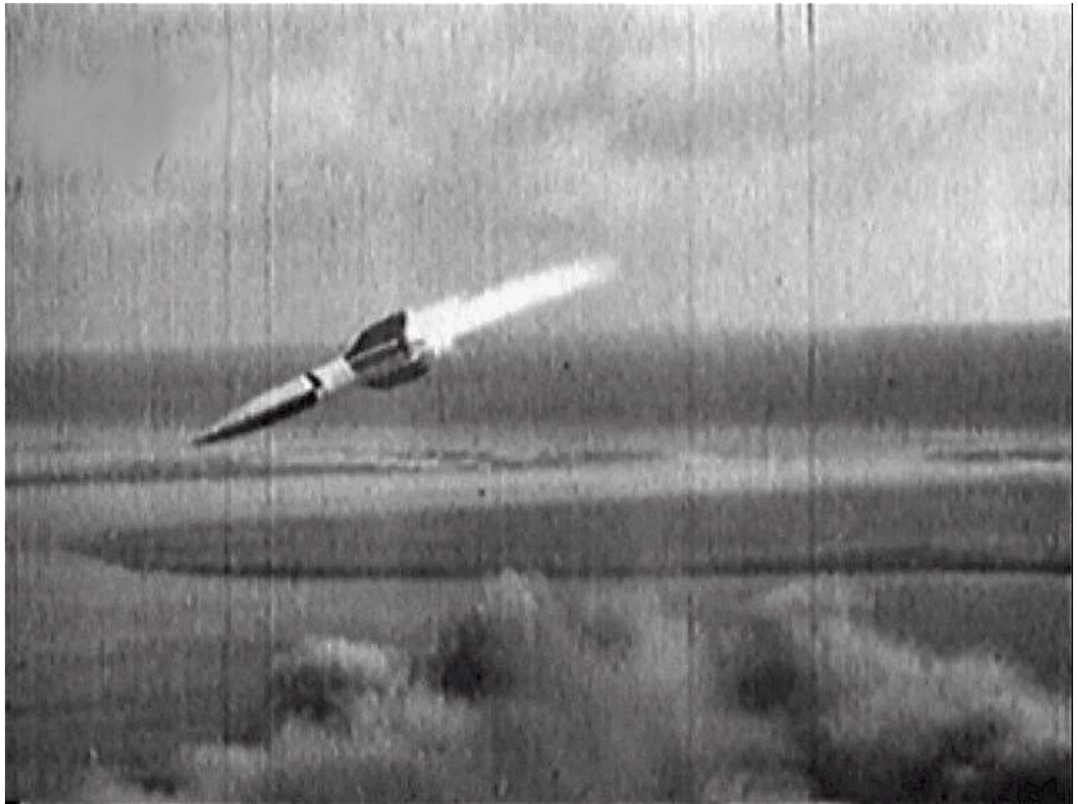
”Big Science” and funding of research:

- a trip to the Moon and how it startet ->
  - **Wernher von Braun**:
    Heroe of science or corrupt betrayer of morality?

Wernher von Braun – model scientist?

- Born 1912
- Early interest i space exploration (book by Romanian physicist)
- Volunteered for the military (1932) in order to do research
- With Dornberger starting Peenemünde 1936;
- Privately a big snobb
- Success at the end of the 1930’s; first good tests of rockets in (1943); V2 was deveoped
- No doubt aware of the use of concentration camp inmates to produce these weapons
- Reported to USA in 1945, they transgered him to USA
- Became leading figure in NASA
- Leading the Moon landing project
- Died in 1977

