14th International Conference LCA FOOD 2024 HEALTHY FOOD SYSTEMS FOR A HEALTHY PLANET

CORSUS CORPORATE SUSTAINABILITY

# Reducing complexity for a single score for food products

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IMPACTS OF FOOD

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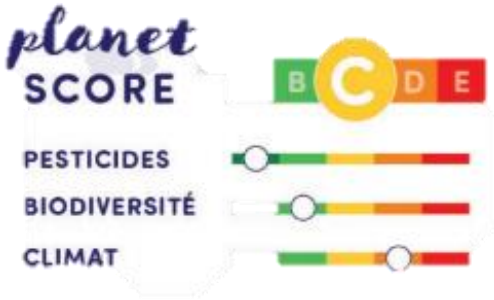
# Introduction

- Easily understandable information for consumers
- Environmental footprint method

- Activities can have an effect on different impact categories


# Research question

Which impact categories can be excluded from a single score for food products without significantly altering the signal of the respective single score?

# Methodology – data base

**Agribalyse data base**

| Inventory Analysis | Classification | Characterization |
|---|---|---|
| $CH_4$, $N_2O$, $CO_2$, …<br>$SO_2$, $NH_3$, …<br>Organic chemicals, metals, …<br>Surface water, ground water, …<br>… | Climate change<br>Acidification<br>Ecotoxicity<br>Water use<br>… | LCI x CFs = kg $CO_2$ eq<br>LCI x CFs = mol $H^+$ eq<br>LCI x CFs = CTUe<br>LCI x CFs = $m^3$ eq<br>… |

# Methodology – data base

## Data Extension

### Impact Assessment

**Terrestrial biodi-versity using BVI (Lindner et al. 2021)** (Data provided by Ademe)

### Weigthing

Weigthing for terrestrial biodiver-sity is based on CLIF

## Data Preparation

### Normalization

kg $CO_2$ eq / 7553
kg $CO_2$ eq/person
mol $H^+$ eq / 55.6
mol $H^+$ eq/person
CTUe / 56716,6
CTUe/person
$m^3$ eq / 11468.7
$m^3$ eq/person
…

### EDA

**Descriptive Statistics:**
Minimum, Maximum, Histogramm, …

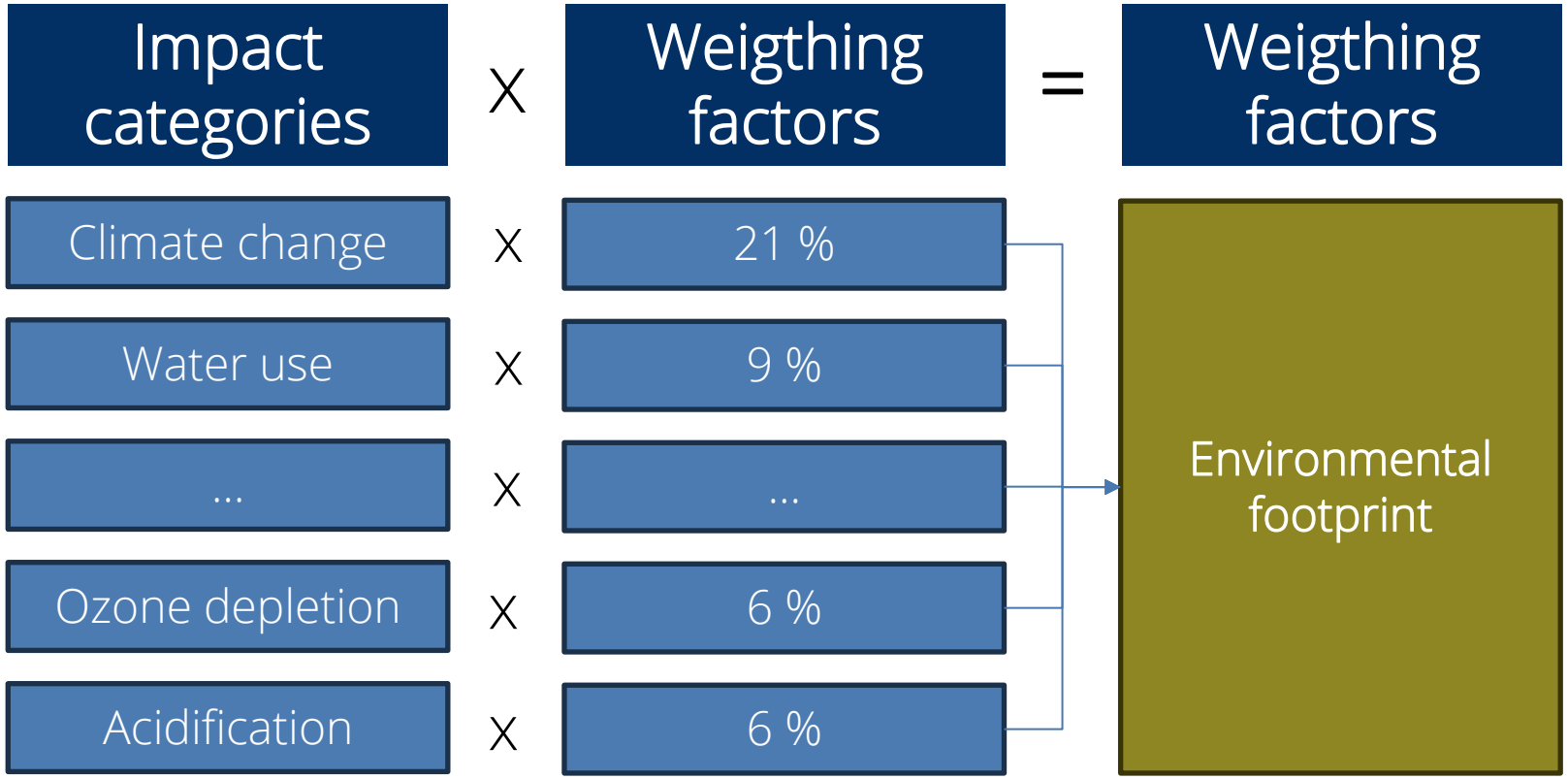
**Outlier Analysis:**
Cooks distance
Isolation forest

### Reduction

- Included multiple times
- No impact assessment for biodiversity
- Water use < 0
- Outlier
- N = 2.518 -> 1.538

