22nd Discussion Forum LCA
Evaluation of Long-Term Impacts in LCA
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Discounting and LCA

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DISCOUNTING **is defined as valuing damages differently at different points of time using a positive or negative discount rate.**

Net present value (NPV):

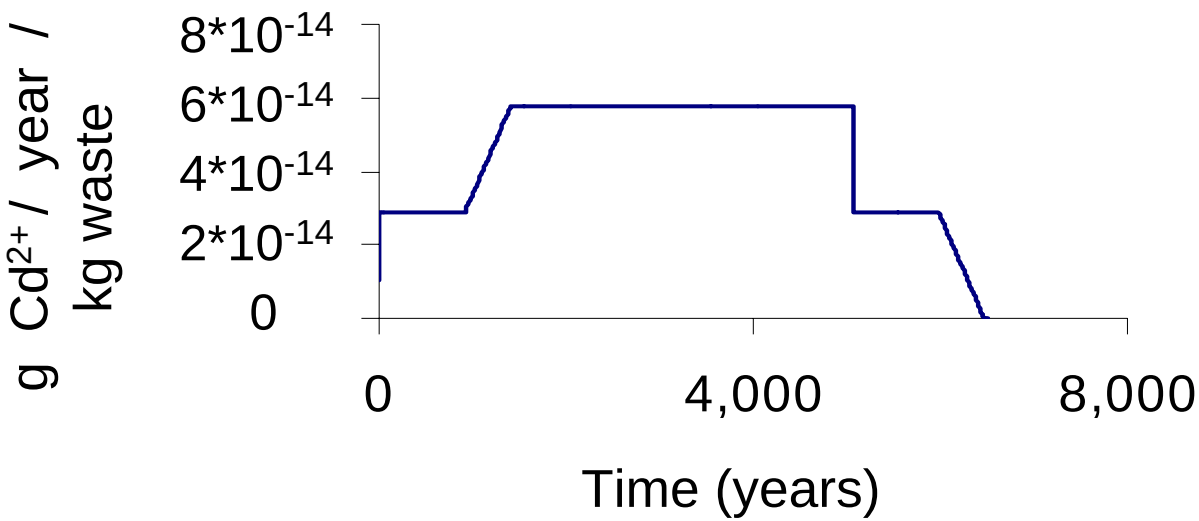
$$NPV = \sum_{t=0}^{T}((B_t - C_t) * \frac{1}{(1+r)^t}$$