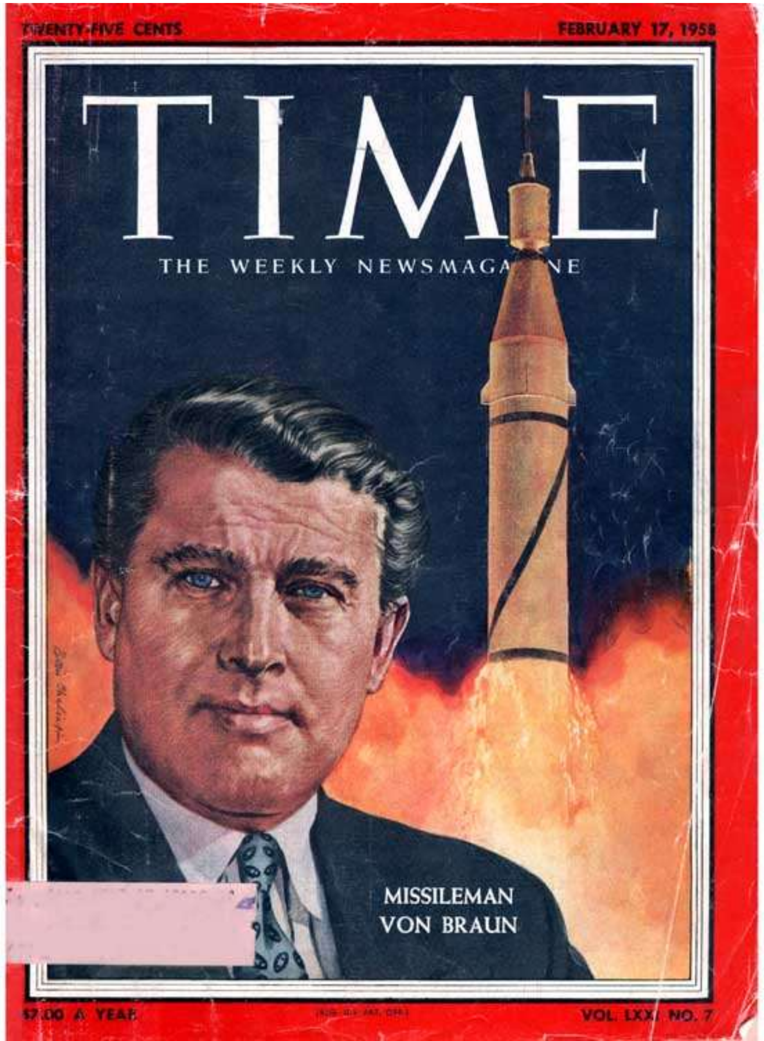

Bundesarchiv, Bild 146-1978-Ausl.024-03
Foto: o.Ang. | 1941 Frühling



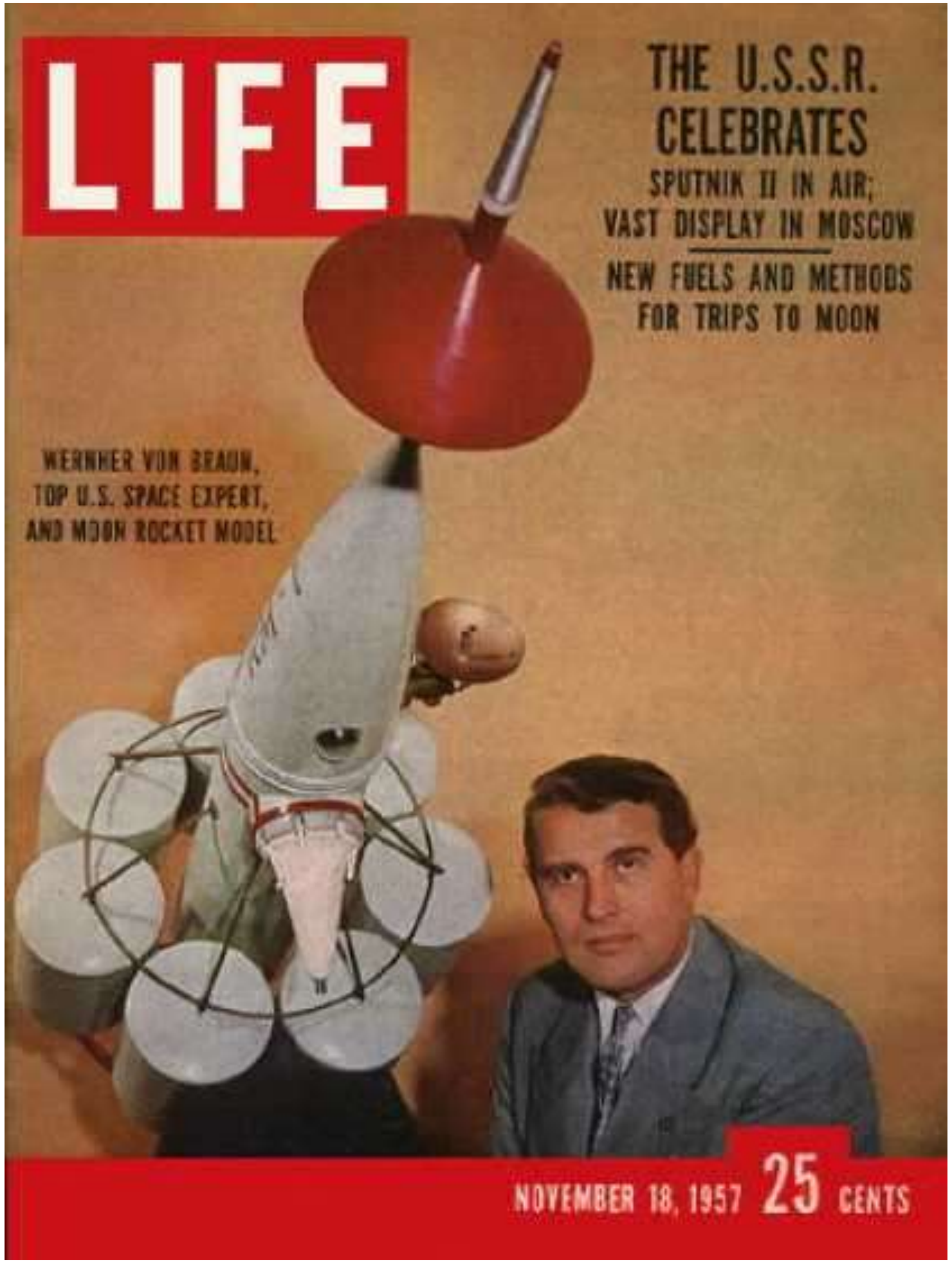




Werner von Braun Rocket Science Team Surrenders to the U.S. 324th Regiment - 44th Infantry Division, May 2, 1945


TWENTY-FIVE CENTS
FEBRUARY 17, 1958
TIME
THE WEEKLY NEWSMAGA NE
MISSILEMAN
VON BRAUN
$7.00 A YEAR
VOL. LXXI NO. 7

”I do not care if I work for Uncle Sam [USA] or if I work for Uncle Joe [Joseph Stalin], as long as the uncle is rich!”
Wernher von Braun, NASA



Three reflections:

- Yes, I have met the same type of researcher like Wernher von Braun, even in our days.