# Methodology – aggregation models

- 4 aggregation models
- Differences:
  - included impact categories
  - Used weigthing factors
    - Based on JRC
    - Based on CLIF
- 6 weigthing scenarios



# Methodology - statistics

## Multiple linear regressions

| Model building | Results | Interpretation |
| --- | --- | --- |
| For each possible number of impact categories:<br>Best subset selection using exhaustive search | For each Model:<br>• Included impact categories<br>• Performance measures<br>• Regression coefficients | • How many and which impact categories to include<br>• Model quality<br>• Regression coefficients |

# Methodology - statistics

## Multiple linear regressions

### Model building

| Number of included impact categories | 1 | 2 | 3 | … | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|
| Climate change | ? | ? | ? | ? | ? | ? | X |
| Ozone Depletion | ? | ? | ? | ? | ? | ? | X |
| … | ? | ? | ? | ? | ? | ? | X |
| Resource use, fossils | ? | ? | ? | ? | ? | ? | X |
| Land use (terrestrial biodiversity) | ? | ? | ? | ? | ? | ? | X |
| (adj.) $R^2$ | <1 | <1 | <1 | <1 | <1 | <1 | 1 |
| MSE | >0 | >0 | >0 | >0 | >0 | >0 | 0 |

# Methodology - statistics

## Multiple linear regressions

| Model building | Results | Interpretation |
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| For each possible number of impact categories: **Best subset selection using exhaustive search** | For each Model:<br>• Included impact categories<br>• Performance measures<br>• Regression coefficients | • How many and which impact categories to include<br>• Model quality<br>• Regression coefficients |

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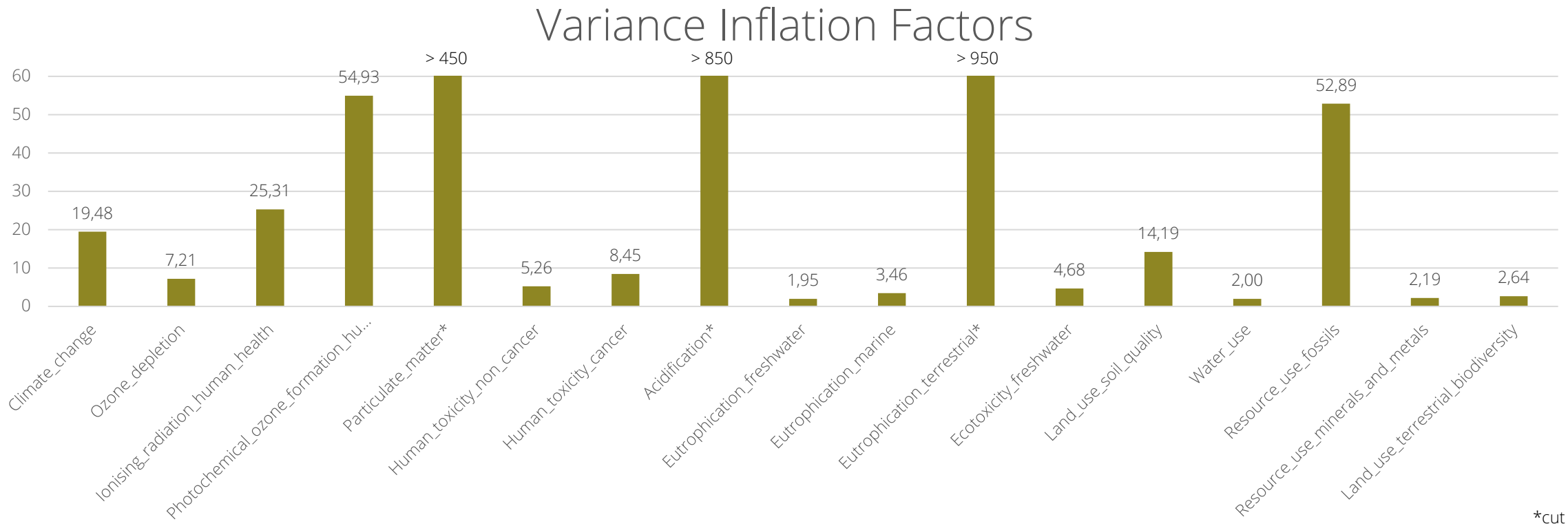
# RESULTS

