The use of indicators for ecosystem and health effects

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Overview

- Methodological issues
  i. Integrated impact assessment
  ii. Impact pathway approach
- An indicator for human health impacts
- An indicator for biodiversty impacts
- Summary and outlook

How to assess the environmental performance of technologies and policies?

→ integrated impact assessment

- **Integrated Assessment (IA): a multidisciplinary process of synthesizing knowledge across scientific disciplines with the purpose of providing all relevant information to decision makers to help to make decisions.**

- **Integration across**
  i. **sources (e.g. transport, energy conversion, etc.),**
  ii. **pollutants (e.g. PM, ozone, greenhouse gases, etc.),**
  iii. **impacts (health, ecosystems, climate change),**
  iv. **environmental media (air, soil, water),**
  v. **scales (local, regional, global)**

Integrated impact assessment

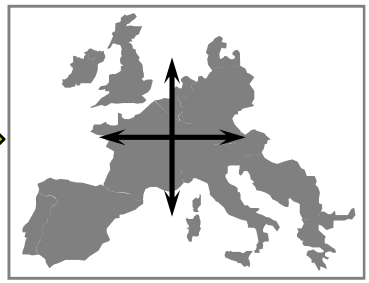
- Important issues:
  i. Relation between pressure and effect is in general non-linear and
  ii. Effects depend on time and site of the activity
  iii. Assessment of impacts/damage (e.g. health risk), not of pressures (e.g. emissions of pollutants)

→ **Bottom-up approach needed for the complex pathways: the 'impact pathway approach'**

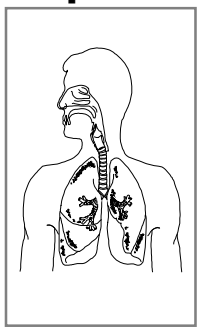
Impact Pathway Approach

Pollutant/Noise Emission

Transport and Chemical Transformation; Noise Propagation



Differences of Physical Impacts



Calculation is made twice: with and without project!

Main features of the Impact Pathway Approach

All alternatives, that pose a higher health risk on individuals or exceed sustainability targets, e.g. health impacts that occur with higher probability, are excluded in advance. Weighting is only possible for small individual risks and reversible ecosystem damage.

Assessment of impacts is needed at all spatial levels: local, regional, hemispheric, global. The relative importance of larger scale impacts is increasing.

Life cycle impacts (construction and dismantling, provision of fuels, waste treatment and disposal) should be taken into account.

Impacts included in detailed approach (I)

Impact Cat.	Pollutant / Burden	Effects
Human Health mortality	$PM_{10/2.5}$	Reduction in life expectancy due to short and long time exposure
	SO_2, O_3, Cd, As, Cr	
	Benzene, BaP, 1,3-butad., Diesel part., dioxins	Reduction in life expectancy – fatal cancer
	Noise	Reduction in life expectancy due to long time exposure
Human Health morbidity	$PM_{2.5}$, O_3, SO_2	Respiratory hospital admissions
	PM_{10}, O_3	Restricted activity days
	$PM_{2.5}$, CO	Congestive heart failure
	Benzene, BaP, 1,3-butad., Diesel part., Cd, As, Cr, dioxins, furanes	Cancer risk (non-fatal)
	$PM_{10/2.5}$	Cerebrovascular hospital admissions, cases of chronic bronchitis, cases of chronic cough in children, cough in asthmatics, lower respiratory symptoms
	Lead, mercury	IQ loss in children
	O_3	Asthma attacks, symptom days
	Noise	Myocardial infarction, angina pectoris, hypertension, sleep disturbance

Impacts included in detailed approach (II)