- ”you have to go where the money is” , ”After all, we just provide the knowledge, it is others that use it”,
- No, I do not think that our society today can afford this type of scientist.
  - We expect social responsibility in exchange for academic freedom!.
- If you agree with statements 1. og 2., then it ”only” remains to answer the question what type of instruments one should use in order to increase the ethical responsibility of the workers at the workbench. -> Ethics in science, research ethics,…
  - Education?
  - Guidelines? …
  - Ethical committeees?
  - Broad public debate …

Part 2: Risk and precaution: value based approaches

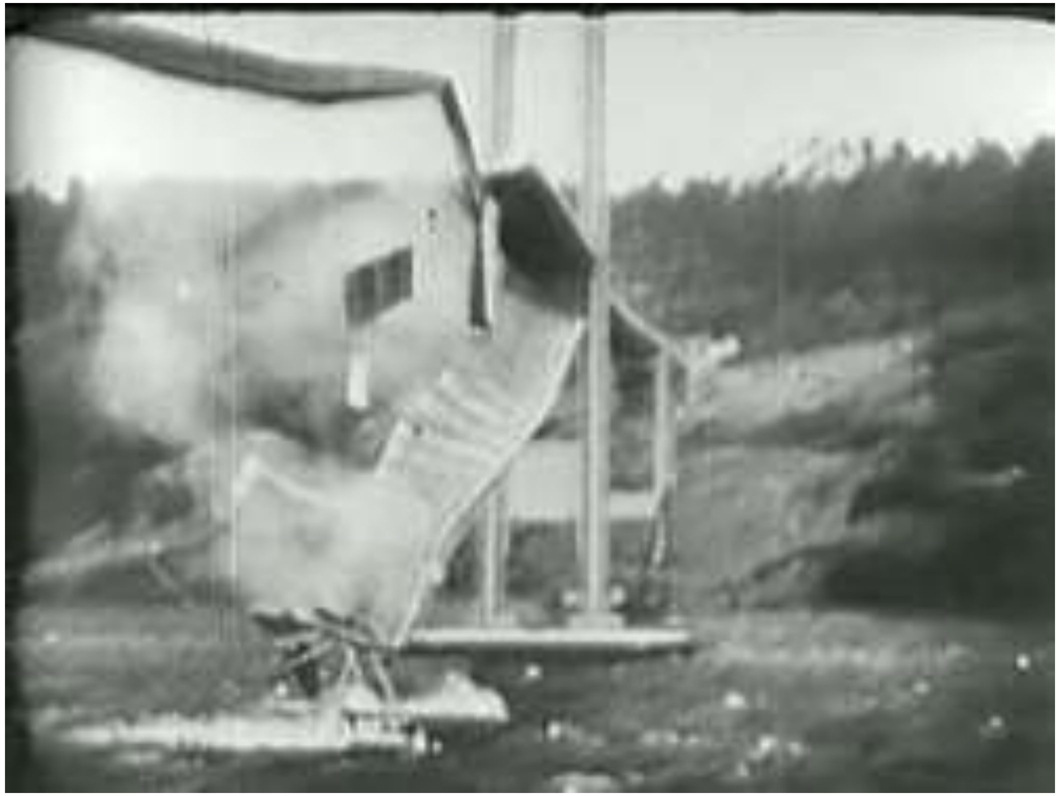
Reflect on risk and responsibility!