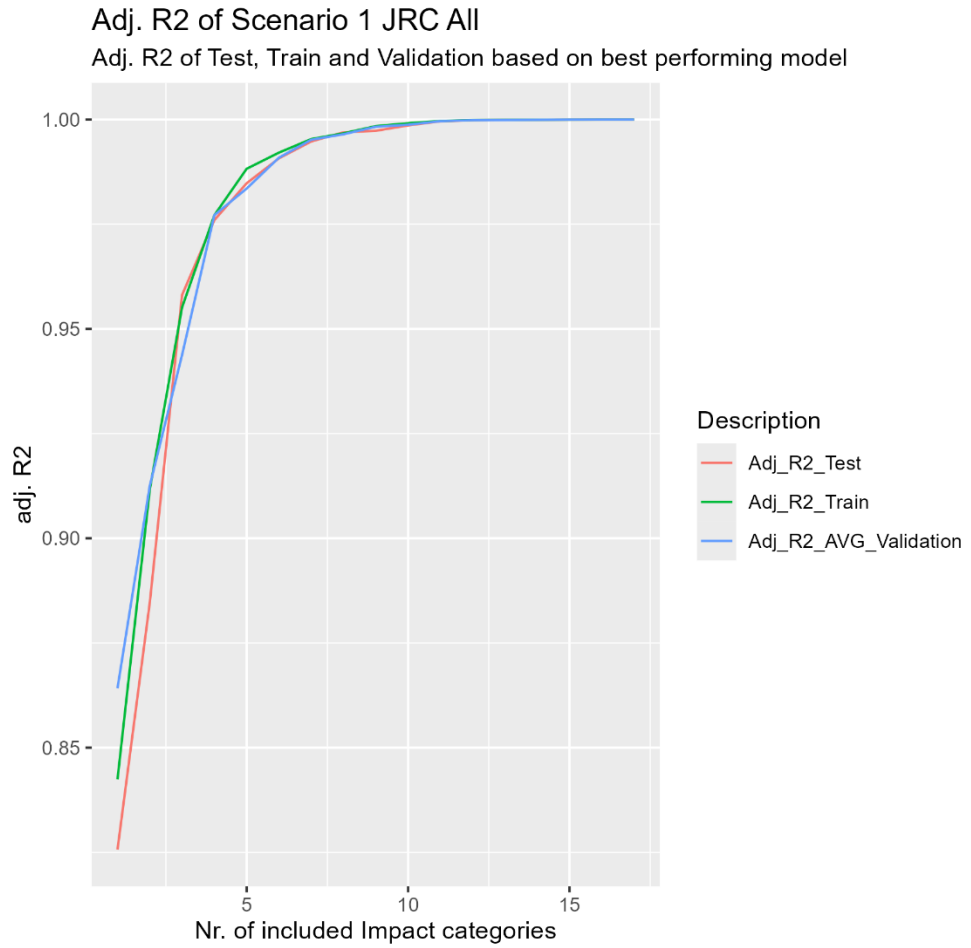
# Results – Variance Inflation Factors

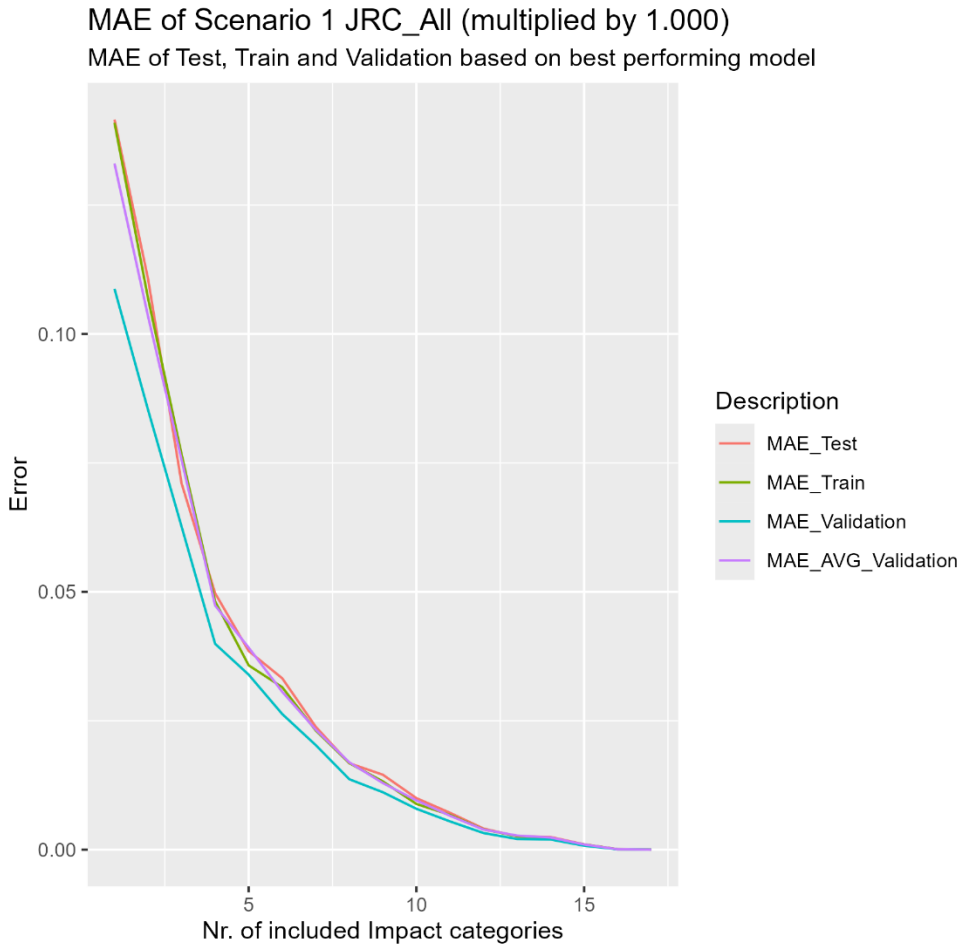
- $VIF_j = \frac{1}{1-R_j^2}$



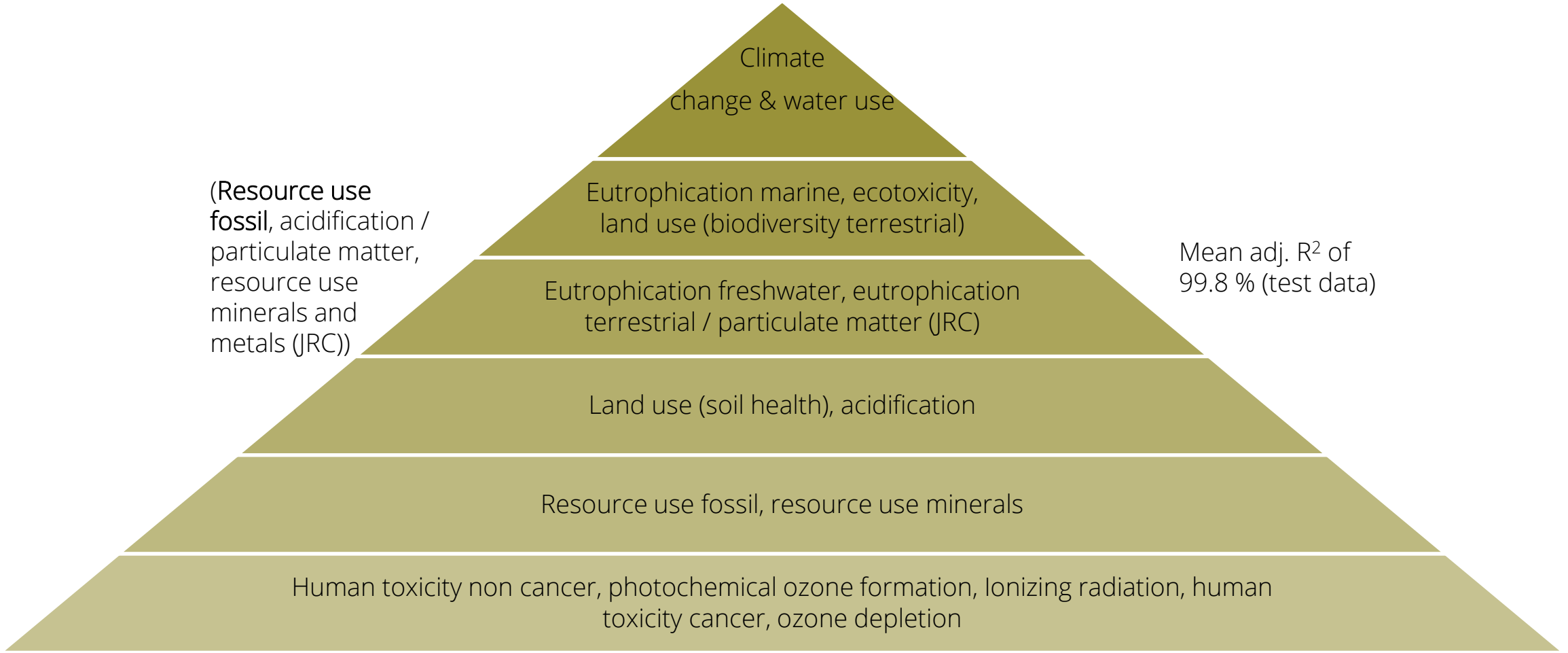

*cut

