ReCiPe overview

product ecology consultants

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Partners of ReCiPe project

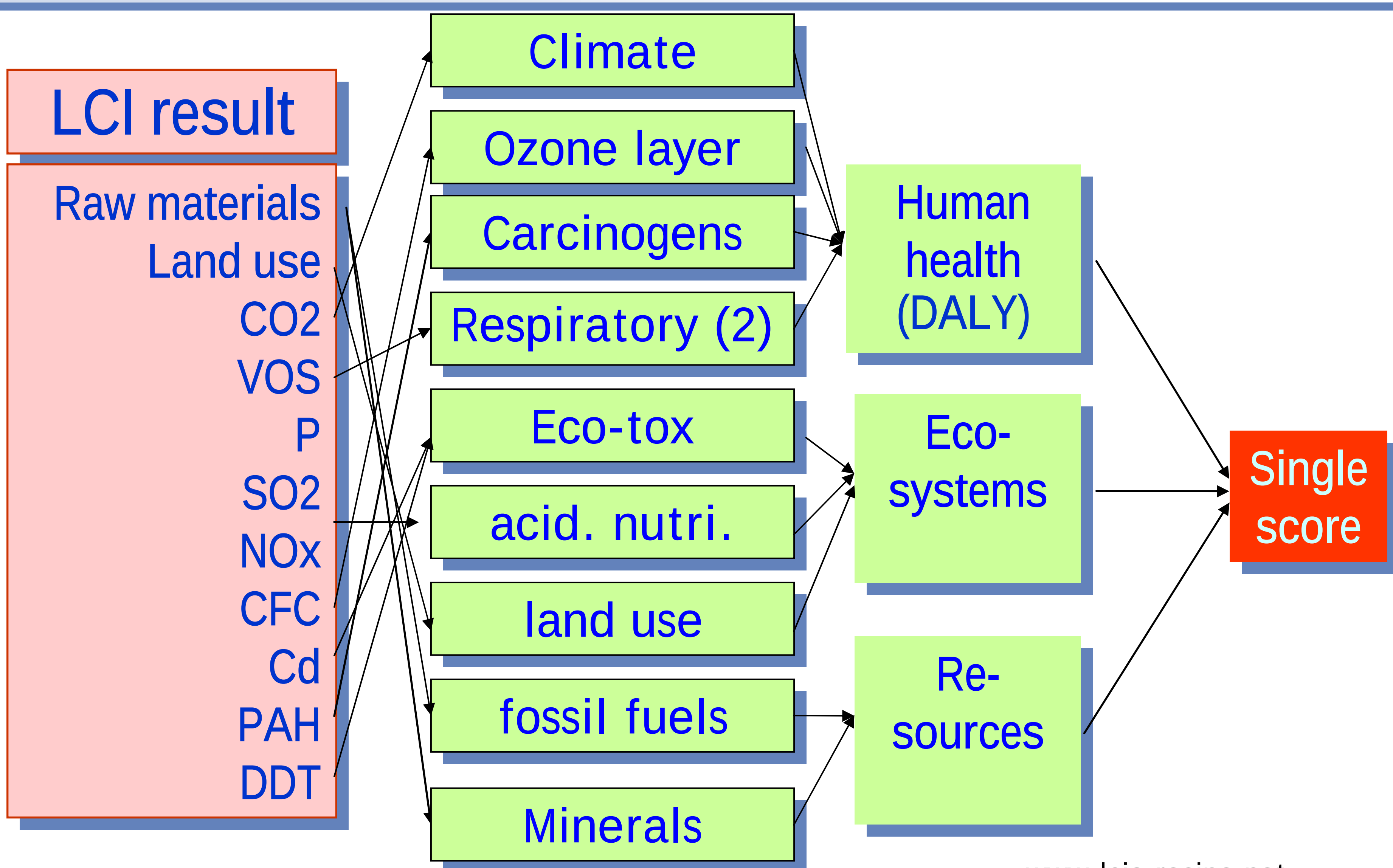
- RIVM
  - modelling expertise in many types of environmental impacts
  - Jaap Struis
- CML
  - developer of midpoint-oriented method in Handbook on LCA
  - Reinout Heijungs
- PRé
  - developer of endpoint-oriented Eco-indicator 99
  - Mark Goedkoop; An de Schryver
- RUN
  - Radboud University Nijmegen
  - Mark Huibrechts, Rosalie van Zelm

research for man and environment

product ecology consultants

Radboud University Nijmegen

Eco-indicator 99 endpoint method



www.lcia-recipe.net

Key features/weaknesses

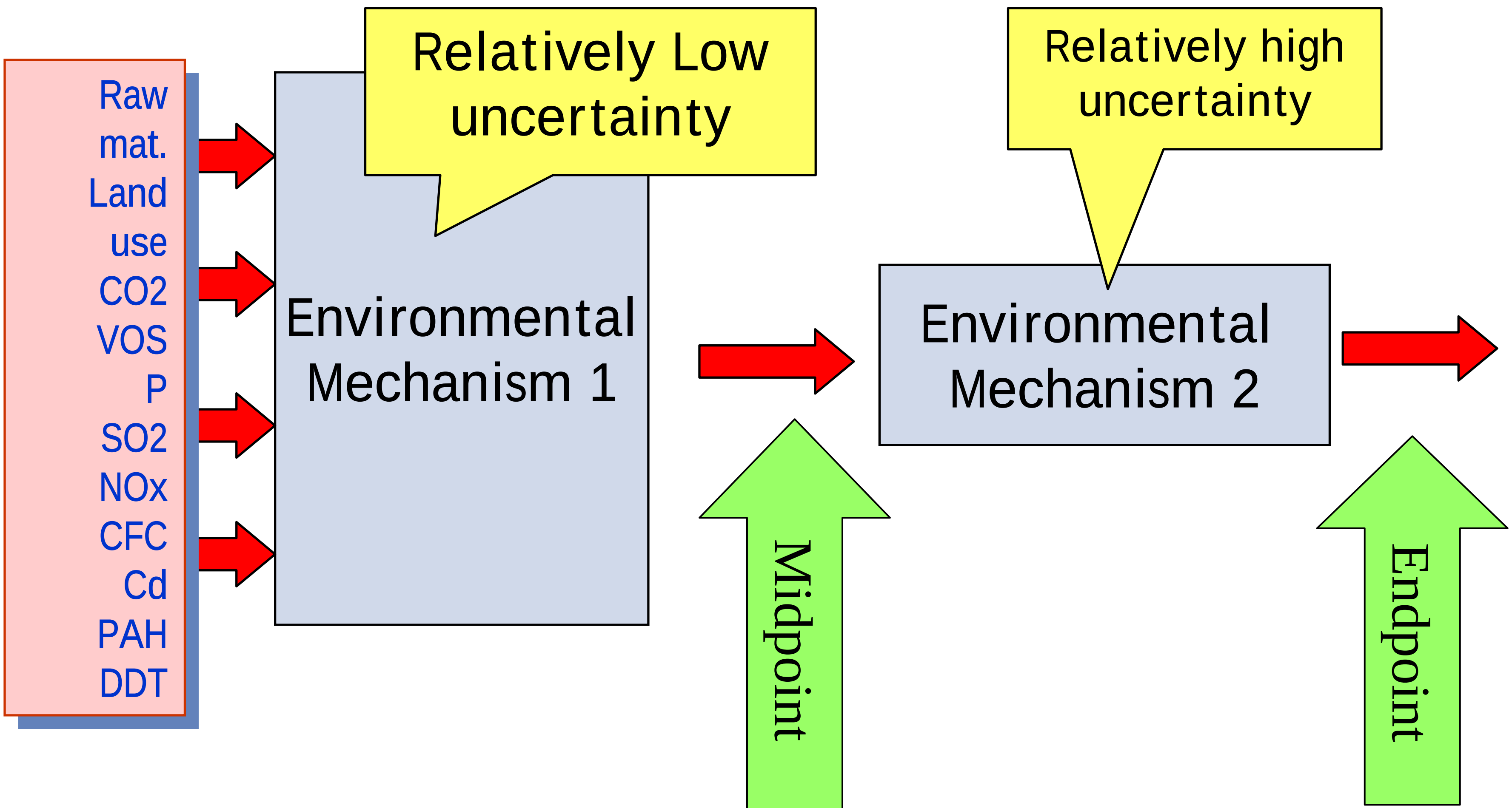
- Key features
  - Focus on simplifying the weighting problem
    - Just three endpoints
    - Endpoints are relatively easy to interpret
    - Default weighting sets
  - Management of subjective choices through cultural perspectives
- Key weaknesses:
  - High uncertainties in endpoint models
  - Missing links: impacts in water bodies, climate impact on ecosystem, etc.
  - Limited range of toxicity factors
  - About 10 years old

Your assessment….