Inspiration:

https://www.youtube.com/watch?v=3m5qxZm_JqM

The Changing Culture of Risk

1: Risk as engineering error: "Galloping Gertie" Tacoma Narrows Bridge 1940



https://www.youtube.com/watch?v=nFzu6CNtqec&t=87s

Engineering error:

- Problem:
  - Overlooking variables in nature
  - Distance from theoretical model to real system
- Solution:
  - Safety margins to be built in

1.a The unseen risks:
”There is poison all around us now” The New York Times, review av Silent Spring

FORSKNINGSETISKE KOMITEER

”Unseen risks”

- Problem:
  - Frightening for large parts of the public
  - Detection often too late?
- Solution:
  - Scientific risk assessment (regulated)
  - Trustworthy communication

2: Risk as consequence of Big (Frightening) Technology: Nuclear Power

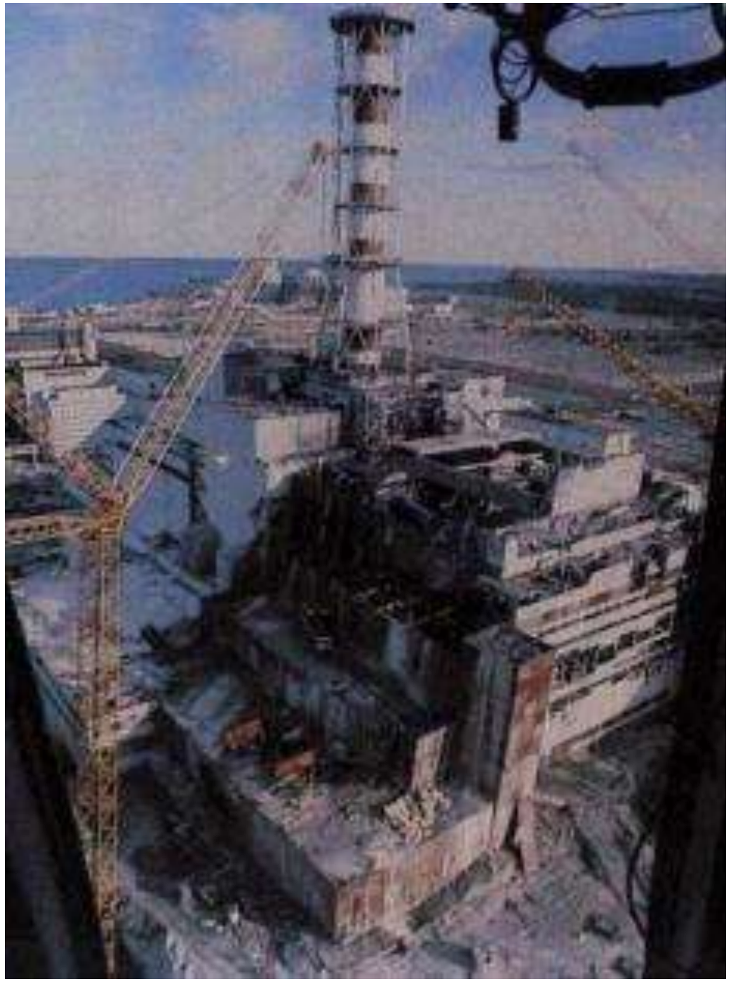
Big Technology risk

- Problem:
  - Possible harm not localized to cause of risk
  - Complex technological system with multiple causal pathways
  - Population perceives risks as large; resistance
- Solution:
  - Risk analysis
  - Safety measures / Protection standards
  - Countermeasures and restoration
  - Scientific education of people / decision-makers

In social science:

- Ulrich Beck, Risikogesellschaft (”Risk society”) 1986
- Kristin Shrader-Frechette, Risk Analysis and Scientific Method, 1985

Chernobyl showed reality of risk:

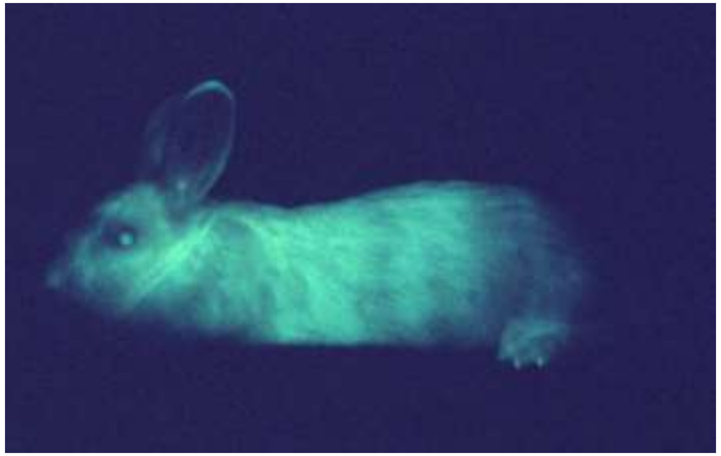


… and more recently: Fukushima !

http://www.youtube.com/watch?v=90NEIj7EmNo

2 a: Risk, biotechnology, and modern agriculture

http://www.youtube.com/watch?v=QobuvWX_Grc



Big ”bio”-technology risk

- Problem:
  - Similar to Big Technology risk
  - Causal pathways via biological material
  - Fear factor large;
- Solution:
  - Biosafety assessments and measures
  - Containment as far as possible
  - Consumer information & choice

: Incalculable risk: 9/11

Incalculable risks:

- Problem:
  - ”outrageous events”, human behaviour
  - Politics involved
- Solution:
  - Security measures aimed at preventing outrageous events to occur
  - International cooperation

4: Risk as co-extension between nature, society, and technology: Tsunami 2004

Co-extension of nature, society and technology risks:

- Problem:
  - Dimensions of possible harm vary with complex conditions prior to risk cause and with abatement measures
- Solution:
  - Precautionary measures
  - All-encompassing security

Conceptual clarifications:

- Risks ≠ hazard, event (real)
- Risks in part a social construct, result of & framed within social experience, including communication about potentially hazardous events. (Dimension of <u>meaning</u>)
- Risk communication -> pursuit to understand risk related decisions and behaviour by dynamic analysis of exchange of information about risks.

Definition by O. Renn (1992, 1996)

- risk denotes a mental concept about the possibility that an undesirable state of reality (adverse effects) may occur as a result of natural events or human activities.

  - This definition implies that humans can and will make causal connections between actions (or events) and their effects, and that undesirable effects can be avoided or mitigated if the causal events or actions are avoided or modified. Risk is therefore both a descriptive and a normative concept.

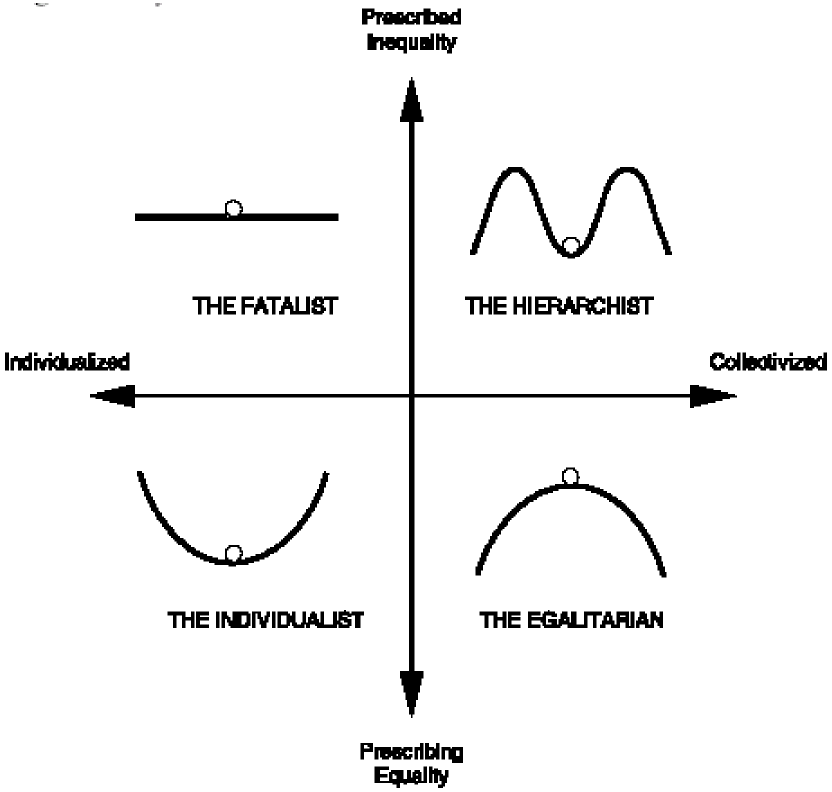
Large field of study on perceived ”riskiness”:

Table: Basic dimensions underlying evaluation of risk by individuals
(based on Vlek & Keren 198?)