# Results – JRC (incl. Biodiversity) basis scenario



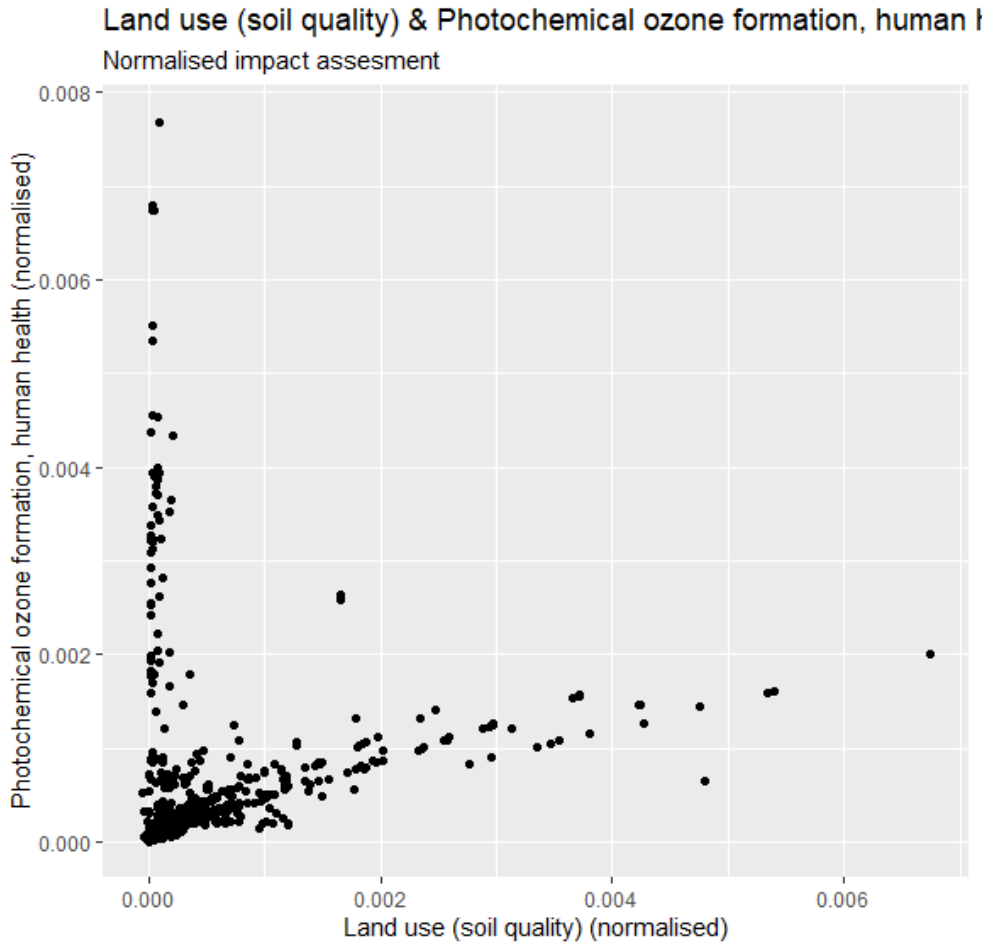
# Results - Impact categories

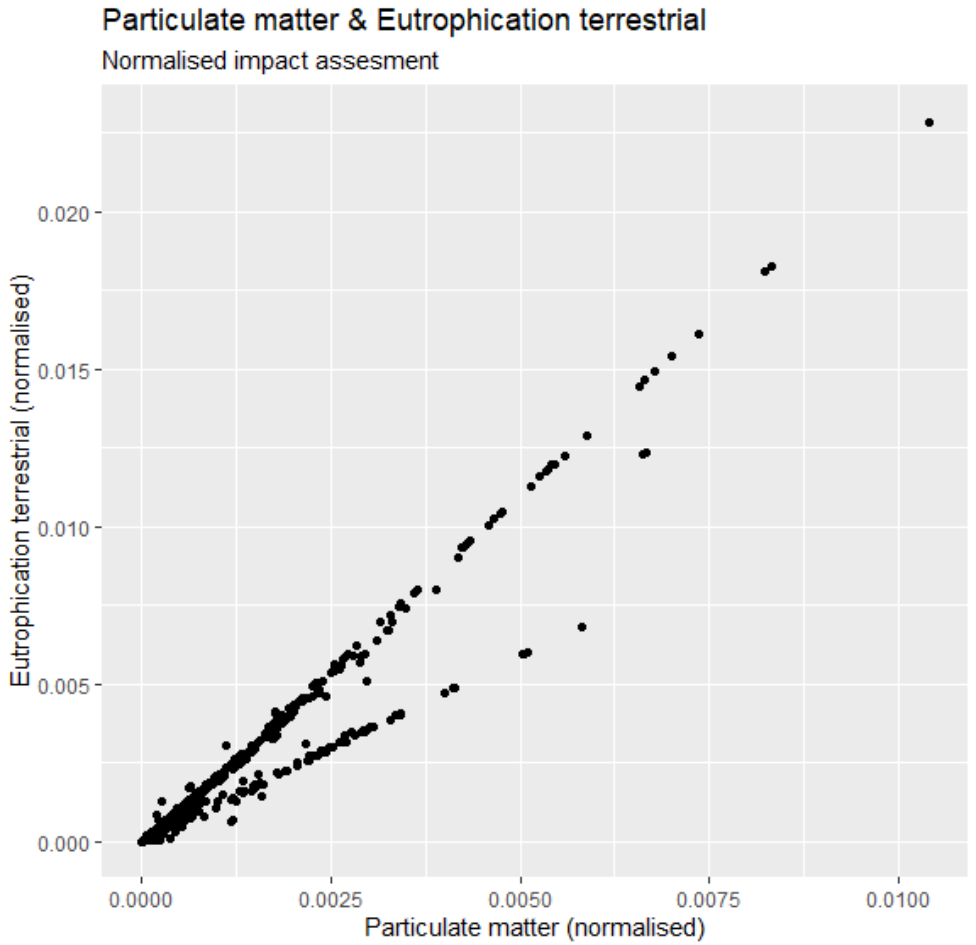



(Resource use fossil, acidification / particulate matter, resource use minerals and metals (JRC))