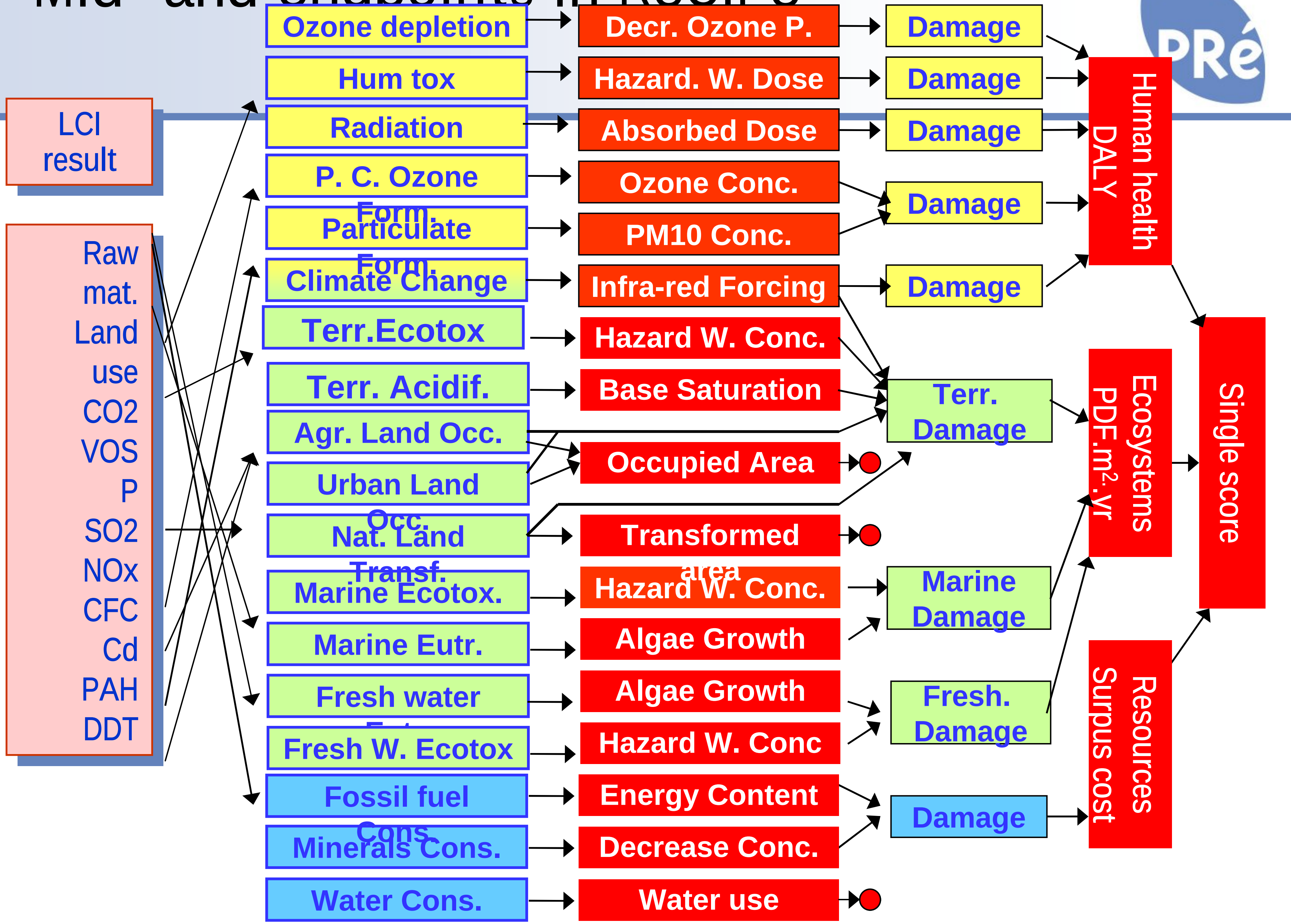
Emerging consensus

LCI result

- Midpoint taken at first point where impacts are unified



Mid- and endpoints in ReCiPe

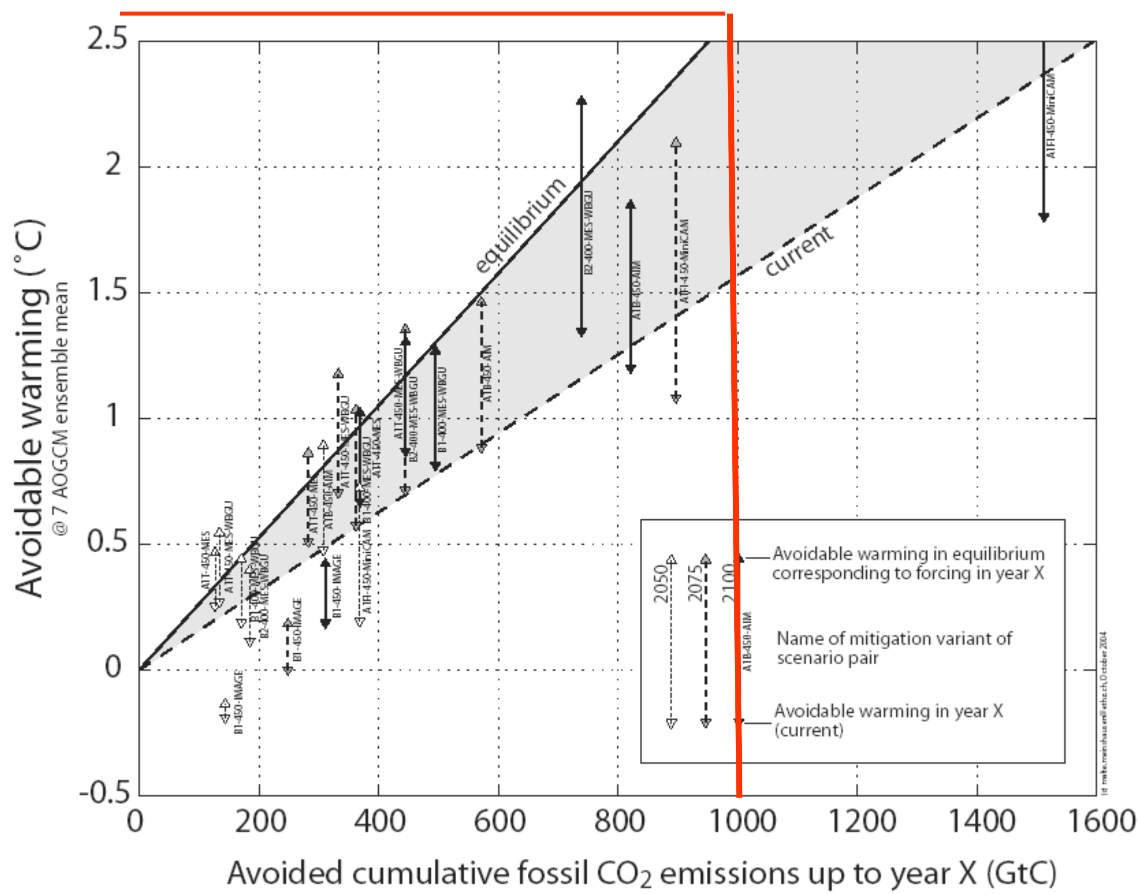


(New) endpoint indicators

- Human health: DALY [yr]
- Ecosystems. Species.year [yr]
  - PDF.m^2.yr and PDF.m^3.yr are harmonised on the basis of species density
  - Only known species
  - Only habitable terrestrial area, only top 200 meters of marine water bodies
- Resources: Increased costs [$]
  - Characterisation model calculates surplus cost per ton
  - In theory damage is indefinite…..
  - Discount rate of 3% is used to calculate fixed amount
  - Other rates can be choosen

Example: endpoint climate change
Step 1: temperature increase

- Meinshausen analysed many climate models and investigated effect of CO2 mitigation on temperature
- If 10 Giga ton carbon emission per year is avoided during 100 year, the temperature will be 2,6 degree lower after 100 year.



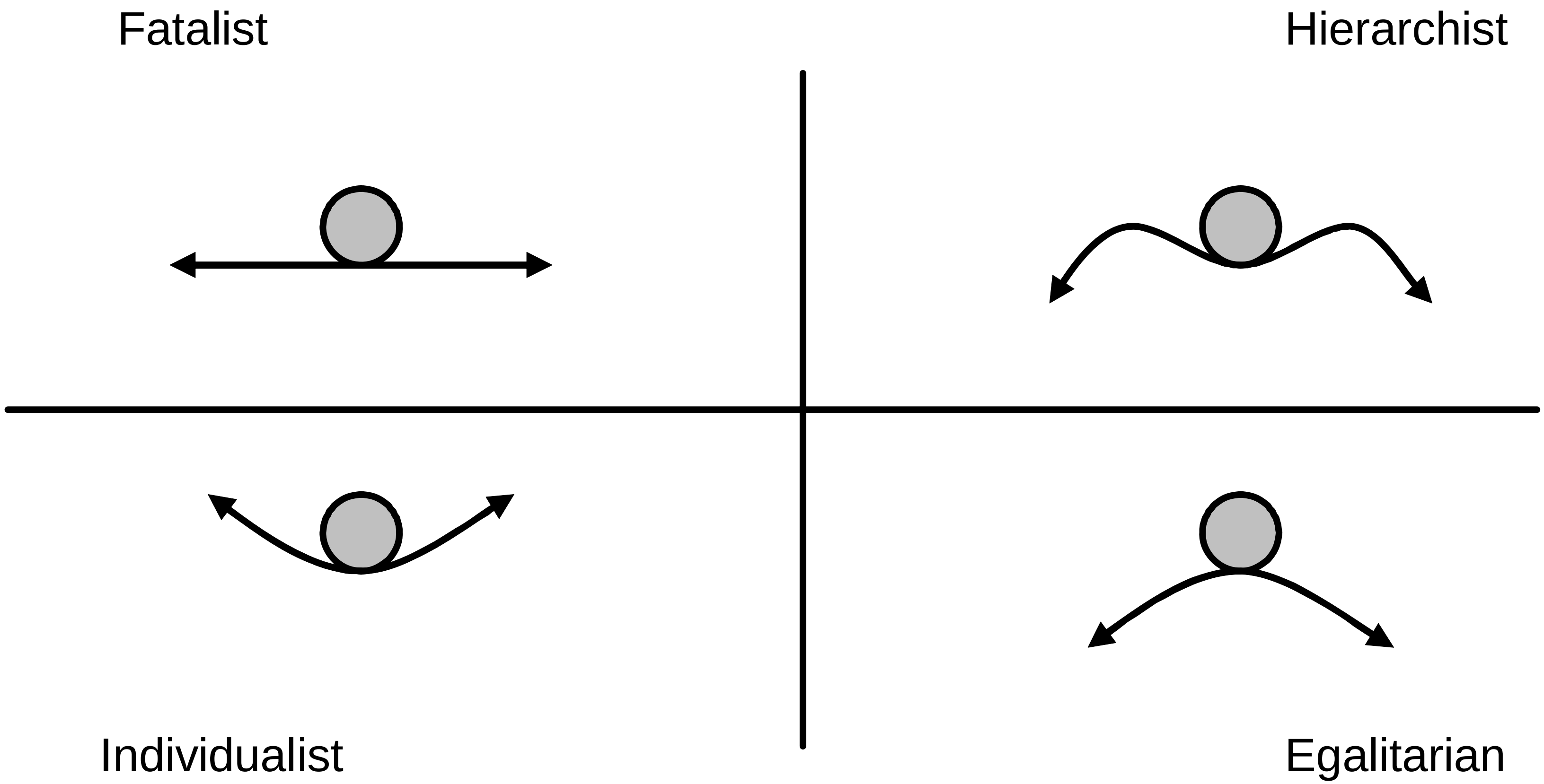
Meinshausen, M., 2005, Emission & Concentration Implications of long-term Climate Targets, Dissertation 15946 for the Swiss federal Institute of Technology, Zurich.

Example: endpoint climate change
Endpoint: Human health damage

- Basis: WHO study
  - McMichael, A.J., Campbell-Lendrum, D.H., Corvalan, C.F., Ebi, K.L., Githeko, A., Scheraga, J.D., Woodward, A., 2003. Climate change and human health. Risk and responses. Word Health Organization, Geneva. 322p.
- Problem: Many assumptions have to be made regarding:
  - Adaptation; will people adjust to different climate?
  - Role of economy: Malnutrition can be avoided if economy is healthy
  - Manageability: will policies work?
- Three senarios (Used in all impact categories)