Impact Category	Pollutant / Burden	Effects
Building Material	SO_2, Acid deposition	Ageing of galvanised steel, limestone, mortar, sand-stone, paint, rendering, and zinc for utilitarian buildings
	Combustion particles	Soiling of buildings
Crops	SO_2	Yield change for wheat, barley, rye, oats, potato, sugar beet
	O_3	Yield change for wheat, barley, rye, oats, potato, rice, tobacco, sunflower seed
	Acid deposition	Increased need for liming
	N, S	Fertilising effects
Amenity losses	Noise	Amenity losses due to noise exposure
Ecosystems	SO_2, NO_x, NH_3	Eutrophication, Acidification
Land use change		pdf

Impact Pathway Approach

Pollutant/Noise Emission

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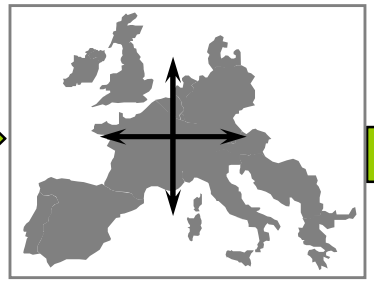

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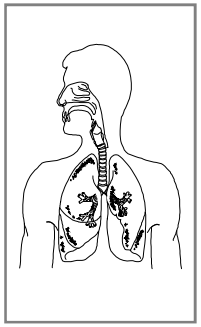


Monetary Valuation

Calculation is made twice: with and without project!

Assessment of Environmental Impacts

Assessment of impacts is based on the (measured) preferences of the affected well-informed population

This implies:

Available information should be explained before measuring preferences

Benefit transfer of unit values e.g. with income adjustments

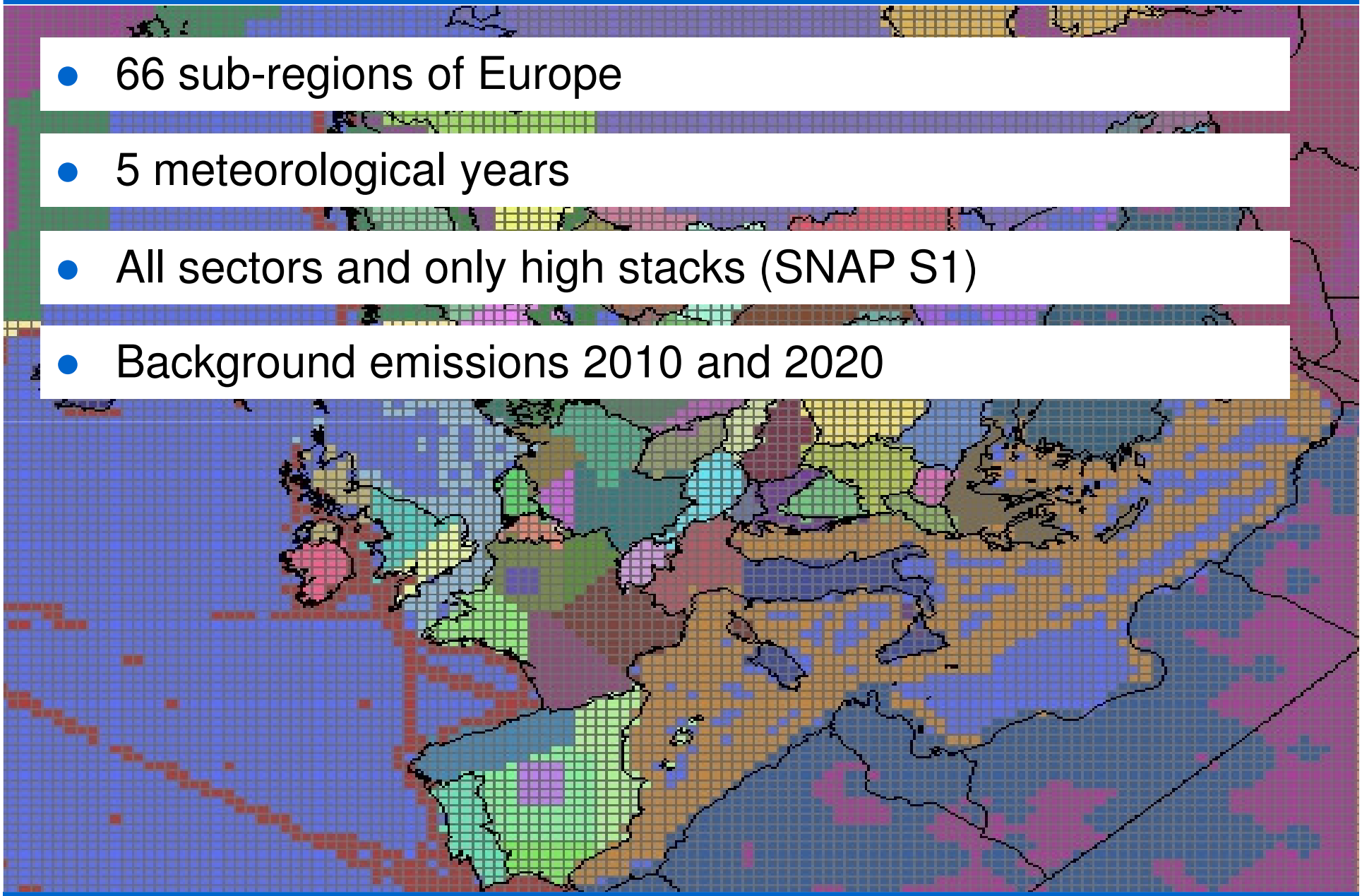
Increase of monetary values with time: income elasticity of 0.7-1.0