B: Benefits
C: Costs
r : Discount rate
t: Time index

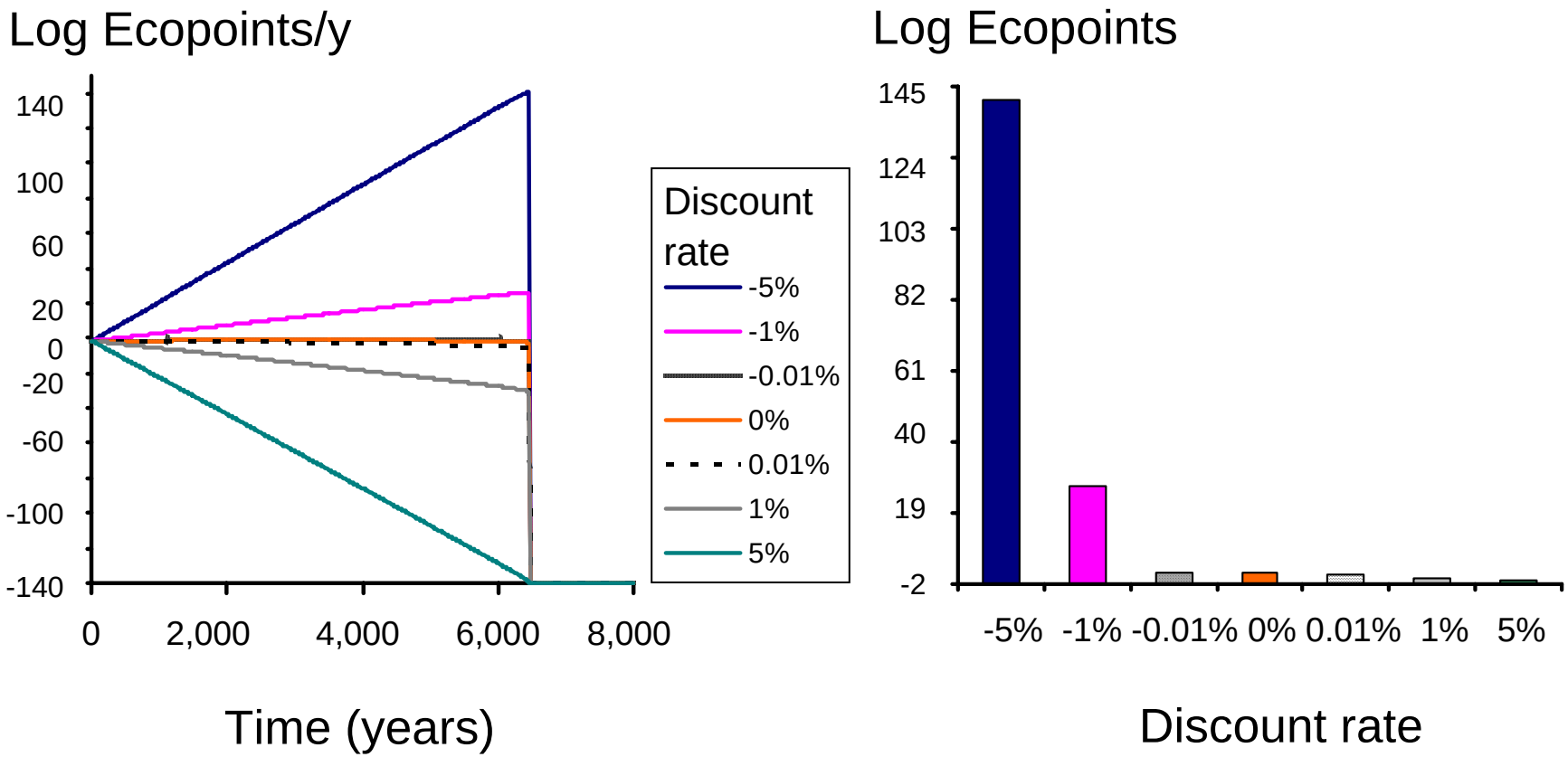
Example: A certain amount of money C_0 is put on a savings account at an interest rate of 3%. After 10 years, the money has 'grown' to

$$B_{10} = C_0 * (1 + 3\%)^{10}$$

Case study: Landfill emissions



Case study: Discounted LCIA results



Discounting has a strong influence on the results, if long time-horizons are involved

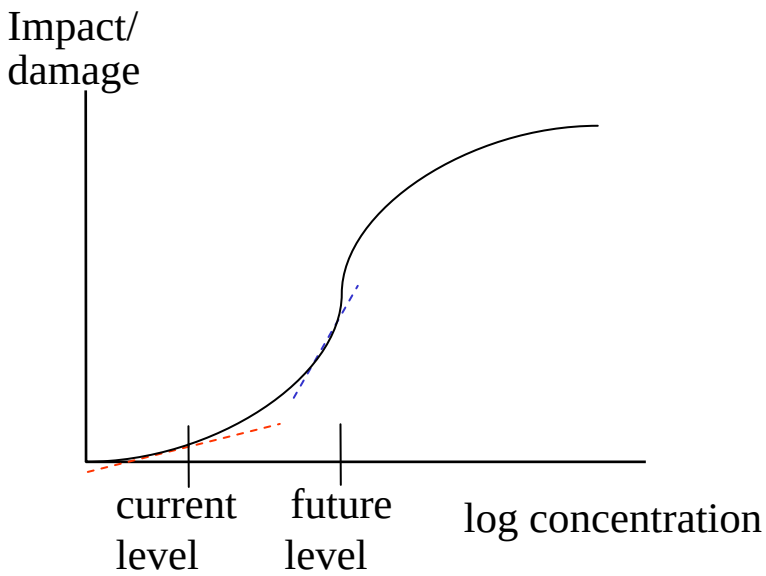
There are four reasons for discounting in economics:

1. Changes in the price level
2. Pure time preference
3. Productivity of capital and
   diminishing marginal utility of consumption
4. Uncertainties

Can these motivations ‘justify’ discounting in the context of LCA?

