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Assessment of Biodiversity Losses

External Costs of Biodiversity Losses due to Land Use Transformation and Air Pollution

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Biodiversity losses due to land use changes and depositions of airborne emissions

- NEEDS: New Energy Externalities Developments for Sustainability Integrated project, EU FP6
- «Assessment of Biodiversity Losses – Monetary Valuation of Biodiversity Losses due to Land Use Changes and Airborne Emissions»

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  www.econcept.ch/index.php?eID=tx_nawsecuredl&u=0&file=uploads/media/550_sb.pdf&t=1244470929&hash=4ffb040e762f197d29672d196e929829

External costs of biodiversity losses: Objectives

- Identification of the most relevant effects reducing biodiversity:
  - Biodiversity losses due to **land-use changes** caused by energy production and transmission/distribution infrastructures
  - Biodiversity losses due to **energy related airborne emissions of** NO_x, SO_x, NH_3 , causing eutrophication and/or acidification of natural habitats
- Methodology to assess biodiversity losses and corresponding external costs due to land use changes and airborne emissions
- Estimation of these marginal external costs of biodiversity losses for 32 countries

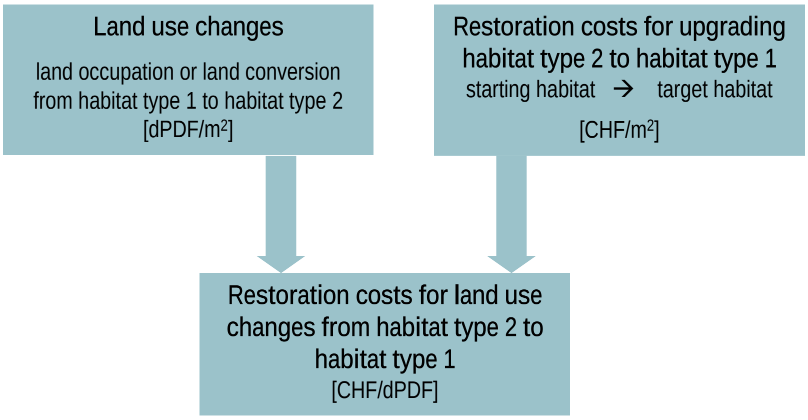
Approach

- Measure for biodiversity: Species richness, measured by the occurrence of vascular plants, i.e. the number of vascular plants in a certain area
- Indicator for biodiversity losses and ecosystem damage: Change in the number of plant-species: relative decrease of the number of species x area
- Characterisation factor and measure for species missing: Potentially disappeared fraction; PDF = (species diversity$_{reference}$ – species diversity$_{use}$)/species diversity$_{reference}$
- Eco-Indicator 99: Potentially disappeared fraction (PDF) for evaluating ecosystem quality or damage
- Koellner: Ecological ranking of 31 land use categories according to their species richness (Corine land use classification) :
  - Environmental damage factor: PDF relative to the reference situation of "*Swiss lowlands*"

Land use changes – Valuation method

- Monetary valuation of biodiversity losses (measured as ΔPDF) due to land use changes is achieved by a restoration cost approach
- Restoration costs = costs incurred by the measures necessary to establish a target habitat going out from a (less valuable) starting habitat →
  - Costs for initial re-establishment and maintenance to the autonomous evolution of the habitat
  - Planning and supervision costs
- Costs derived from different empirical studies from Germany (Bosch 1998; Froelich & Sporbeck 1995/2000; Gühnemann et al. 1999; updated to 2004)
- Results:
  - Restoration costs per ΔPDF for different kinds of land use changes in Germany [€/PDF/m^2; update to 2004 and conversion to other countries by PPS]
  - Restoration costs for establishing specific target habitats, going out from various (less valuable) starting habitats

Valuation of land use changes on biodiversity: Methodology



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Species richness of land use categories

Habitat type [Koellner, 2001]	Corine No.	Number of species	PDF relative to CH-lowland
Swiss lowland (reference habitat)	---	*40*	*0.00*
Integrated arable	2112	7	0.83
Organic arable	2113	26	0.35
Organic orchards	2212	23	0.41
Intensive pasture and meadows	2311	17	0.58
Less intensive pastures and meadows	2312	19	0.53
Organic pasture and meadows	2313	45	-0.14
Semi-natural broad leafed forests	3112	23-24	0.41-0.43
Forest edge	314	48	-0.20

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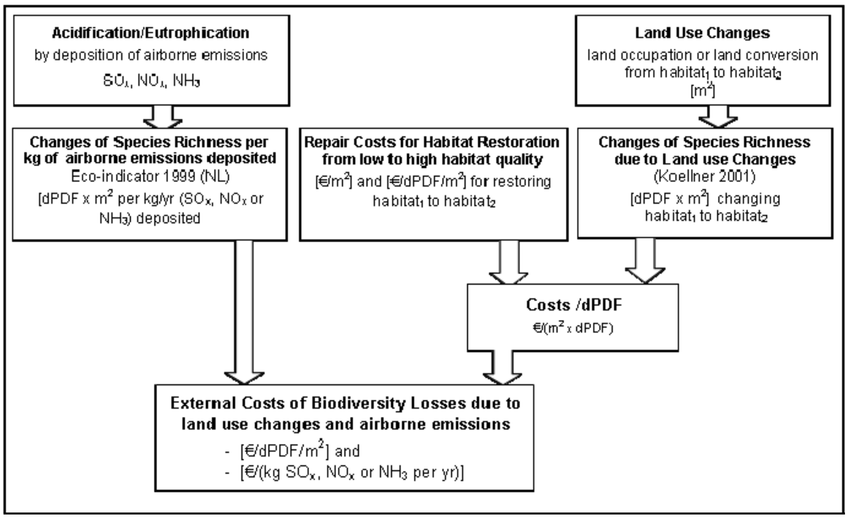
Biodiversity increase and costs of habitat restoration