1. Potential degree of harm or fatality;
2. Physical extent of damage (area affected);
3. Social extent of damage (number of people involved);
4. Time distribution of damage (immediate and/or delayed effects;
5. Probability of undesired consequence;
6. Controllability (by self or trusted expert) of consequences;
7. Experience with, familiarity, imaginability of consequences;
8. Voluntariness of exposure (freedom of choice);
9. Clarity, importance of expected benefits;
10. Social distribution of risks and benefits.
11. Harmful intentionality.

Risk willingness vs risk avoidance

- Depending on perceived qualities of risks
- Depending on individual characteristics
- Depending on what the individual believes about nature or society:



Principles in Environmental Policy

- *curative* model
  Polluter Pays Principle
- ‘prevention is better than cure’ model
  Prevention Principle
- ‘better safe than sorry’ model
  Precautionary Principle

paradigmatic shift from ***a posteriori*** control (civil liability as a curative tool) to the level of ***a priori*** control (anticipatory measures) of risks

Important distinction

- Principle of Prevention -> applies when we have good quantitative risk estimates, often risk-cost-benefit data, and then we decide on protection (even if low probability).
- Precautionary Principle -> applies only in the case of lack of such quantitative data, but prevalence of **scientific uncertainty.**

Sources of uncertainty in science:

- **Variability**: the system / process can behave in different ways; variability is an attribute of nature / reality.
- **Lack of knowledge**: is a property of the analysts' performing a study and / or our state of knowledge.

(based on M.B.A.van Asselt, Persepctives on Uncertainty and Risk, Dordrecht 2000)

3 paradigms of uncertain risks

'deficit view'

- Uncertainty is provisional
- Reduce uncertainty, make ever more complex models
- *Tools:* quantification, Monte Carlo, Bayesian belief networks

'evidence evaluation view'

- Comparative evaluations of research results
- *Tools:* Scientific consensus building; multi disciplinary expert panels
- focus on robust findings

'complex systems view / *post-normal* view'

- Uncertainty is intrinsic to complex systems
- Uncertainty can be result of production of knowledge
- Acknowledge that not all uncertainties can be quantified
- Openly deal with deeper dimensions of uncertainty
  (problem framing indeterminacy, ignorance, assumptions, value loadings, institutional dimensions)
- *Tools:* Knowledge Quality Assessment
- Deliberative negotiated management of risk

Example from environmental science:

- Linearity of effect equations is not always the rule;
- Some systems exhibit more than one equilibrium state, and the transition due to perturbation of the system may occur at various points.

(”Catastrophic shifts in ewcosystems” Scheffer M. Et al. 2002, Nature 413, 591-596.)

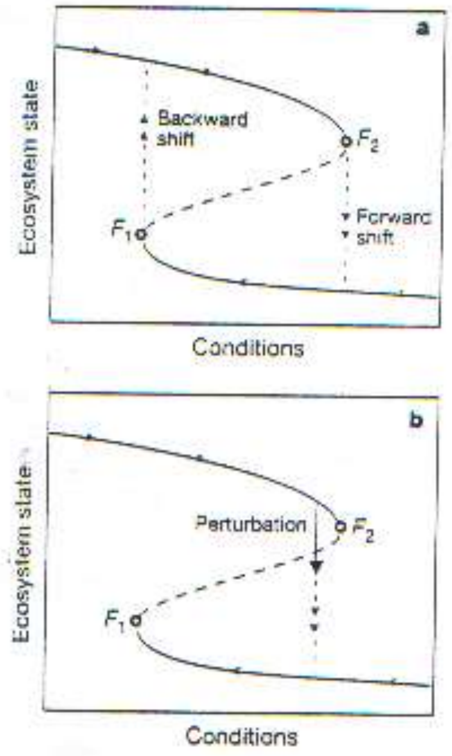


Figure 2 Two ways to shift between alternative stable states. **a**, If the system is on the upper branch, but close to the bifurcation point F_2, a slight incremental change in conditions may bring it beyond the bifurcation and induce a catastrophic shift to the lower alternative stable state ('forward shift'). If one tries to restore the state on the upper branch by means of reversing the conditions, the system shows hysteresis. A backward shift occurs only if conditions are reversed far enough to reach the other bifurcation point, F_1. **b**, A perturbation (arrow) may also induce a shift to the alternative stable state, if it is sufficiently large to bring the system over the border of the attraction basin (see also Fig. 3).