The EcoSenseWeb model

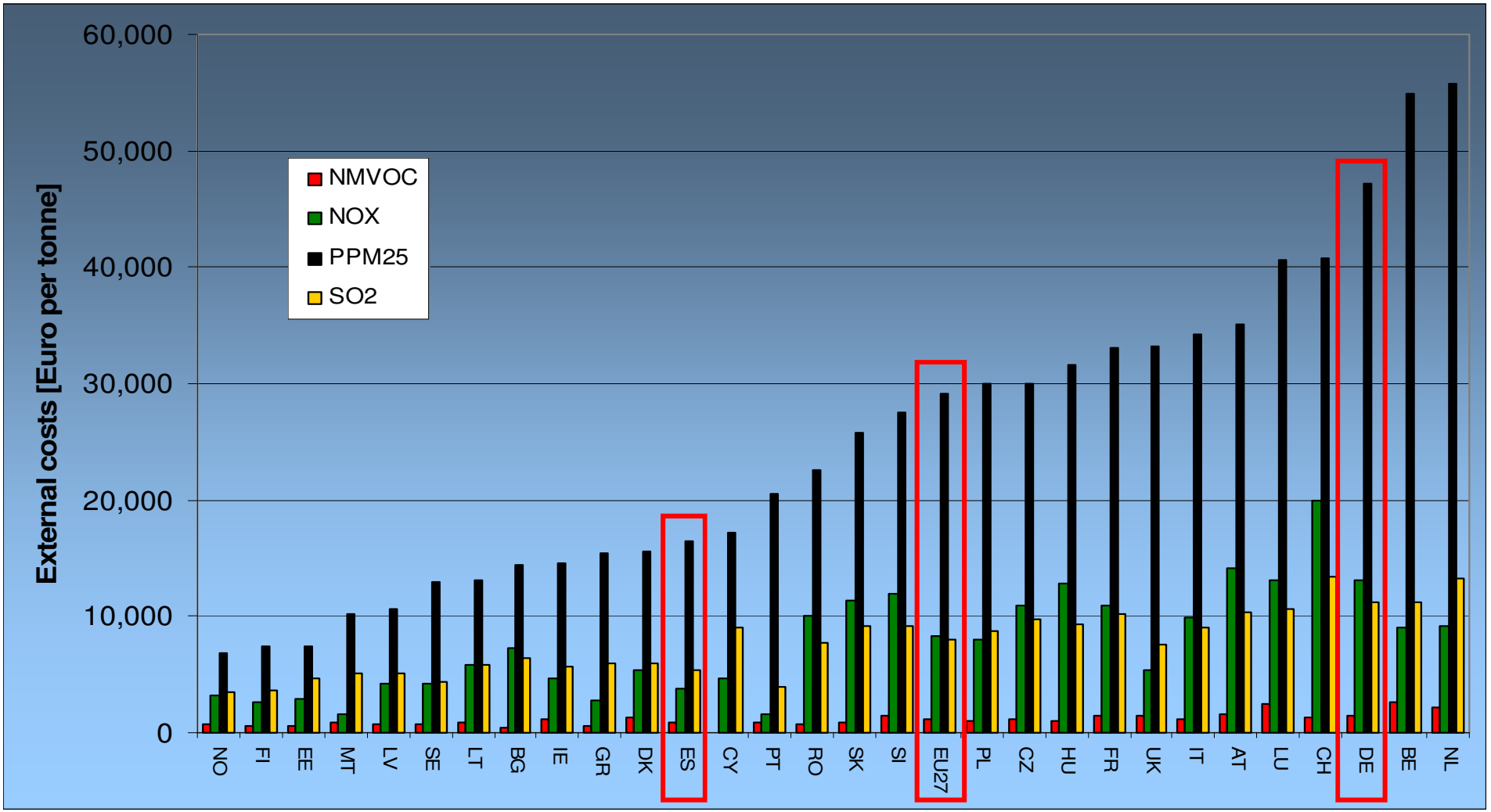
EcoSenseWeb

- Integrated computer system developed within the ExternE project series with latest updates in the EU-project NEEDS
- Estimation of average monetary damage factors per country for all pollutants in order to:
  i. allow for the estimation of „external costs per kg (or per kWh)“ on a country-specific level, including LCA data
  ii. overcome the problem of no availability of site-specific input data
  iii. to avoid costly sophisticated dispersion model runs
- http://ecosenseweb.ier.uni-stuttgart.de

- 66 sub-regions of Europe
- 5 meteorological years
- All sectors and only high stacks (SNAP S1)
- Background emissions 2010 and 2020



Resulting monetary factors (Euro per tonne) for 2010



Which effects are not included?

- Effects on employment → labour market
- Depletion of non-renewable resources (e.g. oil, gas, silicon, copper, etc.) → market for resources
- Research and development → sunk costs

- Assessment of risk aversion (so-called Damocles risks, i.e. low probability, high damage risk) → no agreed method available
- Risk of terrorism or proliferation → no information publicly available
- Visual intrusion or annoyance → large variability, thus benefit transfer difficult
- Precautionary principle to include potentially hazardous substances → lack of information.

An indicator for human health impacts

- Human health impacts are expressed in disability adjusted life years (DALY):