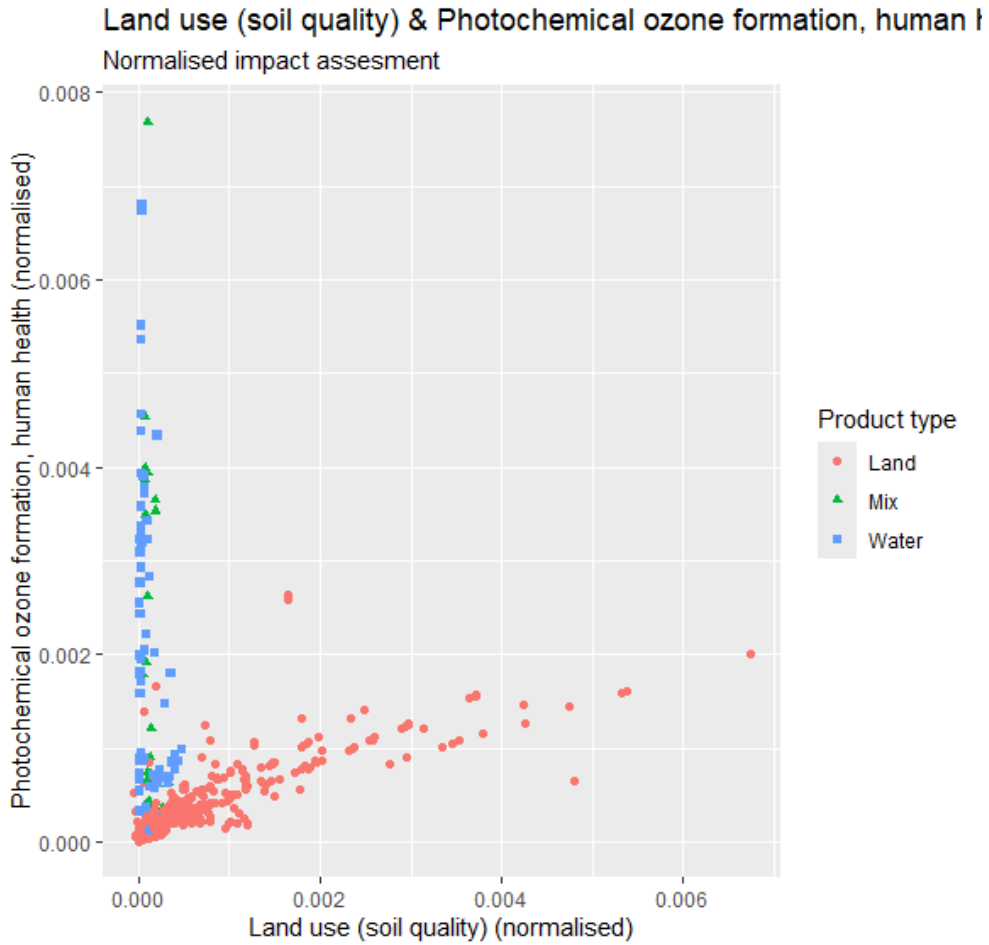
Mean adj. $R^2$ of 99.8 % (test data)