Environmental surprises as inherent uncertainties

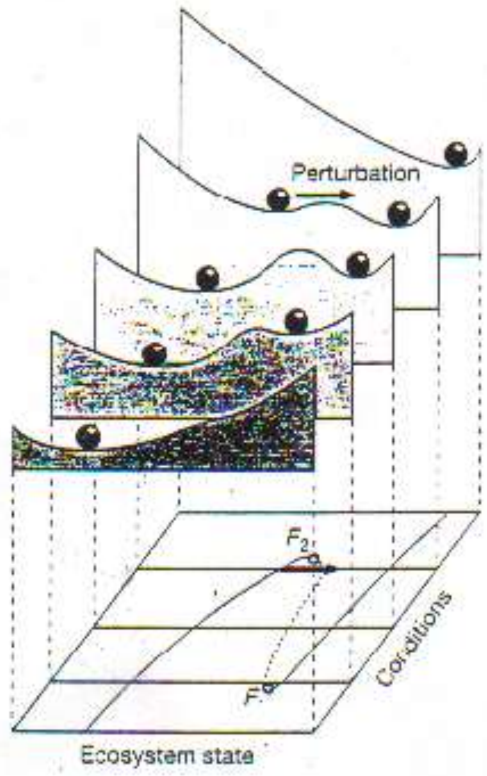


Figure 3 External conditions affect the resilience of multi-stable ecosystems to perturbation. The bottom plane shows the equilibrium curve as in Fig. 2. The stability landscapes depict the equilibria and their basins of attraction at five different conditions. Stable equilibria correspond to valleys; the unstable middle section of the folded equilibrium curve corresponds to a hill. If the size of the attraction basin is small, resilience is small and even a moderate perturbation may bring the system into the alternative basin of attraction.

- Loss of ecological resilience leads to environmental surprises.
- Traditional notion of resilience = stability at presumed steady-state, linear, cause-effect view of predictive science
- Newer definitions = scale of disturbances being absorbed before flipping the system; complex system, non-linear, self-organising, multiple equilibria.
- E.g. shallow lakes and man-induced eutrophication
- Includes humans-nature system

F.Berkes & C. Folke 1998, Linking Social and Ecological Systems, CUP Cambridge

Variability in reality:

- Inherent randomness in nature (stochastic events)
- Human behaviour (”outrageous events” e.g. terrorism)
- Social, economic, political and cultural dynamics (large social scale disruptions)
- Technological surprises (new technology or new effects of old technology)
- Value diversity (cognitive variety)

Lack of knowledge:

- Inexactness (”we roughly know”)
- Lack of data (”we could have known”)
- Practically immeasurable (”we know what we do not know”)
- Conflicting evidence (”we do not know what we know”)
- Reducible ignorance (”we do not know what we do not know”)
- Indeterminacy (”we will never know”)
- Irreducible ignorance (”we cannot know”)