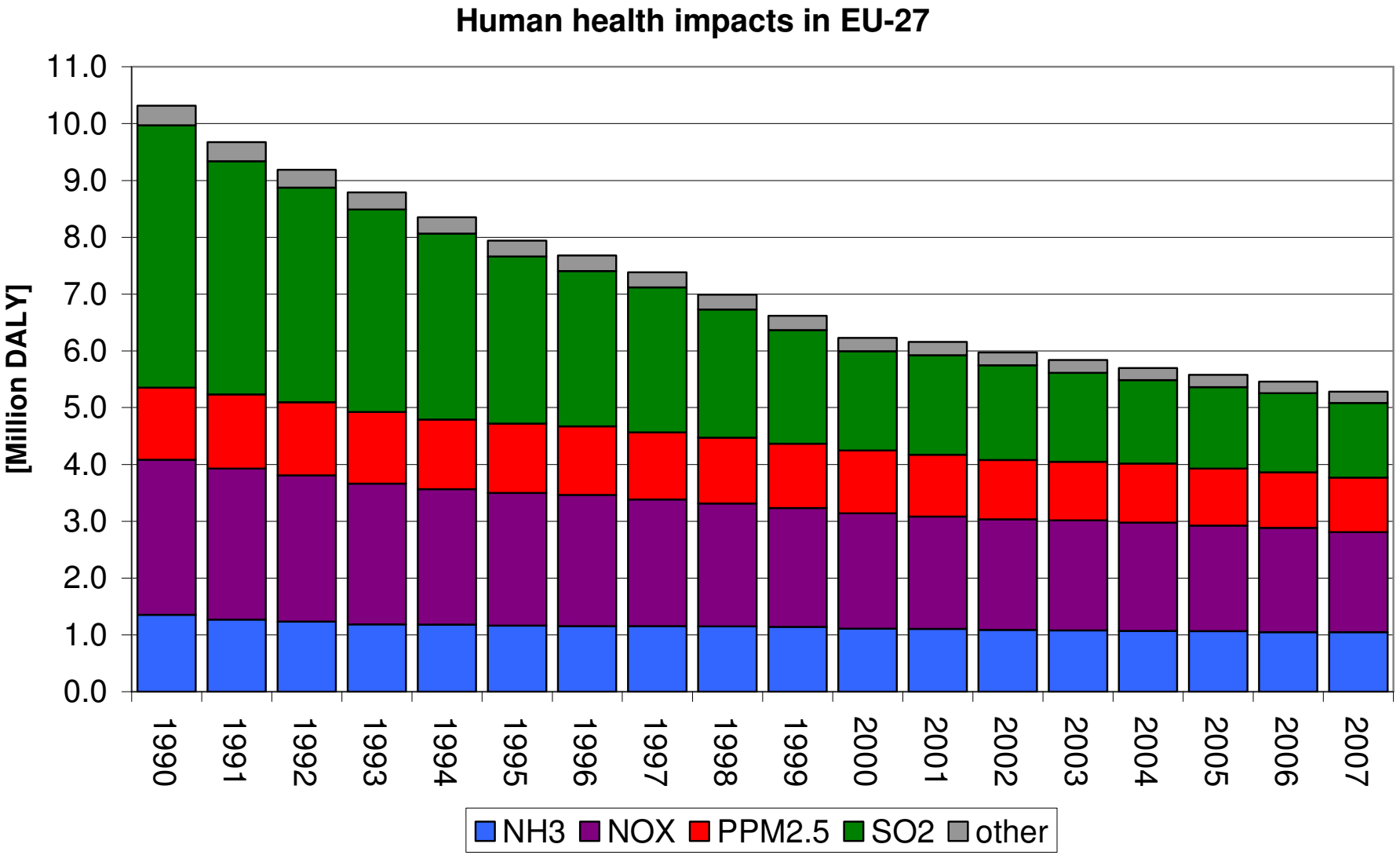
  DALY = years of life lost (YOLL) + years lived with disability (YLD)

  → epidemiological studies

- Country-specific damage factors [DALY/kg] were derived in NEEDS

- Application of emission data from EEA (1990-2007) shows decrease in human health impacts

Decreasing impacts to human health (1990-2007)