From starting habitat →	to target habitat	Biodiversity increase [- PDF]	Restoration costs [€/m^2]
Built up land	Integrated arable	- 0.18	0.23
Built up land	Organic arable	- 0.74	0.60
Built up land	Intensive pasture	-0.47	0.48
Intensive arable	Organic arable	- 0.47	0.59
Intensive pasture + meadows	Less intensive p.+m.	-0.08	1.09
Intensive pasture + meadows	Organic pasture	- 0.86	2.74

Monetarization of biodiversity losses due to airborne emissions

- Quantification of effects of acidification and eutrophication caused by NO_x-, SO_x- and NH_3- depositions on biodiversity
- Methodological and empirical Approach of ***Ecoindicator 99***:
  - Observed effects of acidification and eutrophication on plants (in NL)
  - Target species: Species that should occur in a specific ecosystem without man-made changes → thes species represent the natural state of ecosystem
  - PDF: Fraction of species that have a high probability of non occurrence in a region or habitat due to unfavourable conditions caused by acidification and eutrophication (probability of occurrence < 5%)
  - Fate and damage modelling for NO_x-, SO_x- and NH_3- emissions and depositions for the Netherlands

Valuation of biodiversity losses: Methodology



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From depositions to damages (biodiversity losses)

- Damage model: Changes in the number of **target** species for a specific land use category due to additional depositions of airborne pollutants
- Result: Biodiversity damage (ΔPDF) caused by a marginal increase of SO_x-, NO_x- or NH_3- depositions on natural land (no damage from depositions on built up land)
- Reference value for NL; background deposition level 1999: PDF = 0.746429 $\hat{=}$ 74,6429%

Air pollutant (Netherlands)	Deposition increase on natural soil (10 mol/ha) [kg/(m² x year]	Resulting average PDF for NL	Damage caused by deposition increase [ΔPDF x m² per kg/yr]
SOx	6.4×10^{-5}	0.746540	1.73
NOx	4.6×10^{-5}	0.746867	9.52
NH3	1.7×10^{-5}	0.746870	25.94

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Restoration cost approach: From ΔPDF to costs

- Monetary valuation of ΔPDF by a restoration cost approach:
  - Linking costs per dPDF per m² for habitat upgrading with dPDF per kg deposition by airborne emissions per m² →
    (marginal) costs of biodiversity losses due to the deposition of airborne emissions [€/$kg_{deposited}$]
  - Costs per dPDF [€ /(dPDF x m²] are calculated with restoration costs for land use changes from unsealed natural areas with relatively low biodiversity into natural areas with high biodiversity (ΔPDF at least -20%).
  - Application of minimal costs to value biodiversity increases:
    Minimal restoration costs for Germany (2004: integrated arable → organic arable) : 0.49 €/(dPDF x m²)

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Restoration costs low → high biodiversity

Mean restoration costs per dPDF for different target biotopes 2004 (conversion from built up land)						
Land use category:	CORINE	Average repair costs	[€/dPDF/m^2]			
Conversion from built up land to	No.	Germany	NL	Greece	*CH*	EU 25
Integrated arable	2112	1.00	0.98	0.78	*1.30*	0.92
Organic arable	2113	0.62	0.61	0.48	*0.80*	0.57
Organic orchards	2222	6.56	6.43	5.12	*8.53*	6.04
Intensive pasture and meadows	2311	0.79	0.77	0.62	*1.03*	0.73
Less intensive pastures and meadows	2312	1.50	1.47	1.17	*1.95*	1.48
Organic pasture and meadows	2313	1.55	1.52	1.21	*2.01*	1.42
Forests	311 – 313	4.30	4.21	3.35	*5.59*	3.96
Forest edge	314	6.50	6.37	5.07	*8.44*	5.98
Country average		1.00	0.65	1.32	*2.15*	1.30

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Costs of biodiversity losses due to airborne emissions

External costs per kg of airborne emissions deposited [€/kg]						
	Combined acidification / eutrophication weighting (average restoration costs for D / CH: 0.49 / 0.63 [€/(m^2xdPDF)])			No acidification/ eutrophication weighting		
Country	SOx	NOx	NH3	SOx	NOx	NH3
Germany	0.26	1.41	3.81	0.29	1.57	4.27
NL	0.21	1.15	3.14	0.21	1.15	3.14
Greece	0.00	0.02	0.09	0.40	2.21	6.03
CH	*0.46*	*2.79*	*8.33*	*0.75*	*4.12*	*11.23*
EU25	0.15	0.75	1.88	0.38	2.09	5.71

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Assessment of future land use changes and emissions

- Future restoration costs due to land use changes: Depending on
  - relative development of the costs of restoration activities
  - Acidification and eutrophication pressure
- Future damage costs of airborne emissions: Depending on
  - general development of acidification and eutrophication pressure
  - eventual more country specific empirical studies dealing with the impact of airborne emissions on the species richness of other countries than the Netherlands
  - decreasing if air pollution abatement entails decreasing background immission concentrations

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Concluding remarks

- Empirical basis for the impact of the deposition of airborne emissions is limited: Empirical data accrue from the Netherlands and hat to be transfered to Switzerland and other EU-countries
- Results fit best for central Europe, less for the northern and southern European countries
- The outcomes of results are based on restoration costs which are validated using the outcomes of various willingness to pay studies → seems plausible
- Future decrease of natural areas will increase their scarcity and therefore their value → ev. higher willingness to pay results than the valuation with a restoration cost based assessment.