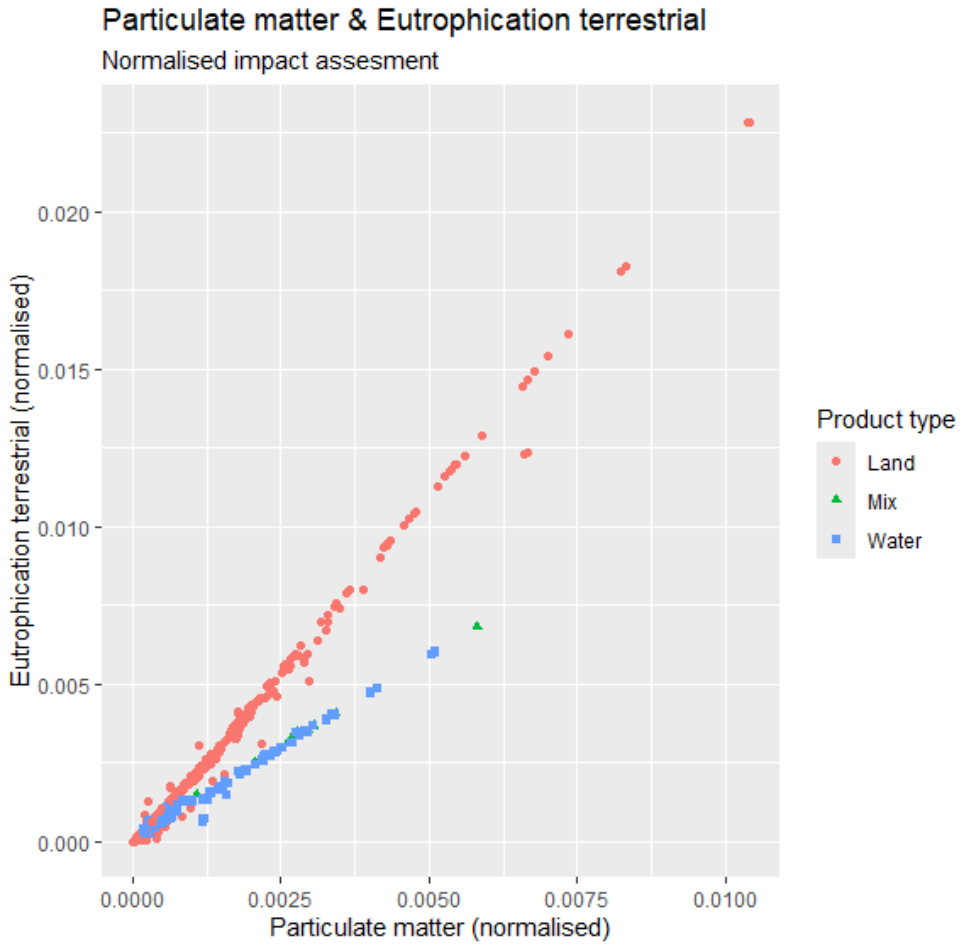
# Results – Exploratory data analysis



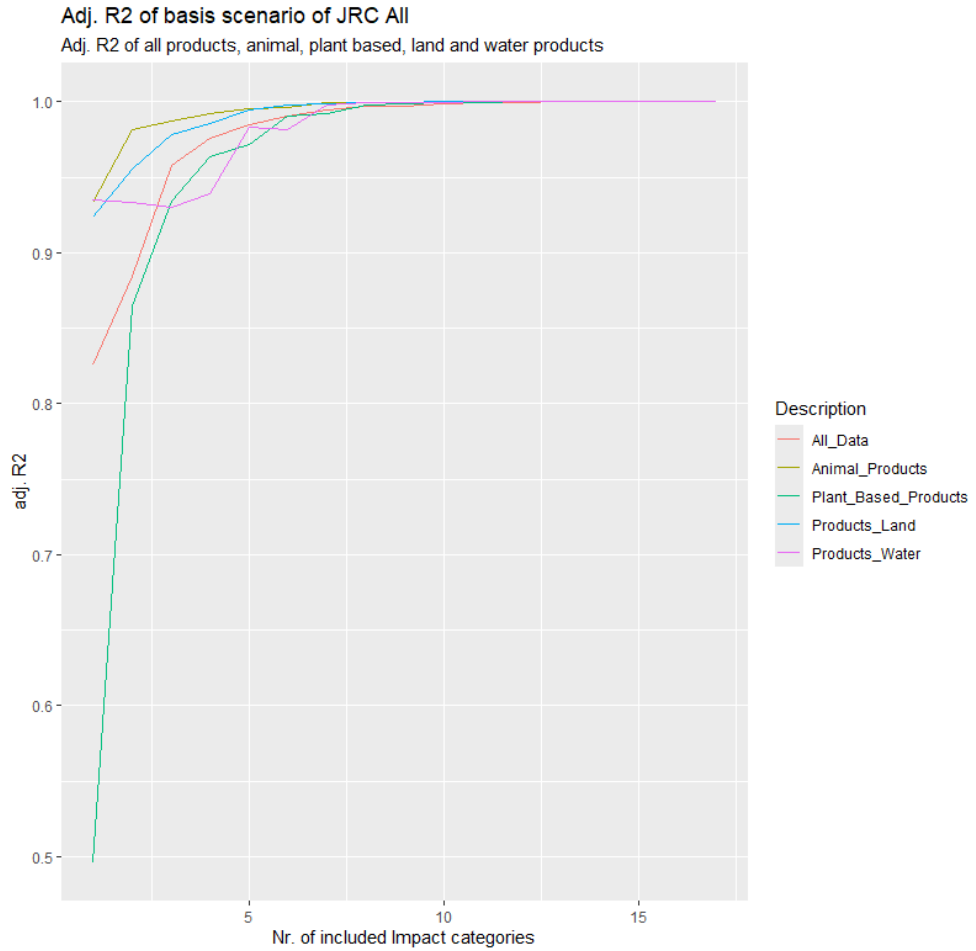



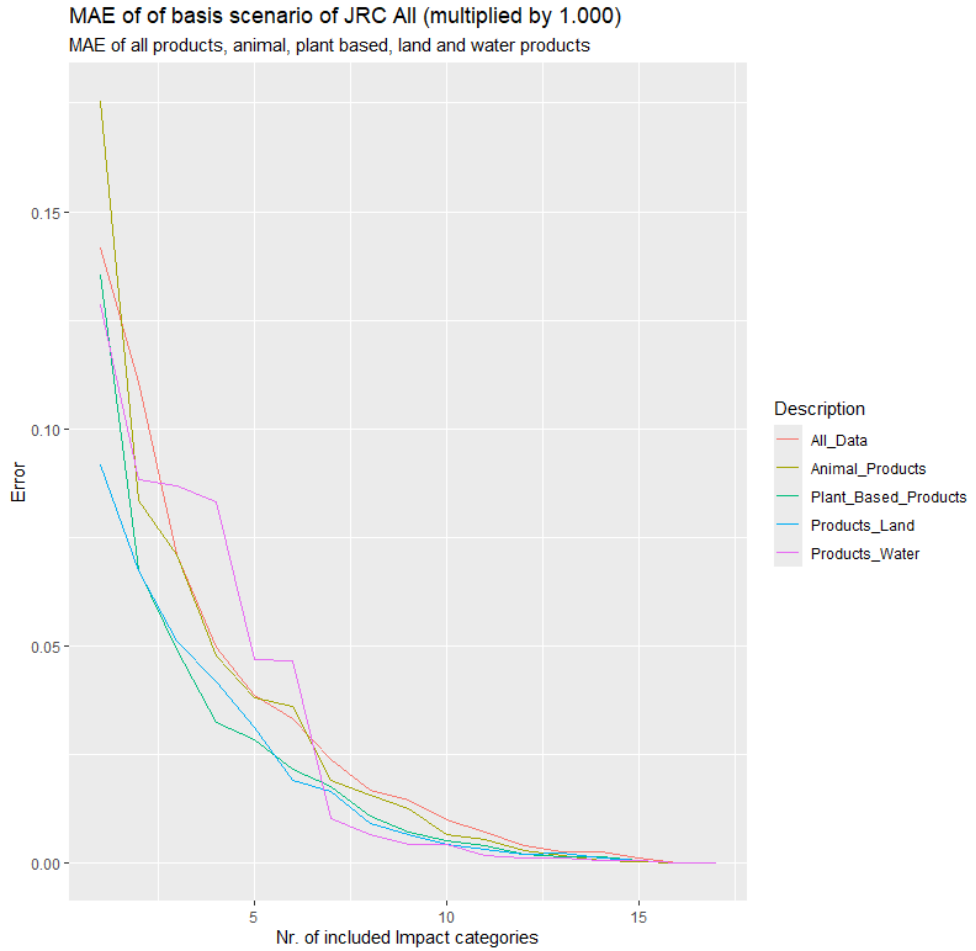
# Results – Exploratory data analysis



# Results – JRC (incl. Biodiversity) – Product Split



# Conclusions

- Few impact categories explain most of the variance (> 99 %)
- Most important impact categories are:
  - Climate change
  - Water use
  - Eutrophication freshwater, marine, terrestrial
  - Ecotoxicity freshwater
  - Land use terrestrial biodiversity