Reason No 1: The price level / magnitude of damage changes.

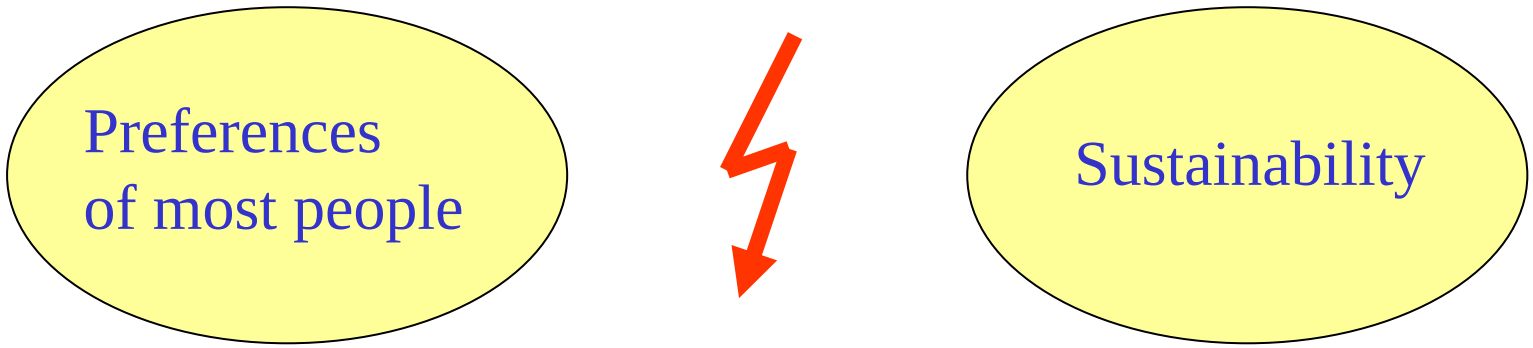
The background concentration of pollutants in the environment changes as a function of time. Assuming non-linear concentration-effect-curves, the magnitude of impact would change as well.



Changes in the magnitude of damage should be considered, but in scenario analysis, not in the discount rate.

Reason No 2: **One and the same damage is valued differently at two different points of time (pure time preference).**

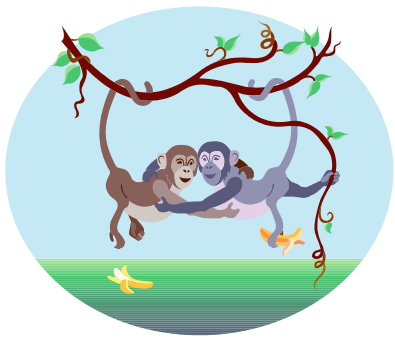
Two technologies cause the identical environmental impact but at different points in time (Technology A today, Technology B in 100 years). Discounting because of pure time preference would mean that Technology B would be preferred to Technology A in spite of the equivalence in impact.



Should LCA comply with sustainability goals or should it entirely be a tool designed according to the preferences of decision makers

Reason No 3 (I): **Capital could be invested in an alternative project so that it grows in the future (opportunity cost).**

A hypothetical landfill does not release major emissions during the first 200 years. Assume that the environmental damages caused by the landfill can be prevented at the cost of 1 Mio Euro. At an interest rate of 2.3%, it would be sufficient to invest 11`000 Euro on the capital market today to pay remediation costs in 200 years.