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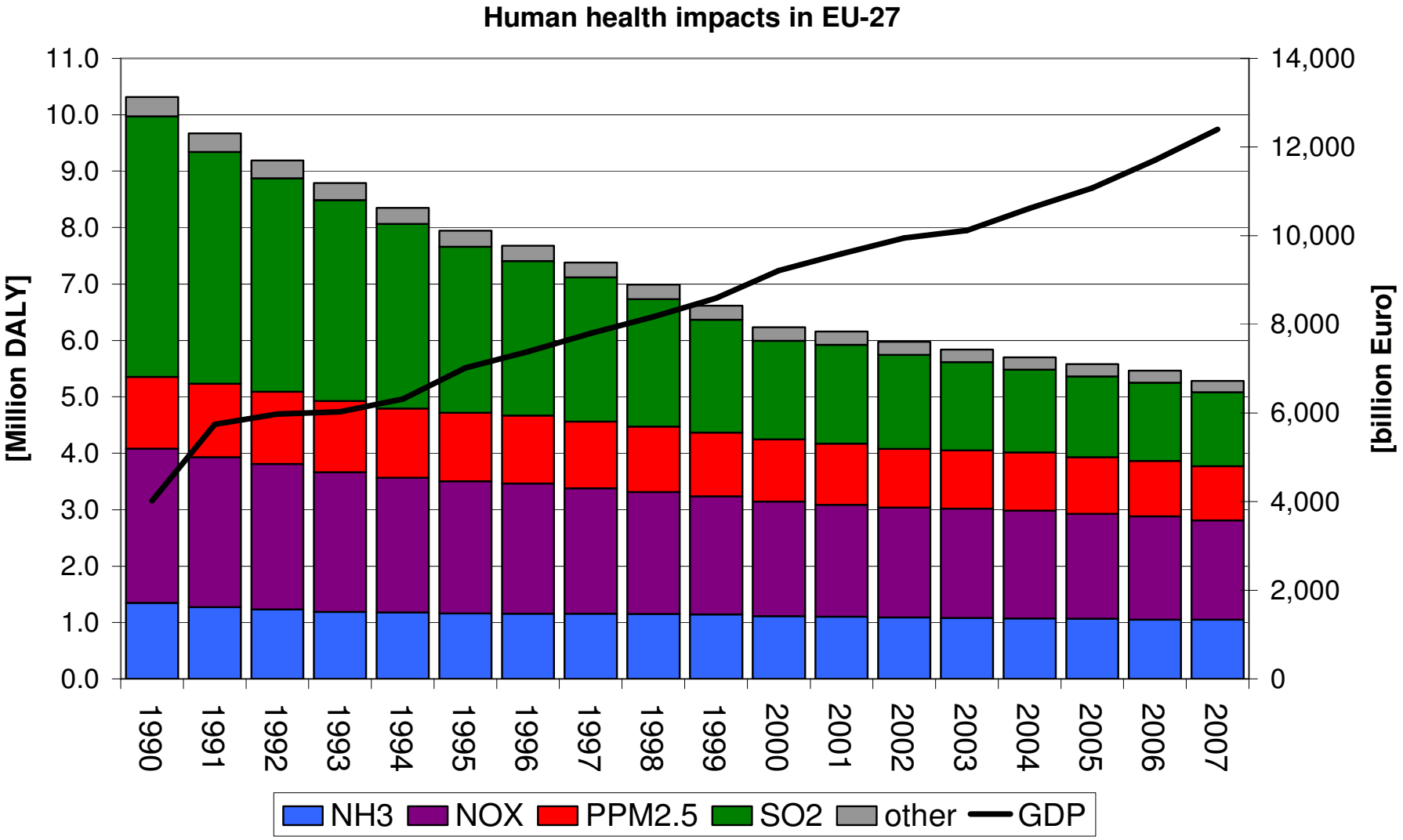

Biodiversity Indicator

- loss of biodiversity due to deposition of air pollutants (NH_3, SO_x and NO_x), originally based on methodology of Koellner (2001) and Eco-Indicator99

PDF	$= 1 - S_{use}/S_{reference}$
S_{use}	= number of target plant species present in an occupied or converted land use type
$S_{reference}$	= average species number in the reference area type

- Use of restoration costs for restoring damaged habitats to more valuable habitats applying different German studies (e.g. Bosch & Partner)