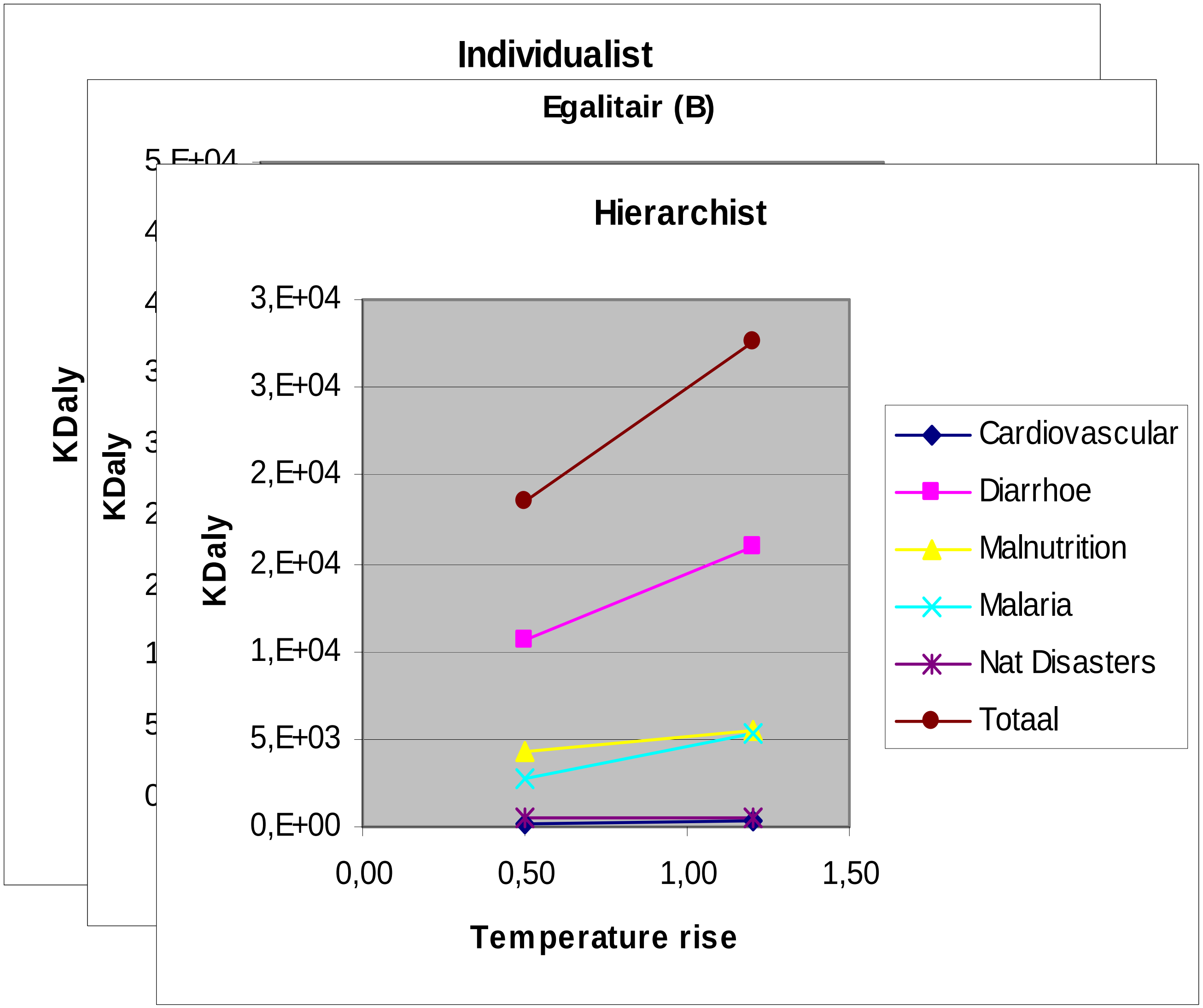
	Time perspective	Manageability	Required level of evidence
H (Hierarchist):	Balance between short and long term	Proper policy can avoid many problems	Inclusion based on consensus
I (Individualist):	Short time	Technology can avoid many problems	Only proven effects
E (Egalitarian):	Very long term	Problems can lead to catastrophy	All possible effects

Cultural perspectives



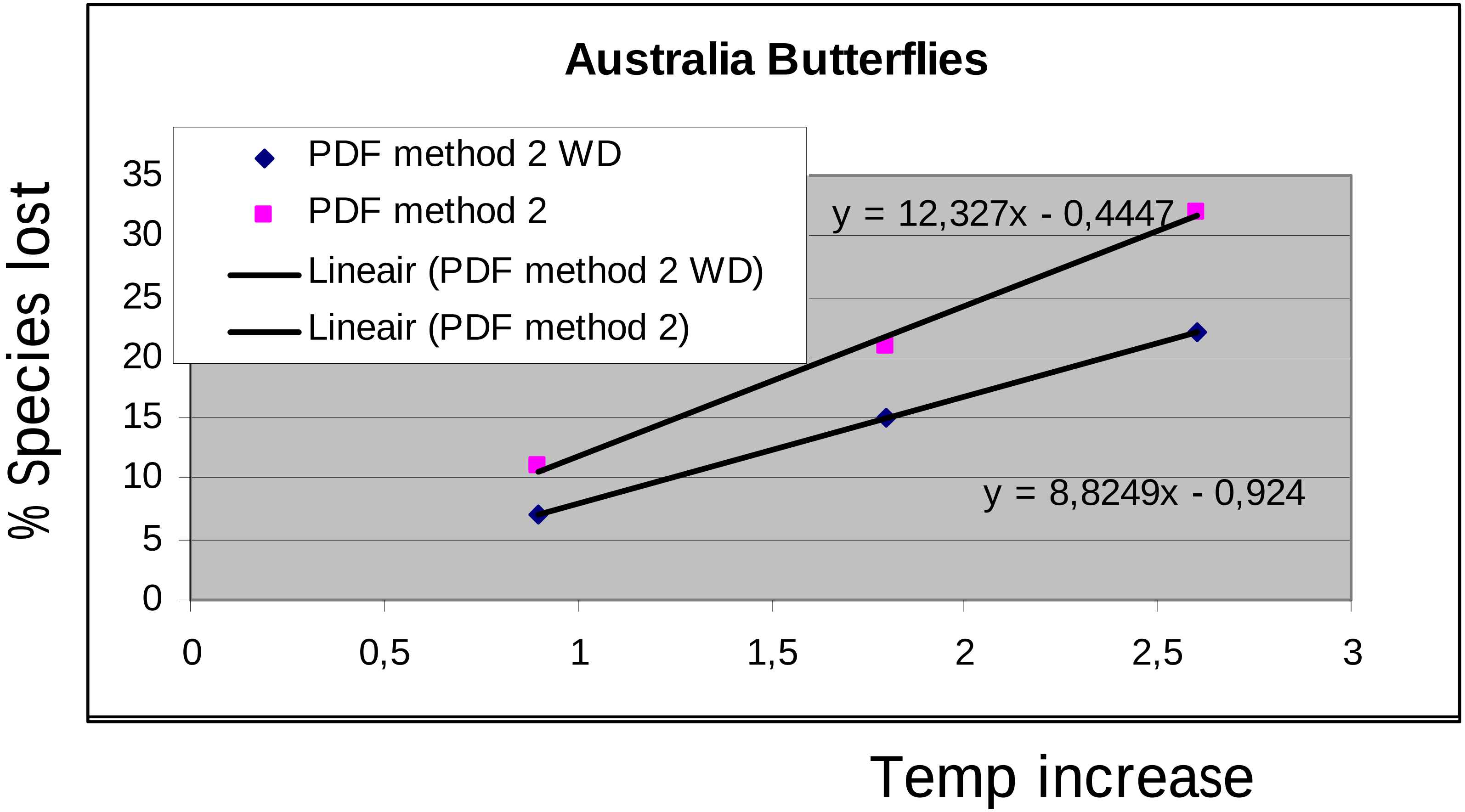
external grid

Example: endpoint climate change Relation Human Health and temperature



Example: endpoint climate change: Loss of species due to temperature increase

- Basis: Article by Thomas et. al. in Nature 2004, that summarises several regional studies, on effect of temperature on PDF



Acidification; European Forests

- PDF related to Base Cation Saturation BCS

$$BCS = \frac{BC}{CEC} = \frac{[K]+[Ca]+[Mg]+[Na]}{[H]+[K]+[Ca]+[Mg]+[Na]} \cdot 100$$

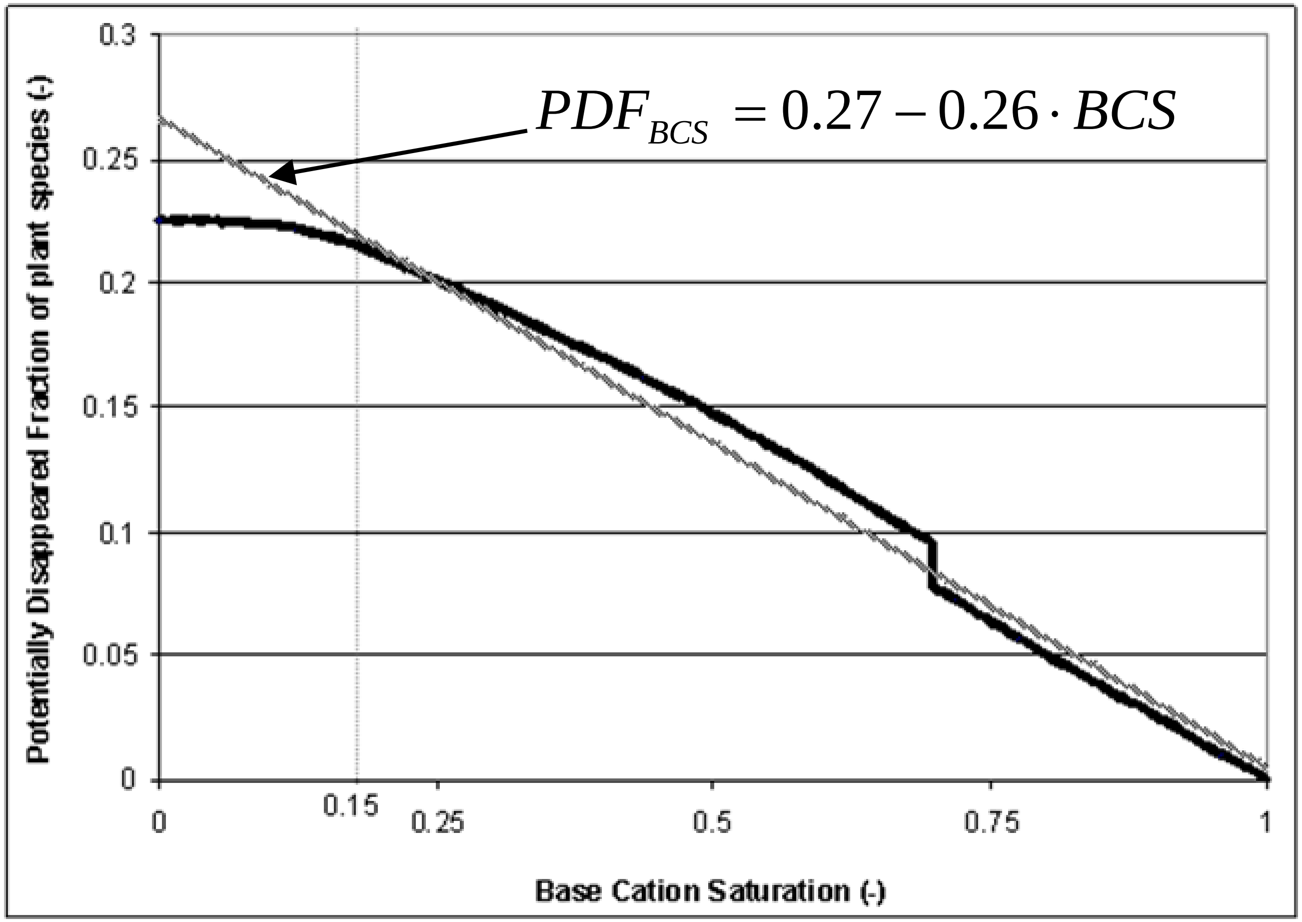
- Fate factor for European grid 50*50 km $FF_{soil,j} = \frac{dBCS_j}{dDEP_j}$

- Effect factor $EF_j = \frac{dPDF_j}{dBCS_j}$

- Regression formula combined with Monte Carlo

$$\ln\left(\frac{P_{crit,s}}{1-P_{crit,s}}\right) = a_s + b_s \cdot BCS_{crit} + c_s \cdot BCS_{crit}{}^2$$