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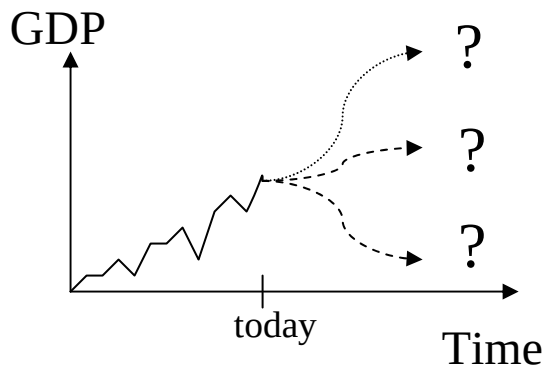
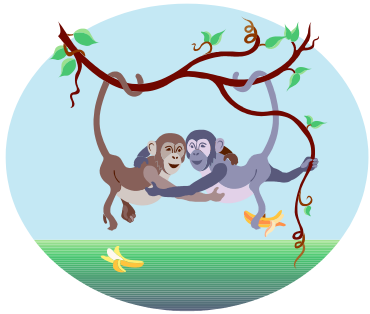


The environment does not „grow“. A relation to economic terms needs to be defined to apply discounting because of capital productivity.

Reason No 3 (II): Opportunity cost



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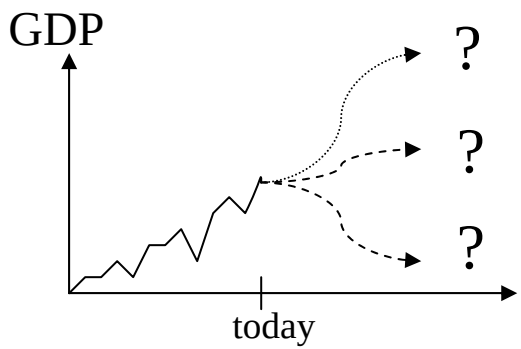
- Use value
- Option value
- Existence value

- Market prices
- Hedonic prices
- Travel costs
- Willingness to Pay (WTP) / Willingness to Accept (WTA)

- Prices are only a projection of value on an economic plane
- Prices, WTP, WTA, ... are not constant over time

Reason No 3 (III): Opportunity cost



Unlimited growth

Catastrophe

Example (Economist, 26.06.99):

Assume that a catastrophe associated with global warming wipes out the entire economy; the GDP in 200 years is $ 8 quadrillion – the cost of inaction would have a present value of only $ 10 billion at a constant discount rate of 7%.

Externalities can influence the growth of the GNP and thereby the discount rate.

Reason No 3 (IV): Opportunity cost

Assume that future generation will be compensated for environmental damages caused by current generations. The compensation payment is invested on the capital market at a positive discount rate.

$$WTP_t = WTP_0 (1+e*g)^t$$

e: income elasticity
g: growth rate

- In the presence of positive income growth, the Willingness to Accept/Pay will increase. The overall discount rate would therefore be reduced.
- If the state of the environment worsens with time, the WTP is likely to increase. As a consequence, the discount rate would decline.

Reason No 4: **It is uncertain whether the damage actually occurs and whether it will be perceived as damage in the future.**

- A toxic emission does not have its impact because humankind (the environment, the earth) does not exist any more or future people do not perceive the impact as damage.
- New technologies will be developed to prevent all damages.

There are severe objections to discounting because of uncertainty about the presence of a society.
Uncertainty concerning the existence of cost should be considered in scenario analysis, not in the discount rate.

Conclusions for the discount rate

- Changes in the magnitude of damage and uncertainties should be considered with scenario analysis.
- Discounting because of pure time preference is ethically not acceptable if several generations are involved.
- There are objections to discounting because of capital productivity. Even if this type of discounting is accepted, the (long-term) discount rate might be(come) zero.
- There is no universal answer to the question whether or not discounting should be applied to environmental damages. However, **if LCA wants to be a ‚sustainability tool', the long-term discount rate should be (close to) zero.**

Practical implications for LCA

- Discounting requires temporally differentiated data, which might be time consuming. **In cases where a large share of impacts occurs in the future, temporal differentiation might deserve this effort.**

- **Possible implementation** in LCA:

    - Time classes (see ecoinvent and toxicity categories from Mark Huijbregts) ➡ easy to implement, but discounting not fully possible

    - Discounted inventory data and characterization factors ➡ discounting possible, but amounts of data increase (for each elementary flow and characterization factor several values)

Further information:

Stefanie Hellweg, Thomas B. Hofstetter, Konrad Hungerbühler (2003):

“Discounting and the Environment: Should Current Impacts be weighted differently than Impacts harming Future Generations?”

International Journal of LCA 8(1), 8-18.