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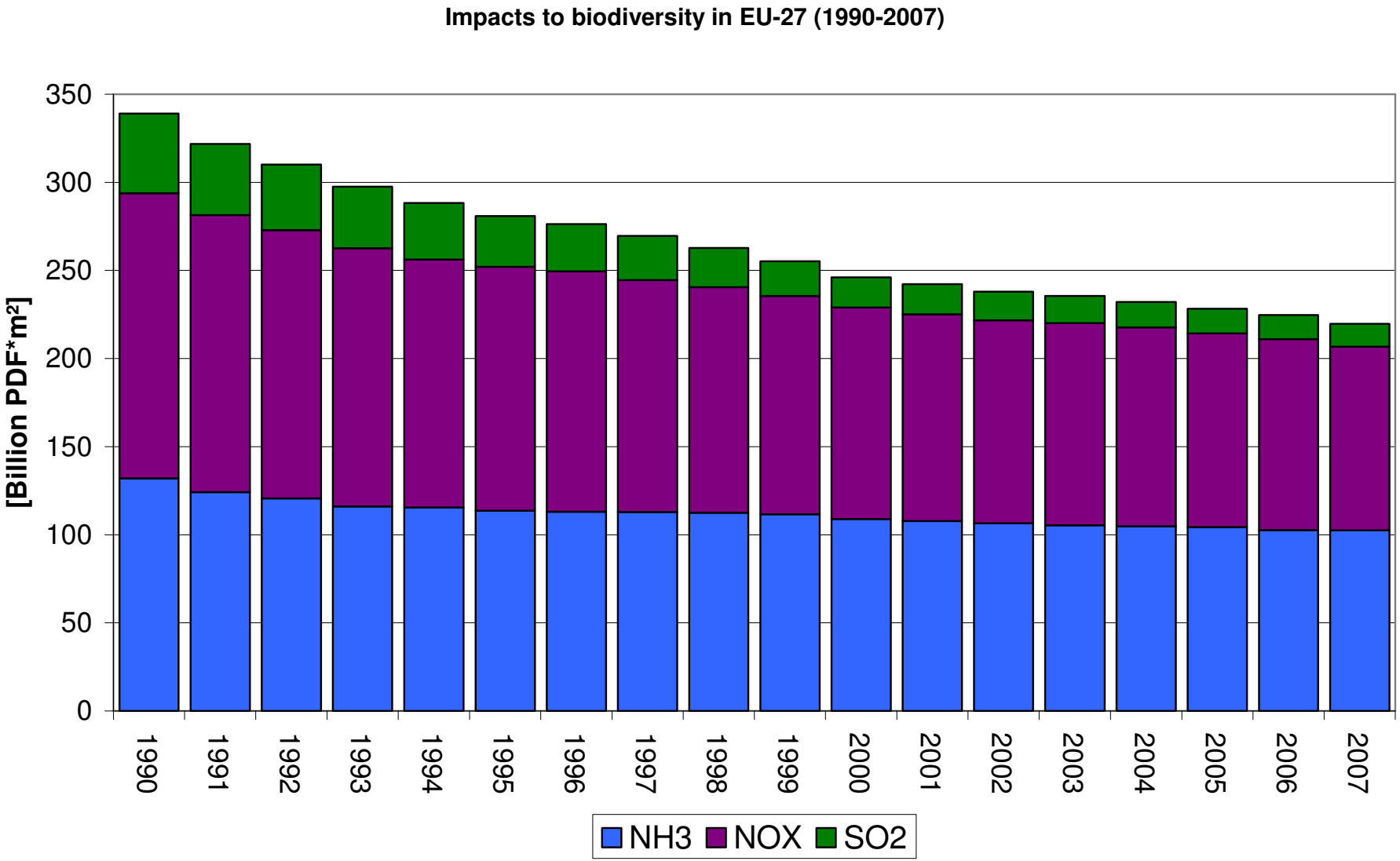