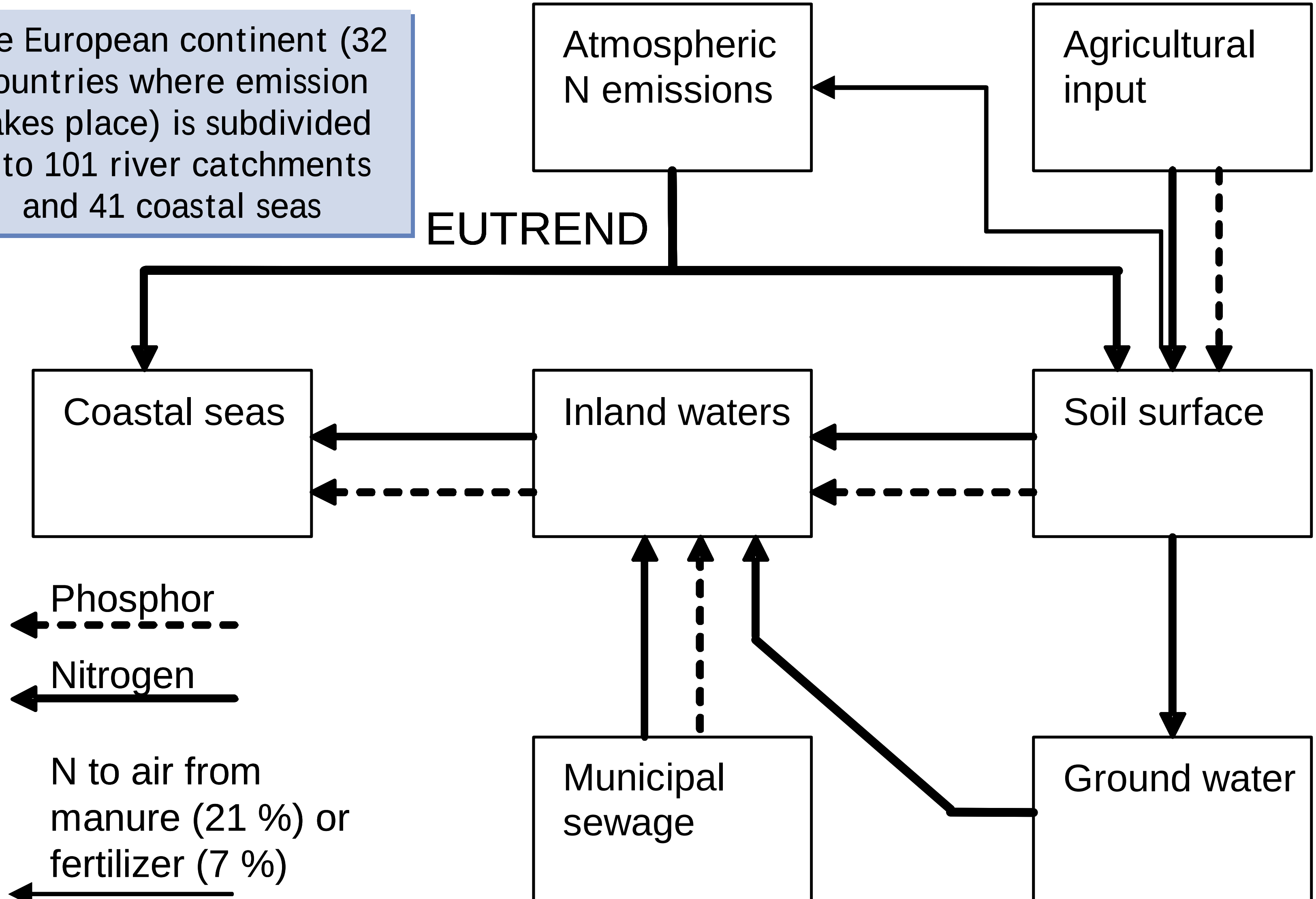
Regression result



Result: Site independent effect factor

Fate aquatic eutrophication (Carmen+EUTREND)

The European continent (32 countries where emission takes place) is subdivided into 101 river catchments and 41 coastal seas



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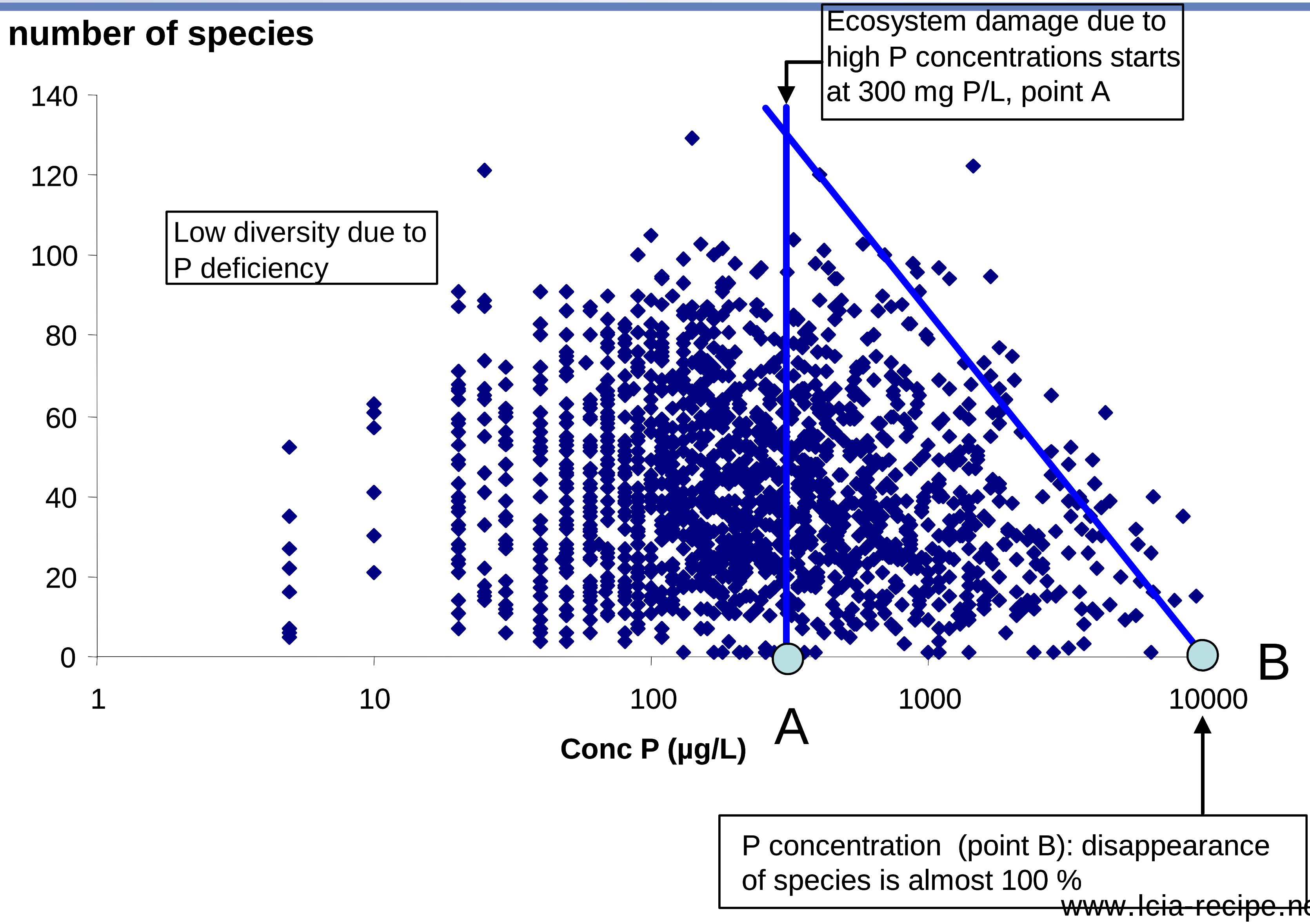
Damage from eutrophication



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Land occupation

$$ED = PDF_{reg} * A_{reg} + PDF_i * A_i + PDF_{occ.} * A_{occ.}$$

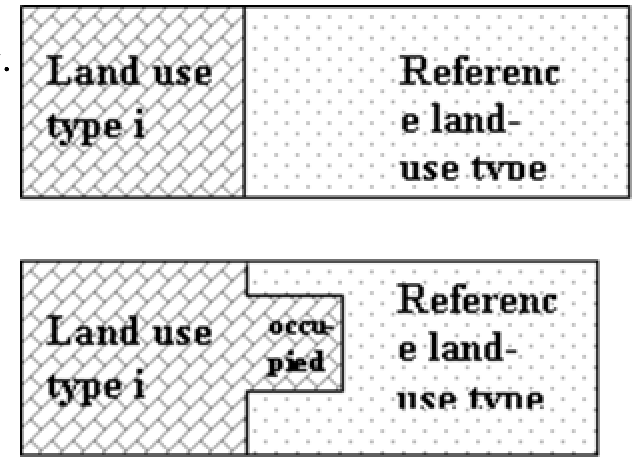
$$PDF_{reg} * A_{reg} = A_{reg.} \frac{\Delta S_{reg}}{S_{reg}}$$