  - Resource use (fossils) & acidification/particulate matter is important for the JRC Model

➢ **The number of impact categories included in a single score can be reduced, but not all impact categories explain the single score in the same way**

# Thank you for your Attention

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# BACKUP

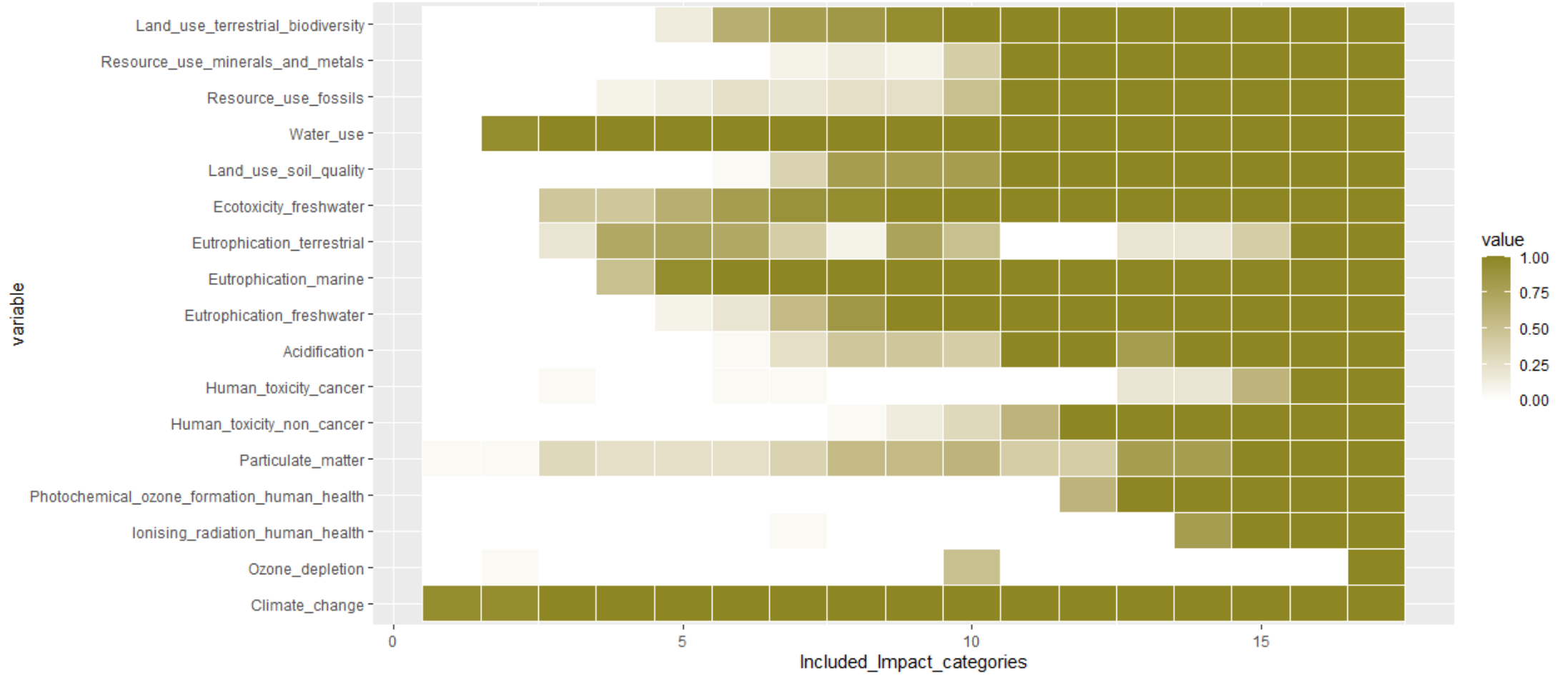
# Methodology – aggregation models

| | Impact assessment categories | Climate change | Ozone depletion | Human toxicity, cancer | Human toxicity, non-cancer | Particulate matter | Ionising radiation, HH | Photochemical ozone formation, HH | Acidification | Eutrophication, terrestrial | Eutrophication, freshwater | Eutrophication, marine | Ecotoxicity, freshwater | Land use (soil quality) | Water use | Resource use, minerals and metals | Resource use, fossils | Land use (terrestrial biodiversity) | *Number of impact categories* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aggregation models | JRC | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | 17 |
| | JRC ecosystem | X | | | | | | | X | X | X | X | X | X | X | | | X | 9 |
| | Planetary boundaries | X | X | | | X | | | | X | X | X | X | X | X | | | X | 10 |
| | CLIF | X | | | | x | | | | X | X | X | X | X | X | | | X | 9 |