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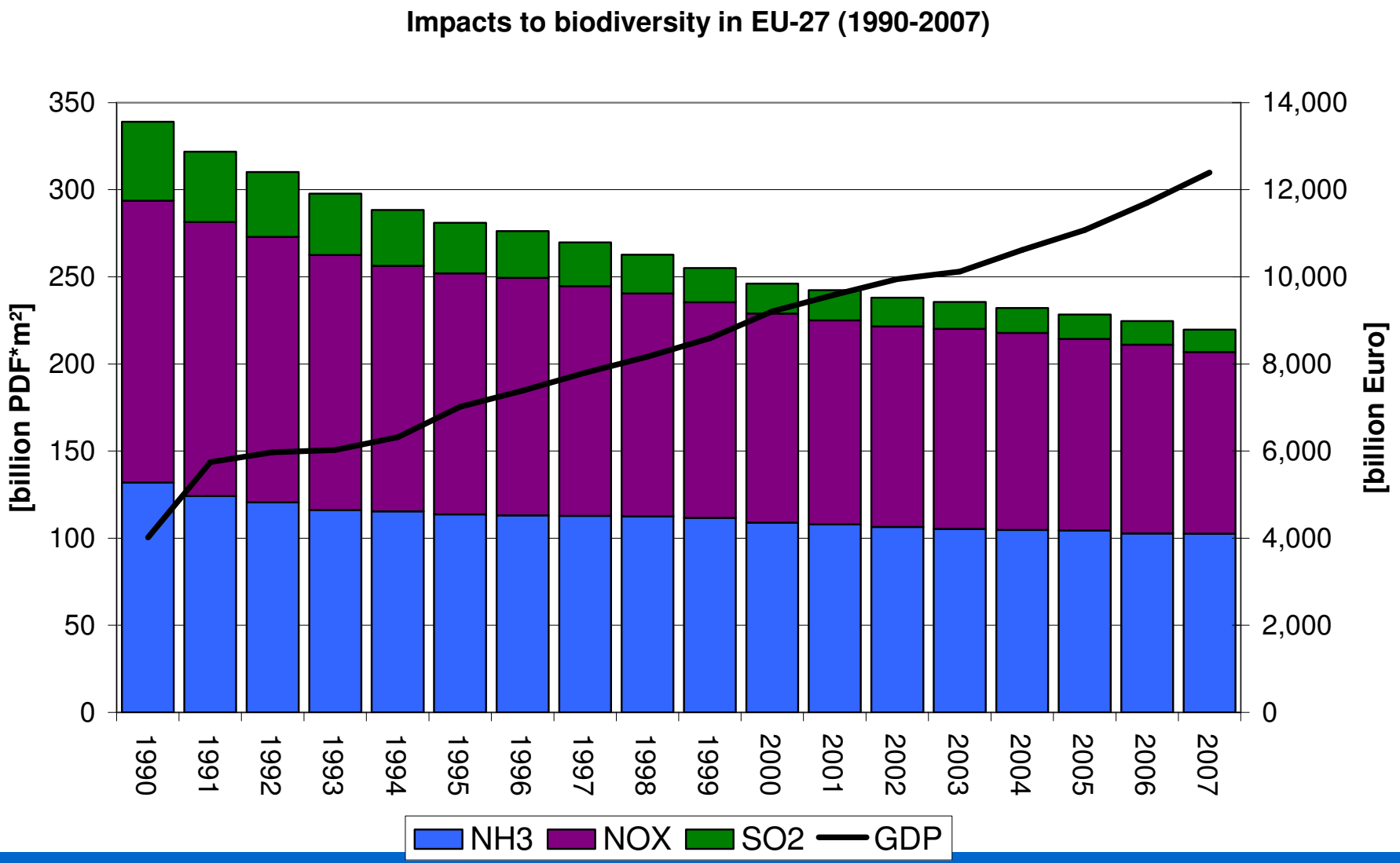

Summary and outlook

- Integrated impact assessment required to analyse the performance of technologies and policy measures
- Bottom-up analysis requires the impact pathway approach
- EcoSenseWeb as a tool for estimating health and ecosystem impacts
- Performance of DALY and PDF indicators based on EEA emission data shows decrease in impacts

Thank you very much for your attention!