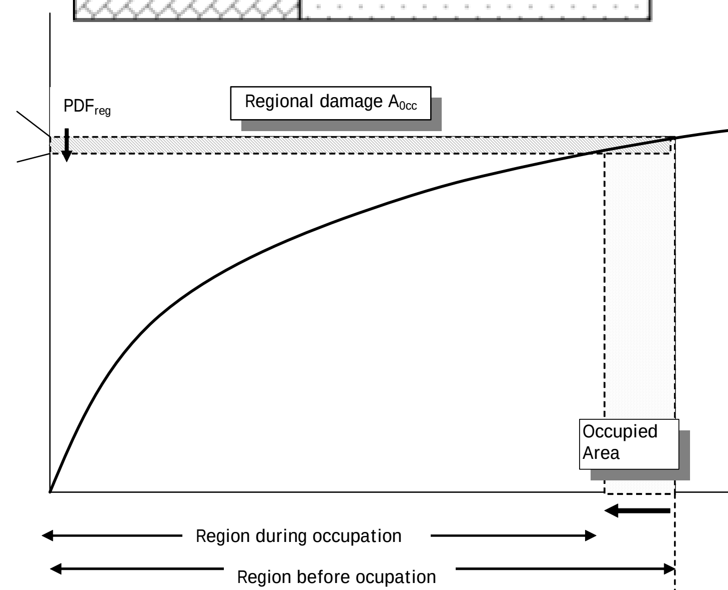
$$S = cA^z$$

$$\Delta S = A_0 cqA^{z-1}$$

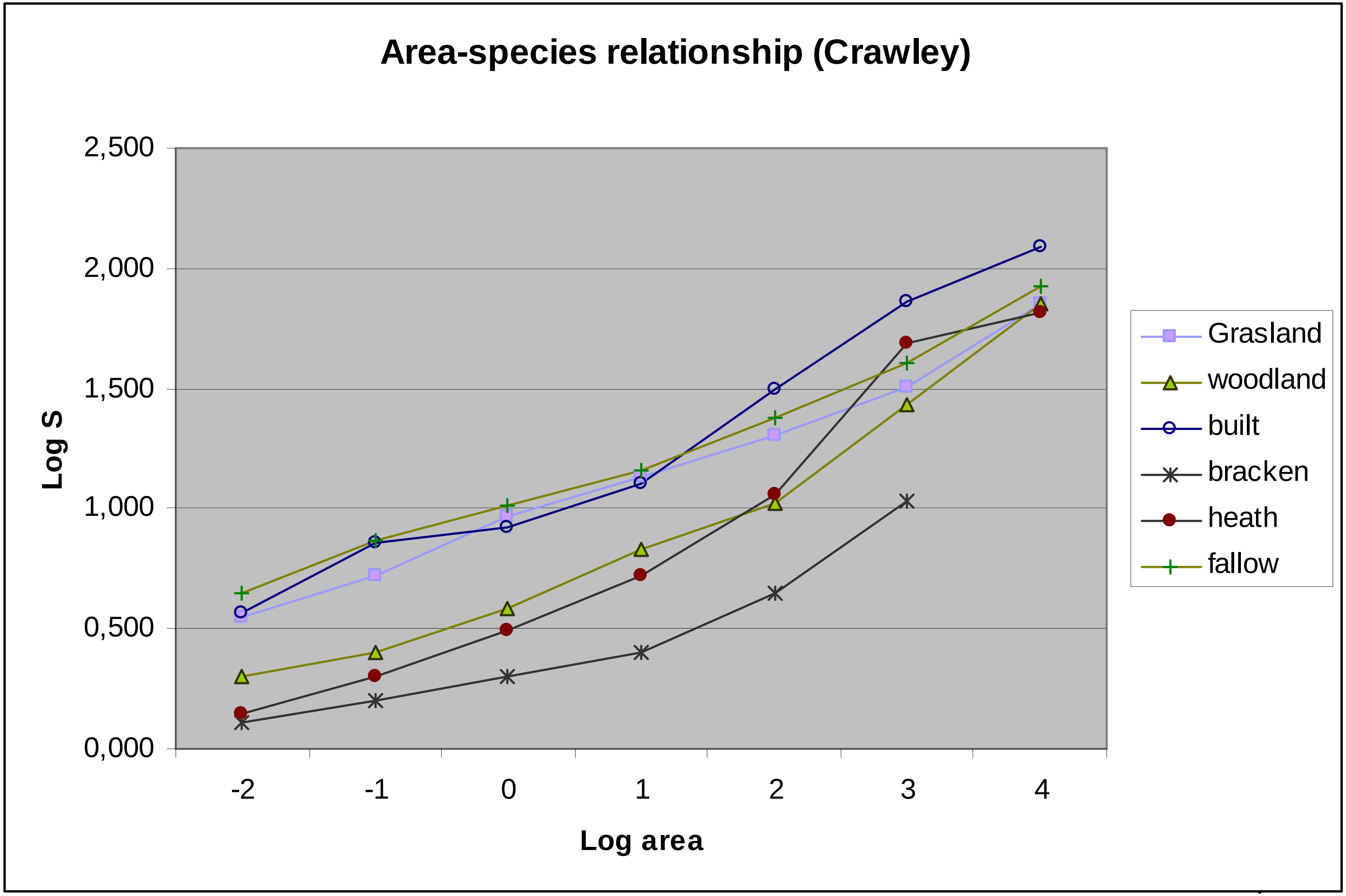
$$PDF_{reg} * A_{reg} = A_R A_0 \frac{c_R q_R A_R^{z_R - 1}}{c_R A_R^z} = A_{occ} * z_{reg}$$

$$PDF_{Occ} = \frac{S_R - S_{Occ}}{S_R} = \frac{c_R A_{Occ}^{z_R} - c_i A_{Occ}^{z_i}}{c_R A_{Occ}^{z_R}} = \frac{c_R - c_i A_{Occ}^{z_R - z_1}}{c_R}$$

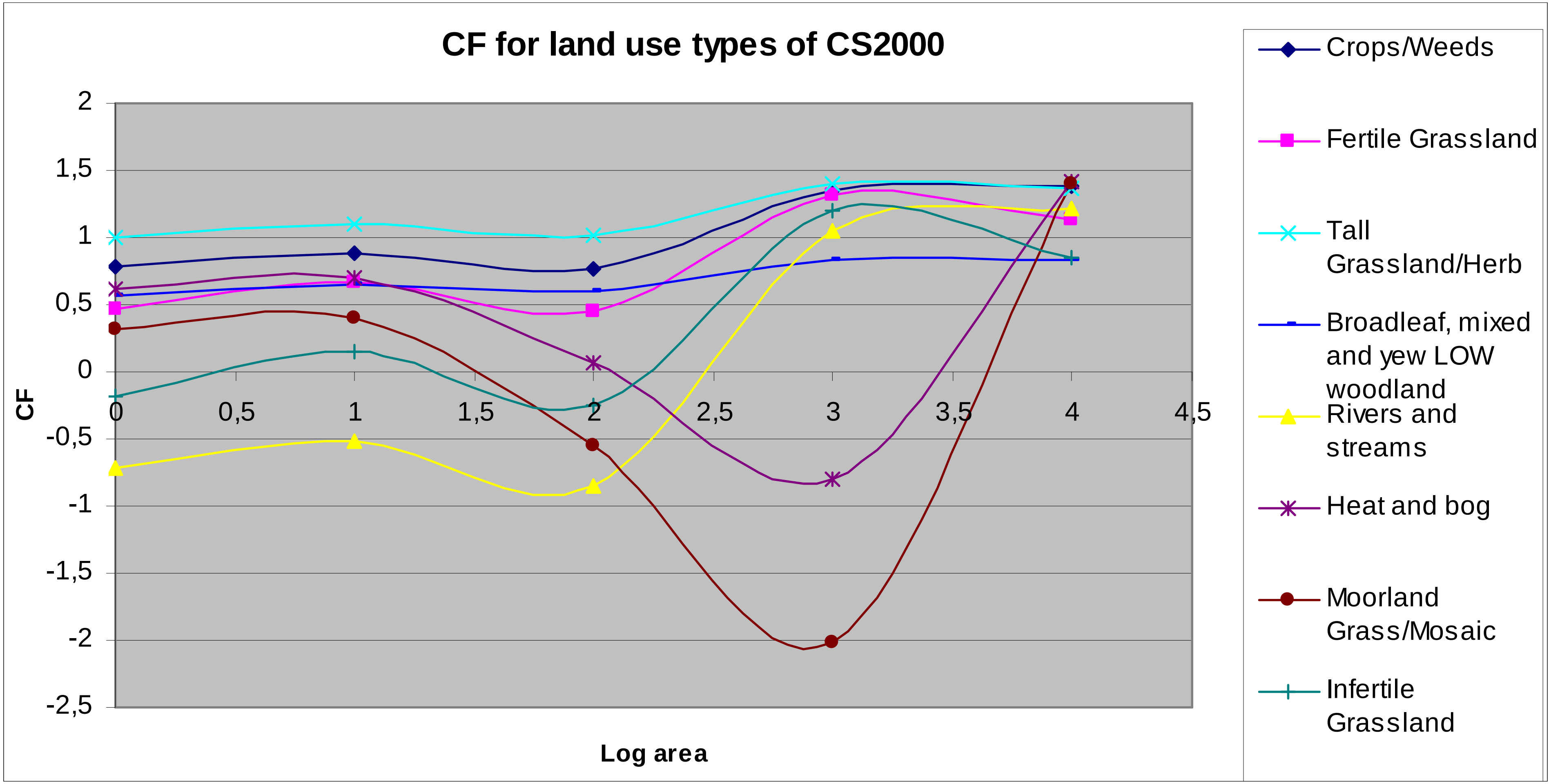




Z is not constant



Which has strange consequences

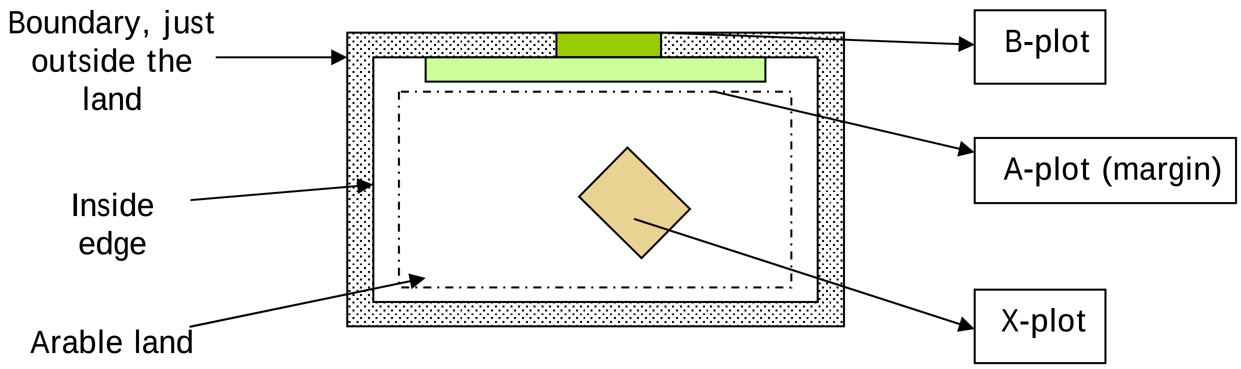


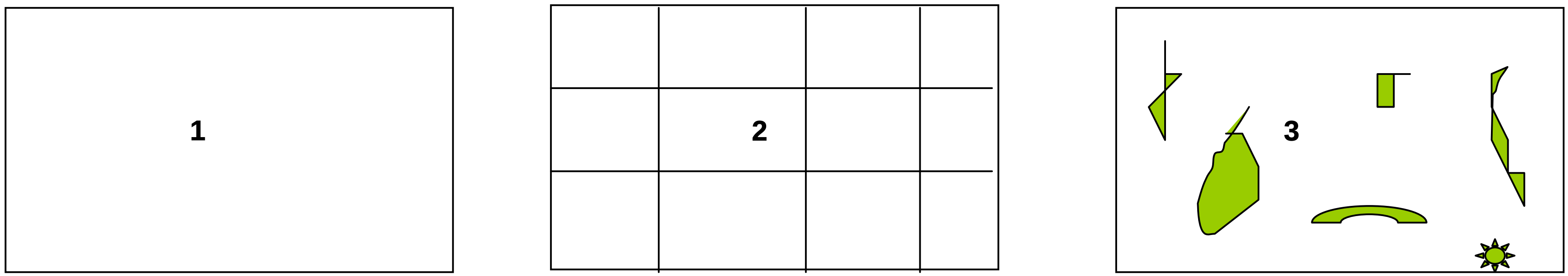
Conversion

Ecosystem	Restoration time (year)
Vegetation of arable land, pioneer vegetation	< 5
Species poor meadows and tall-herb communities, mature pioneer vegetation	5 - 25
Species poor immature hedgerows and shrubs, oligotroph vegetation of areas silting up, relatively species rich marshland with edges, meadows, dry meadows and heath land.	25 - 50
Forests quite rich in species, shrubs and hedgerows	50 - 200
Low and medium (immature) peatbogs, old dry meadows and heathland	200 - 1000
High (mature) peatbogs, old grow forests	1000 - 10000