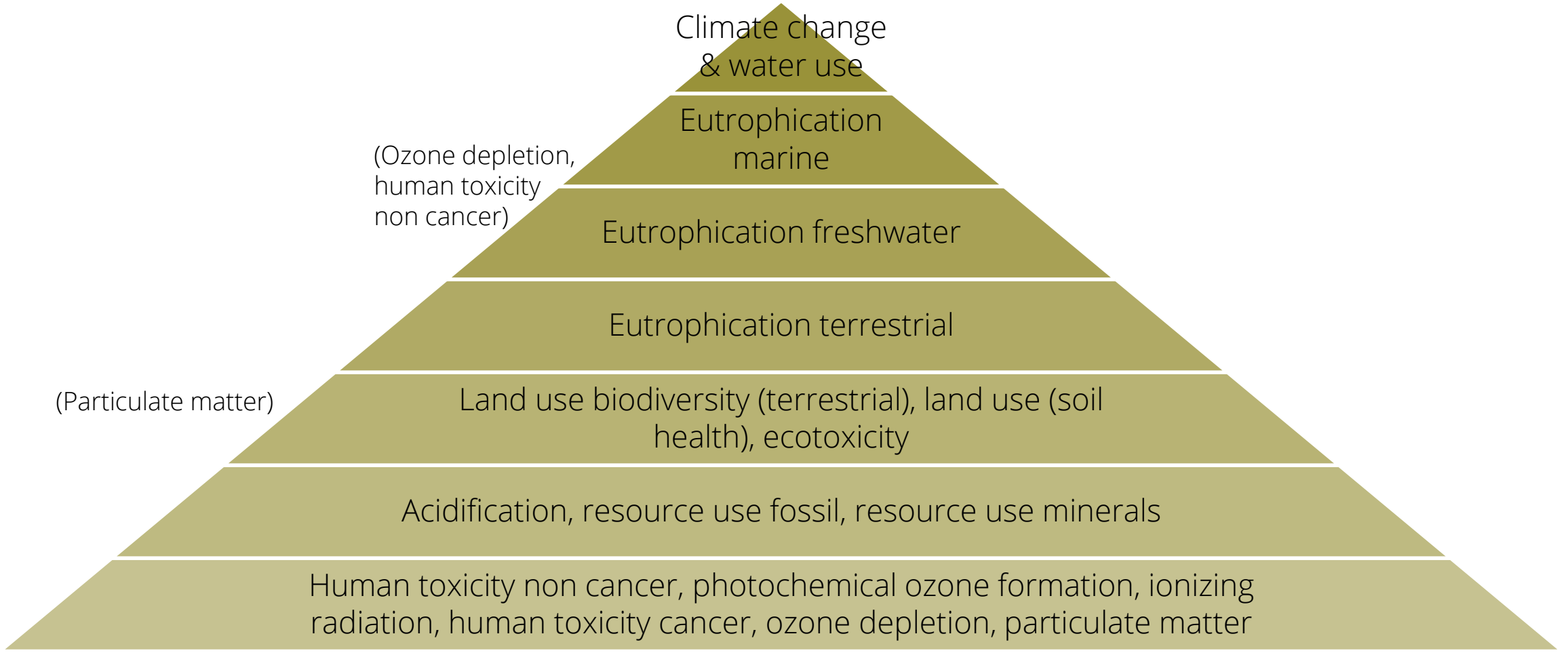
# Methodology – aggregation models

| Weighting | Aggregated weighting Set | Robustness Scale | Robustness factor biodiversity |
|---|---|---|---|
| Basis scenario | Included | - | - |
| Equal weight scenario | Equal weights for every impact category | - | - |
| robustness scenario low (0.1-1.0) | Included | 0.1 – 1 | 0.17 |
| robustness scenario high (0.1-1.0) | Included | 0.1 – 1 | 0.47 |
| robustness scenario low (0.5-1.0) | Included | 0.5 – 1 | 0.53 |
| robustness scenario high (0.5-1.0) | Included | 0.5 – 1 | 0.73 |

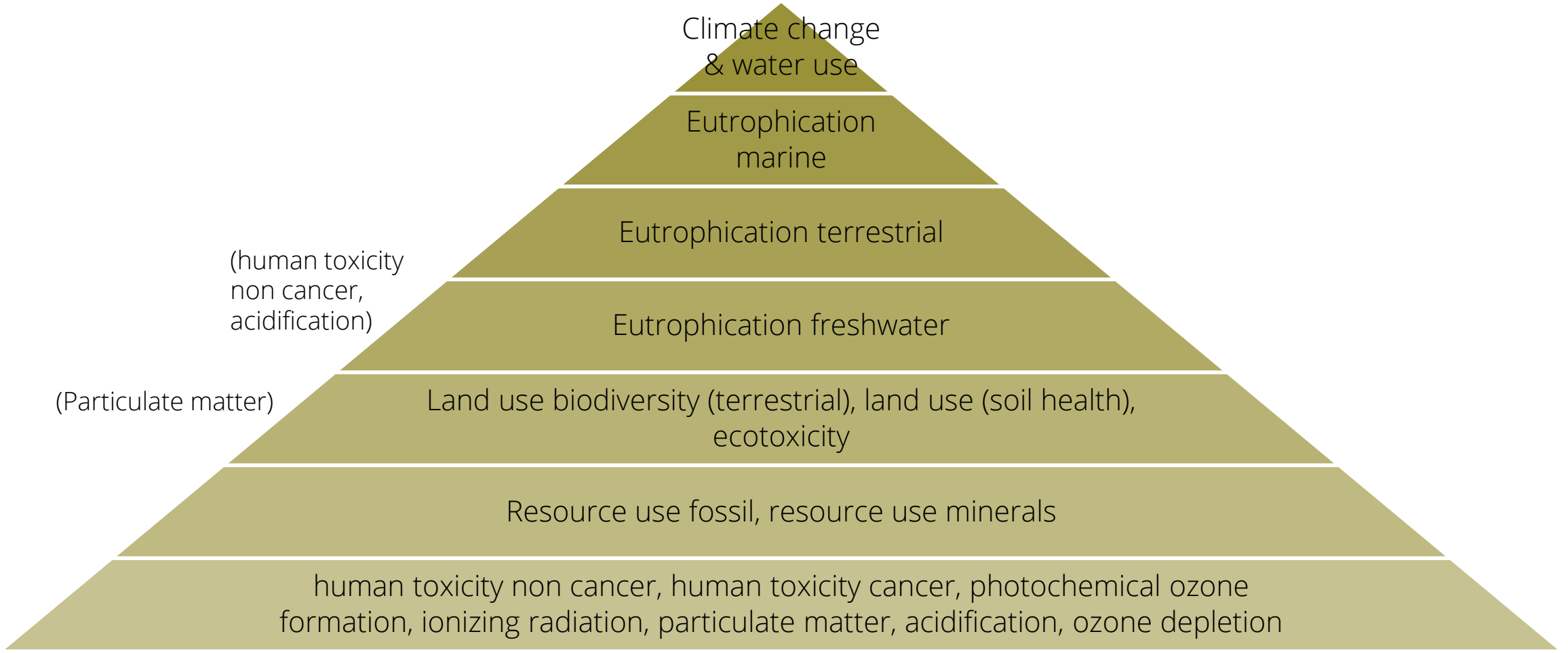
# Results – Percentage included impact categories combined



# Impact categories (product type: water)



# Impact categories (product type: animal)



# Results – JRC (incl. Biodiversity) basis scenario