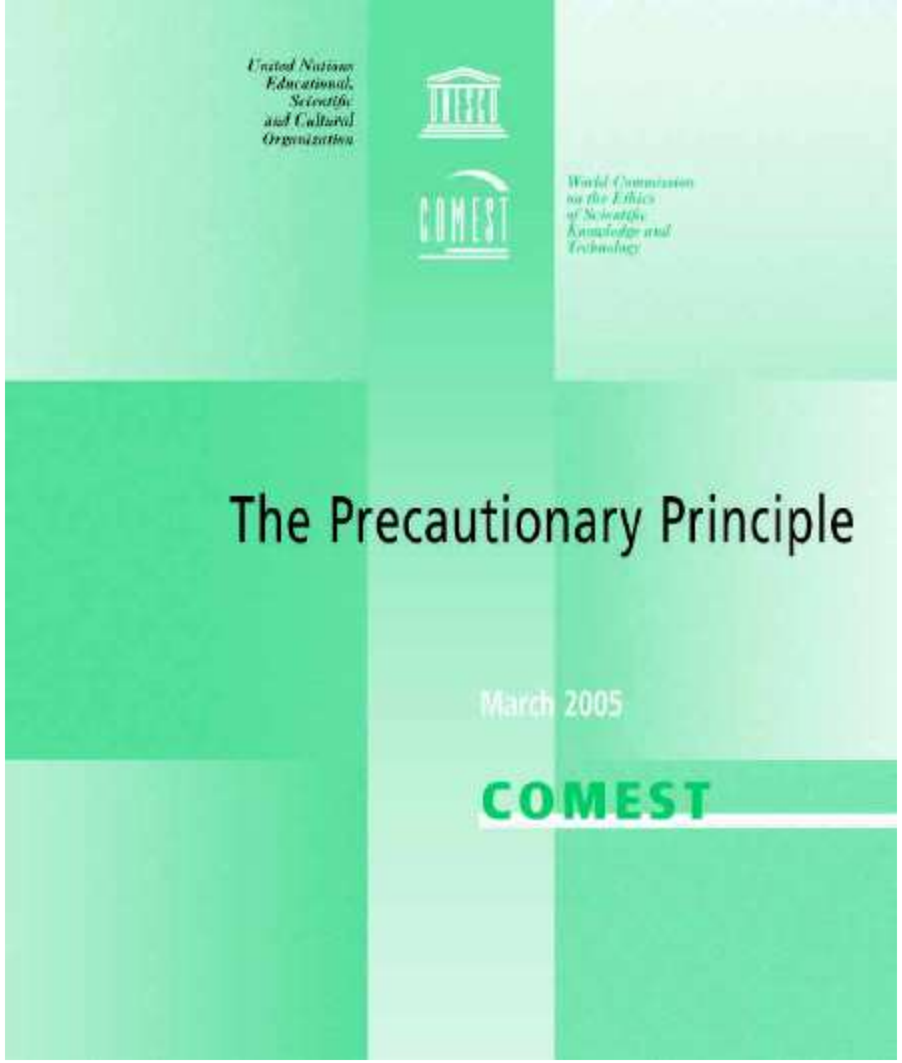
UNESCO World Commission on the Ethics of Scientific Knowledge and Technology (COMEST)

Expert Group Precautionary Principle

- to clarify the PP for decision makers and scientists in order to achieve a more informed debate of the principle and to serve as reference for possible further implementation of PP to present recommendations on how PP can contribute to a sustainable future.

Expert Group members

- **Matthias Kaiser** (Philosopher), NENT, Oslo, Norway. (Chair)
- **Jeroen van der Sluijs** (Associate Professor), Copernicus Institute UU & C3ED UVSQ (Rapporteur)
- **Sharon Beder** (Professor), School of Social Sciences, Media and Communication,University of Wollongong, Australia.
- **Vittorio Hösle** (Philosopher), Department of Philosophy, University of Notre Dame, Notre Dame, USA.
- **Aída Kemelmajer de Carlucci** (Judge, Supreme Court), Mendoza, Argentina.
- **Ann Kinzig** (Assistant Professor), School of Life Sciences, Arizona State University, Tempe, USA.



Available in English, French, Spanish – soon also in Arabic, Chinese.

UNESCO – COMEST, 2005, *The Precautionary Principle*, *Report*, UNESCO: Paris, see also http://unesdoc.unesco.org/images/0013/001395/139578e.pdf; Download also via link: www.jvds.nl

common misunderstanding

- **Absence of evidence** (of possible harm) = **evidence of absence** (of possible harm) ??

➢ No, certainly not, but it is a common fallacy!

  ➢ A report ”*Absence of toxicity of bacillus thuringiensis pollen to black swallowtails under field conditions*” claims in title there is no harmful effect; while they only found ”*no significant weight differences among larvae as a function of distance from the corn field or pollen level*”. Thus, they only failed to demonstrate a harmful effect, they have not proven that there is none.

  ➢ Failure to prove that something is unsafe is sometimes taken as a proof that something is safe.

  ➢ Statistical type I and II errors: typically in science more weight an avoiding a false positive than on avoiding a false negative. (Power analysis often lacking.)

New working definition UNESCO

When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm.

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Morally unacceptable harm refers to harm to humans or the environment that is

- threatening to human life or health, or
- serious and effectively irreversible, or
- inequitable to present or future generations, or
- imposed without adequate consideration of the human rights of those affected.

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Uncertainty may apply to, but need not be limited to, causality or the bounds of the possible harm.

Actions are interventions that are undertaken before harm occurs that seek to avoid or diminish the harm. Actions should be chosen that are proportional to the seriousness of the potential harm, with consideration of their positive and negative consequences, and with an assessment of the moral implications of both action and inaction. The choice of action should be the result of a participatory process.

Advantages of new definition

- Formulated on the basis of positive criteria
- The possible harm referred to, in spite of being uncertain, needs to have some scientific backing
- Allows for a wide range of precautionary actions, provided they appear effective in order to either avoid or diminish the possible harm.

Thank you for your attention!

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