Data for Land-use

- Data found for Swiss lowlands and UK

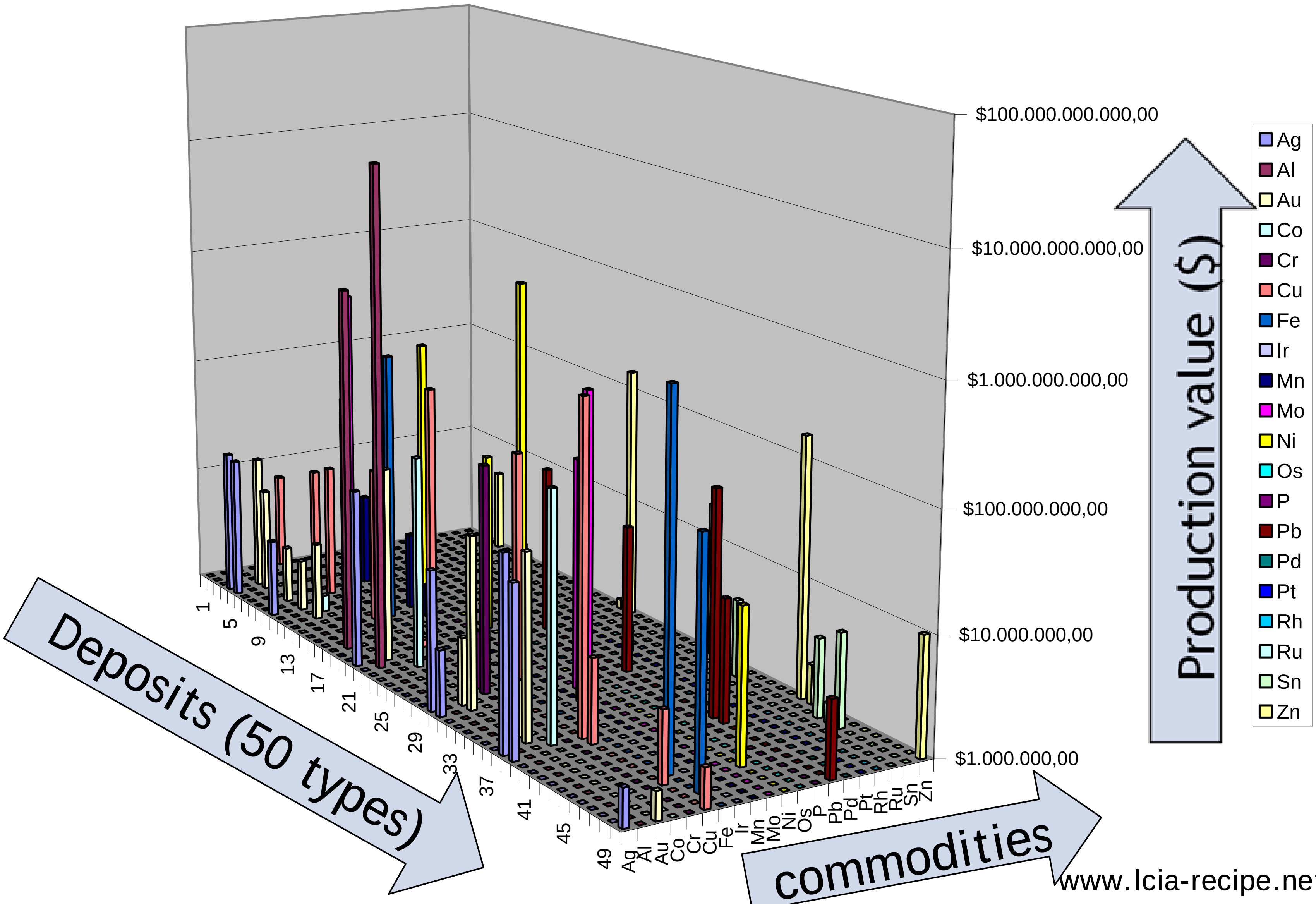




Mineral resource depletion

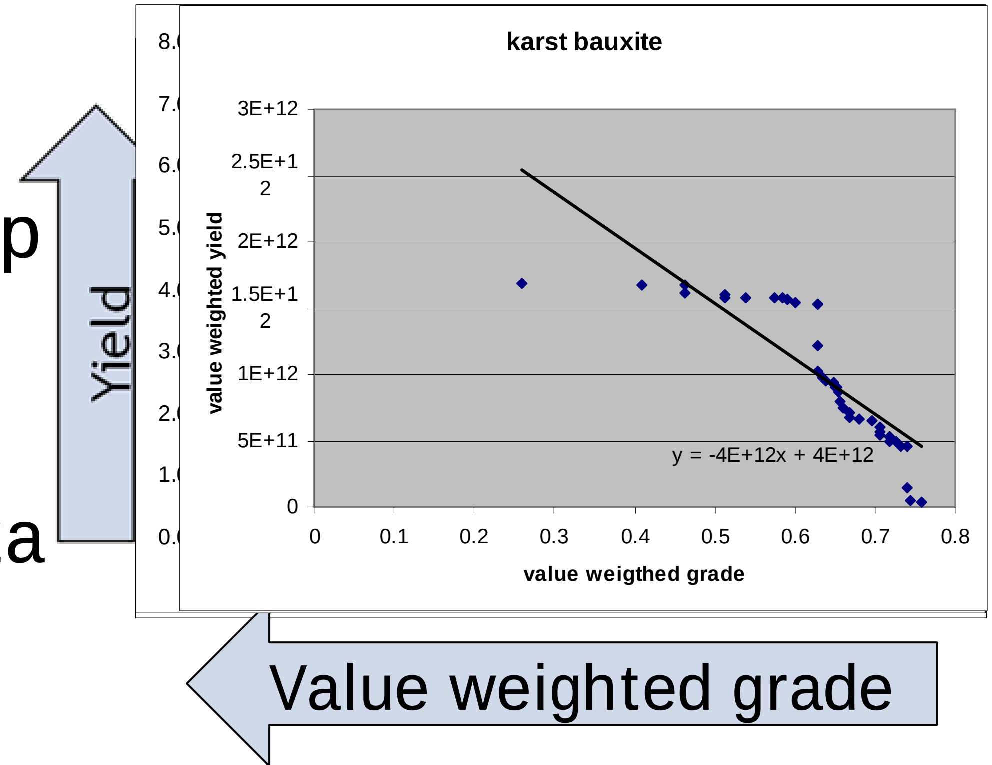
- There is no such thing as copper ore, so you cannot deplete it:
  - Copper is produced from several minerals, and minerals are found in deposit
  - Deposits usually contain multiple commodities like copper, silver, Manganese and Gold etc.
  - Some metals are always small co-products

How commodities and Deposits interrelate

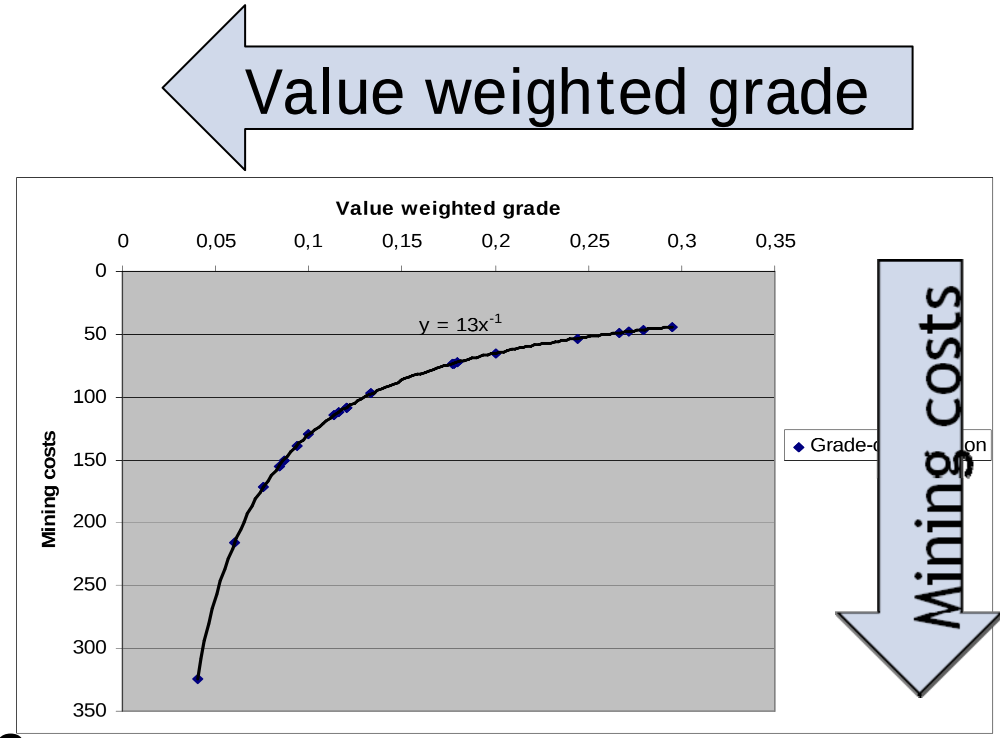


More resources at lower grades

- Actual mining data used to yield/grade relationship per deposit:
  - Grade in $/kg
  - Yield in $
- We expected log, but found linear relationship
- Relationships for all 50 deposits
- In EI99 we had such data per commodity….(?)



- Lower grades means higher efforts:
  - In EI99 expressed as surplus energy
  - In ReCiPe expressed as costs
- Rough estimate:
  - 13 $ per ton processed deposit
  - Grade determines how much must be processed, and thus what the cost are
- Left out in midpoints…

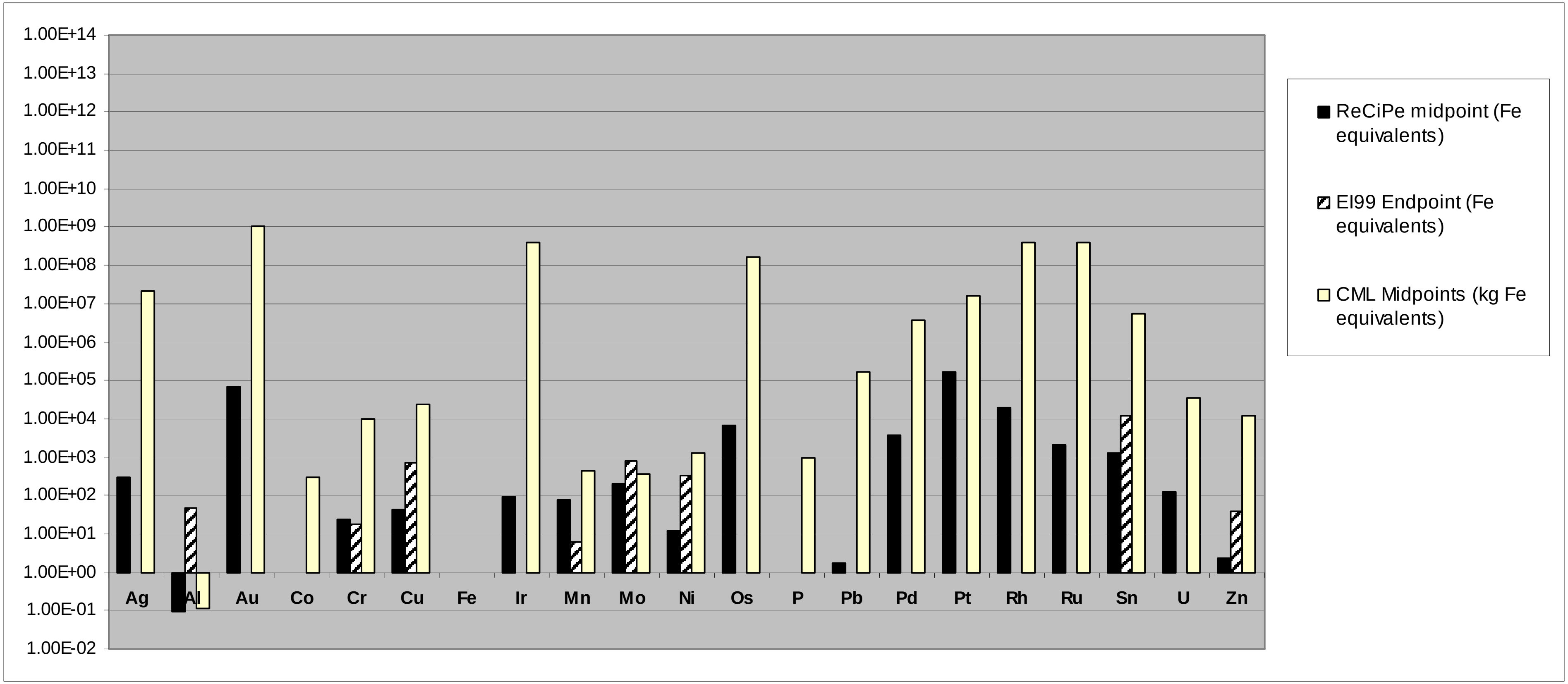


From cost increase per deposit to commodity

- Market value allocation:
  - Cost increase per extracted $ value
  - Cost increase per extracted mass
- Main weaknesses:
  - Grade yield data in mining, not representative for geological reality?
  - Market prices have important influence, and they are not stable…..
- Improvement over EI99:
  - Real data used, and not just expert judgements
  - Co production taken into account

Is the result better?

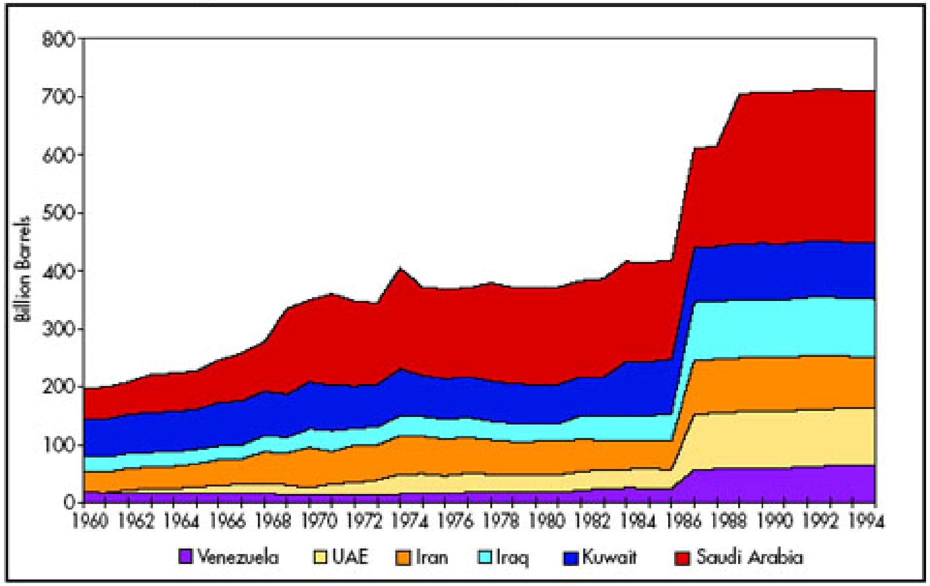
- Comparison, taking iron equivalent as basis:
  - Recipe (Black)
  - EI99 (striped)
  - CML (white)



Fossil resources

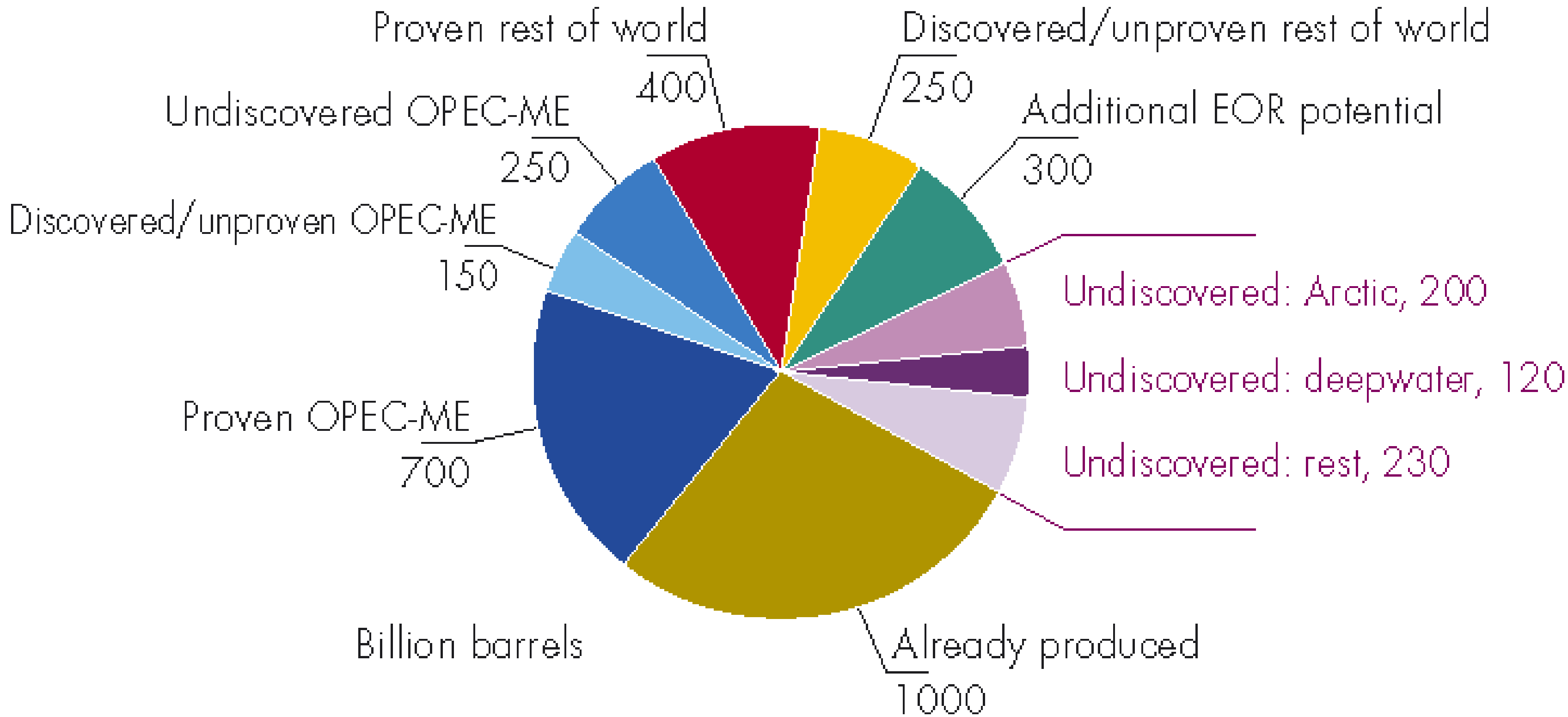
- Grade has no meaning in fossil resources
- In stead we have to gradually move to secondary resources like tarsands, this increases the “effort”
- The problem with resource statisitcs

Figure 7.4: OPEC Official (proved) Oil Reserves

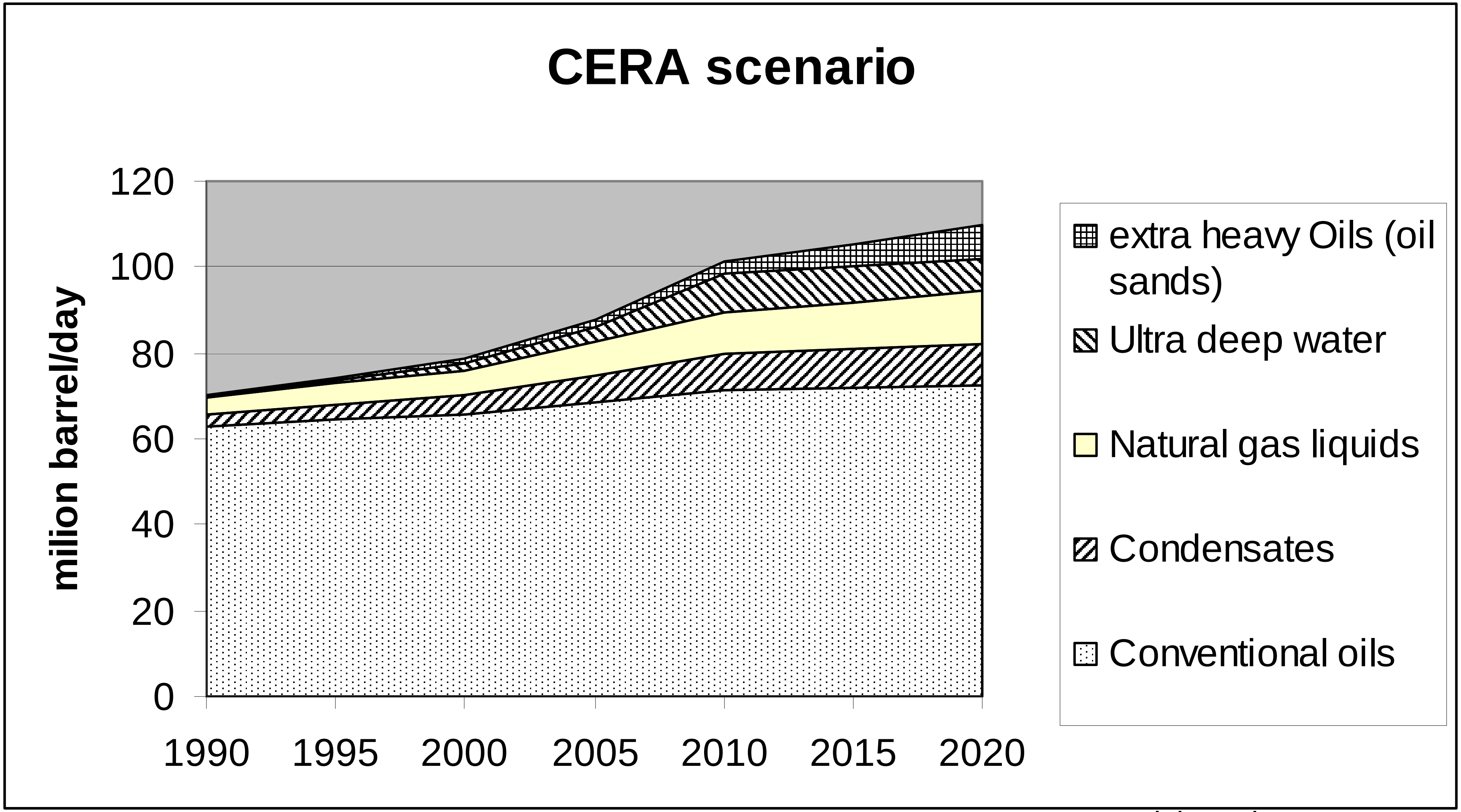


Source: *BP Statistical Review of World Energy*, 1997.

Conventional oil

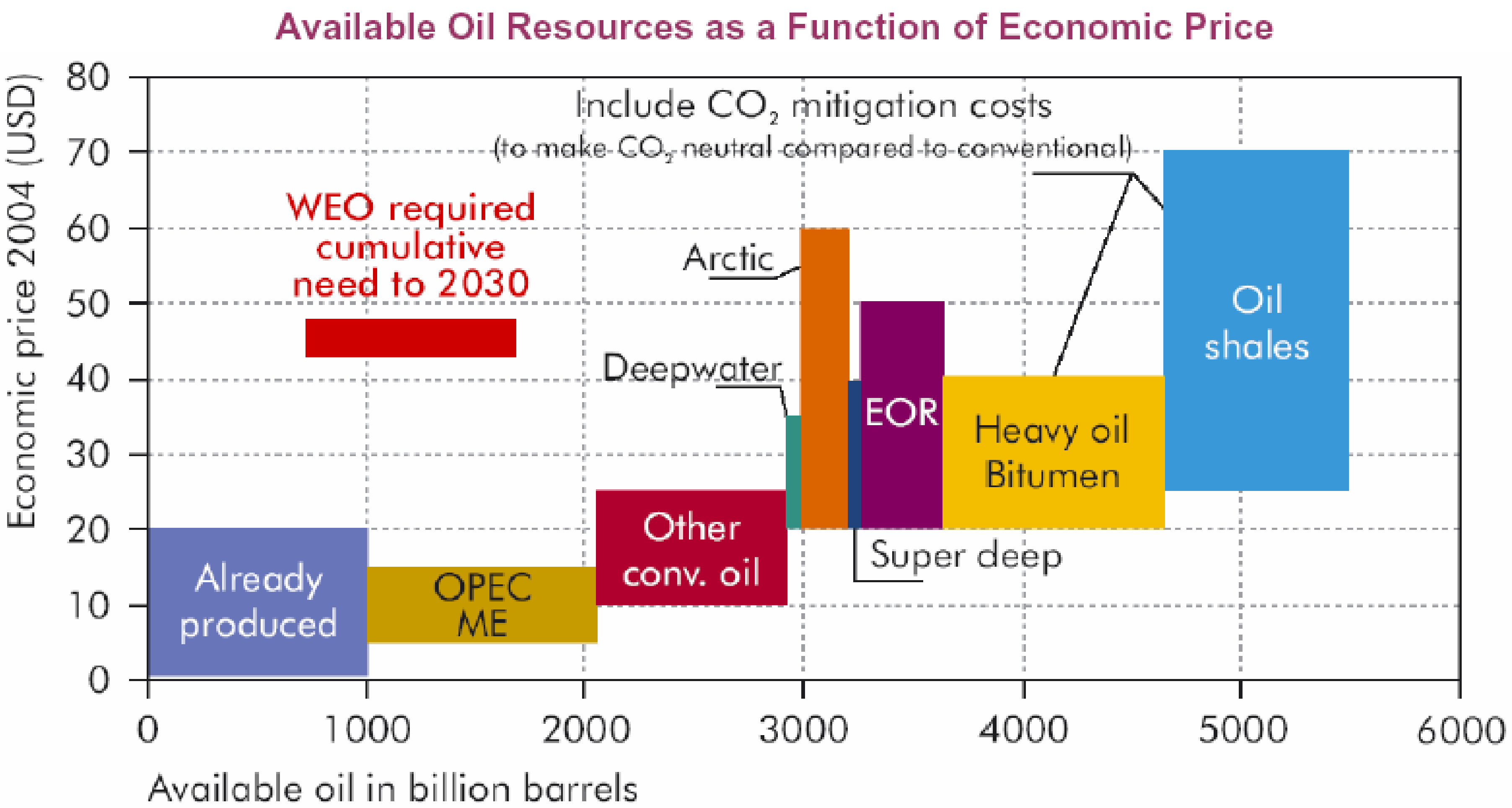


Based on USGS data and IEA analysis



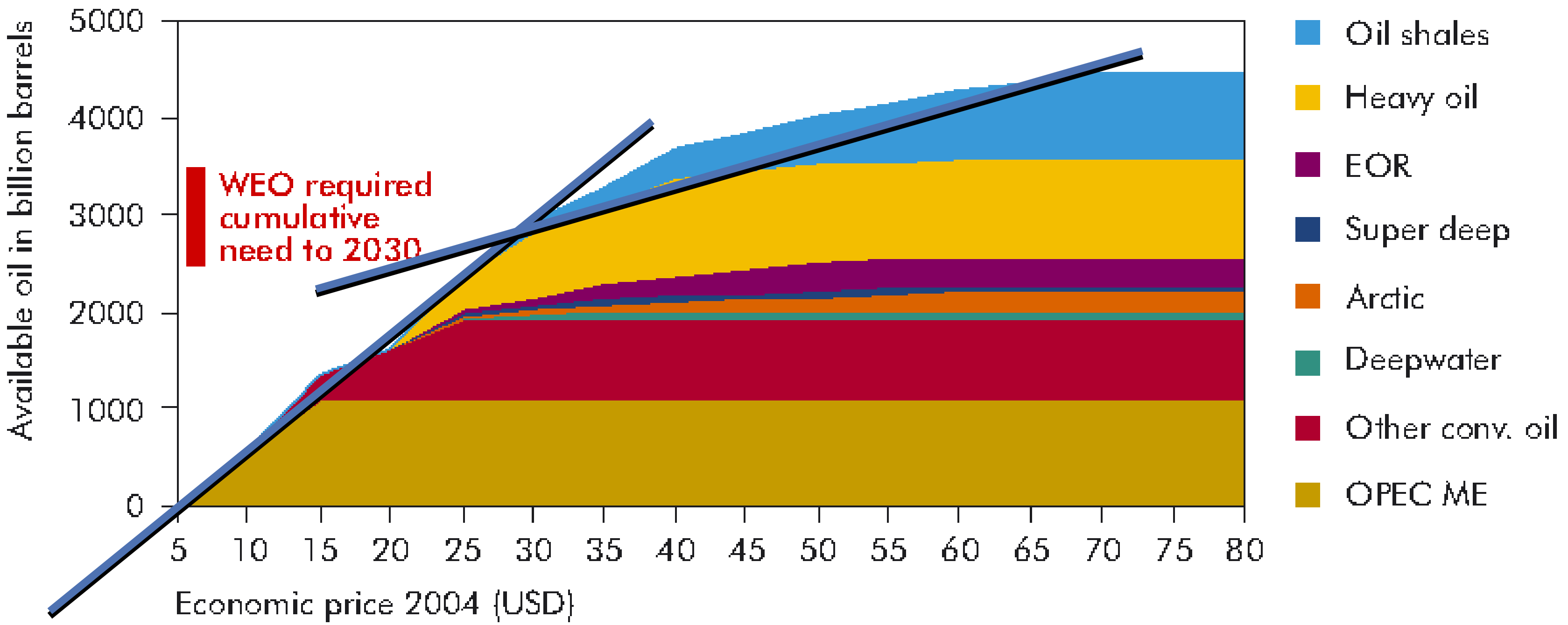
CERA scenario
milion barrel/day
120
100
80
60
40
20
0
1990
1995
2000
2005
2010
2015
2020
extra heavy Oils (oil sands)
Ultra deep water
Natural gas liquids
Condensates
Conventional oils

IEA view



Source: *Resources to Reserves - Oil and Gas Technologies for the Energy Markets of the Future*, IEA, 2005

Depletion fossil fuels (oil)



Source: IEA.

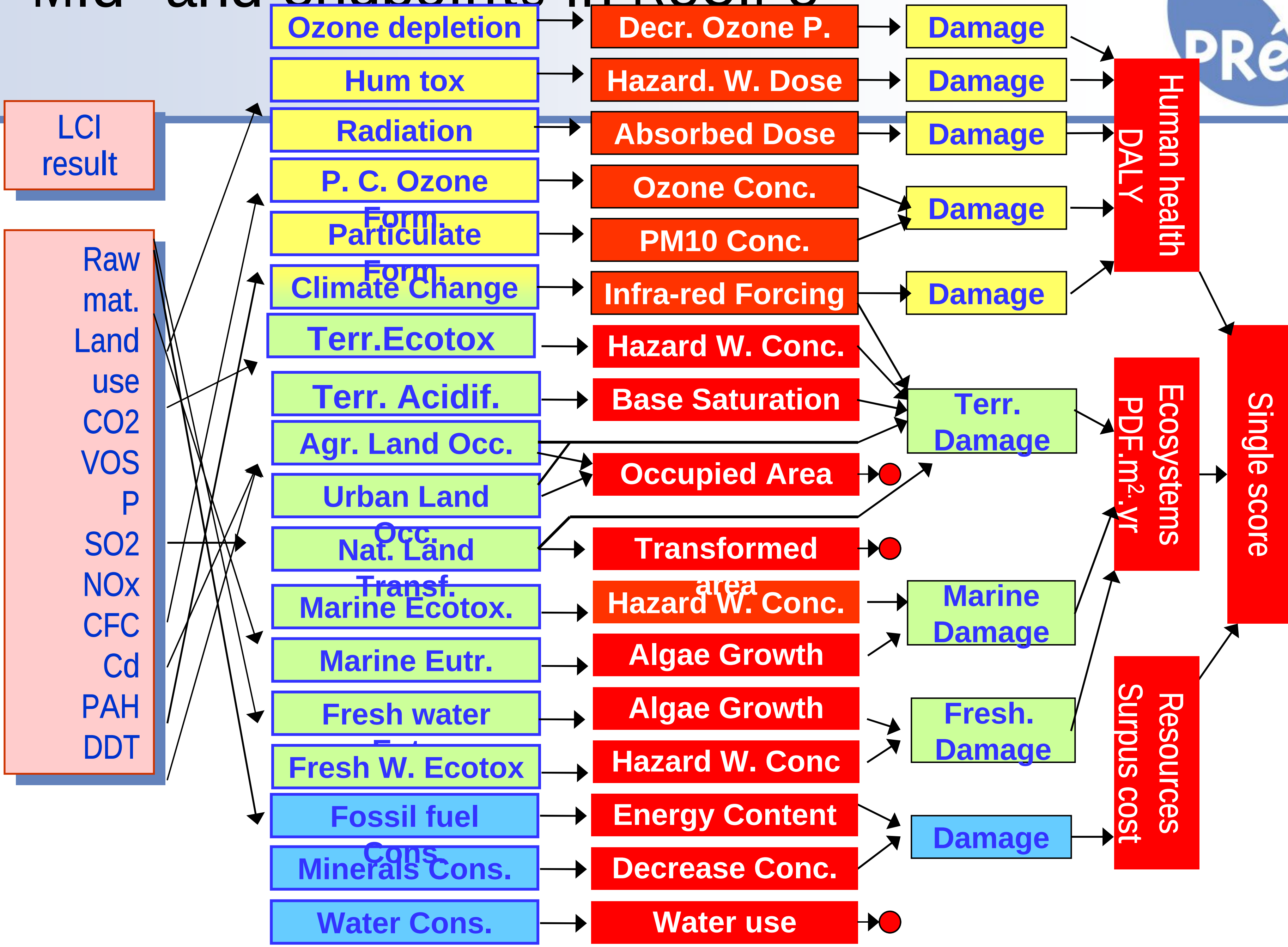
Overview

- Fossil depletion only refers to liquids
- Gas and coal could not be modelled, and are assumed as being as scarce as oil…….
- Very rough model based on IEA statistics:
  - Oil data is inherently unreliable:
  - based on an in-crowd “peakoilists” who have no data
  - OPEC, whose members have no interests in real data
  - Oil companies that underreport

Last step: discounting

- So far the Marginal Cost Increase (MCI) per kg, due to the extraction of a kilo has been determined
  - If the price of steel changes 1 kg, this has a much higher societal cost that if the price of bismuth increases a cent
  - MCI has little societal meaning
- In ReCiPe MCI is multiplied with annual production to get societal cost per year.
- But why not 100 year or indefinite?
- In stead a discounting rate is used (3%)

Mid- and endpoints in ReCiPe



Your Assessment

ReCiPe Features, weaknesses

- Features:
  - Mid and endpoint models
  - Advanced models, state of the art, many are published in reviewed articles
  - Will get good recognition in the EU
  - Much wider range of toxic substances, but rough model
  - Also impacts in water bodies
  - Much better models for climate, ozone, resources and land use
- Remaining weaknesses
  - Weighting problem
  - Sometimes very high uncertainties

Outlook

- ReCiPe website will get all the models, we want to create an open source LCIA community
- FP7 project call open now, builds on EULCIA project:
  - Focus on remaining problems
  - New impact categories for non OECD