Reforming carbon accounting mechanisms around justice-based principles to promote societal sustainability

Technical Annex: Using EE-MRIO tables for the creation of an environmental index

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Introduction

In this study, we investigate the feasibility of employing an Environmentally Extended Multi-Regional Input-Output (EE-MRIO) model to develop an index that effectively portrays the trade-offs between the tangible environmental impacts and societal benefits associated with various economic sectors. Subsequently, we intend to apply this index to compare different economic sectors within the EU, pinpointing those that excel either due to their substantial societal-benefits and minimal physical impacts or conversely, those characterized by the inverse scenario.

To define the index, we utilized the EXIOBASE3 database (Stadler et al., 2021), which offered a chronological sequence of EE-MRIO tables spanning from 1995 to 2022, encompassing data for 44 countries (including 28 EU member states and 16 major economies) along with five rest-of-the-world regions.

For the development of this index, we used the impacts extension in the industry-by-industry format and the Multipliers matrix (M) in particular. This matrix furnishes values for 127 distinct stressors (or impacts), such as GWP100[1] and Employment, per unit of Value Added[2]. Significantly, the matrix concentrates on production, considering both direct and indirect impacts, thereby incorporating all upstream effects along the supply chain, spanning both national and international dimensions.

Methodology

Our planned methodology involved the following steps:

1. Splitting the 127 stressors of the M matrix according to whether they referred to social or physical aspects.
2. Normalising each impact across all sectors and countries. For instance, the sector within all countries with the highest GWP100 got a value of 1 for this impact, while the one with the lowest got a 0. Normalizing across sectors and countries allowed us to compare the different sectors within each country.

[1] 100-year Global Warming Potential.
[2] Value added in an industry or sector represents the increase in value resulting from its production processes, calculated by subtracting the cost of intermediate goods and services from total revenue. It serves as a key measure of economic efficiency and productivity within an economy.

3. To obtain a single figure between 0 and 1 for the social dimension, and the same for the physical dimension. This implied finding a way to aggregate social impacts and physical impacts among them (e.g., weighted sum). Since the chapter focuses on climate change, higher weight was given to emissions related impacts, and lower weight to less relevant impacts (e.g., water pollution).
4. Then, the qualitative index was materialised by representing each sector in a plot with the physical dimension on the x-axis and the social dimension on the y-axis. This was done for each country separately.
5. Then, to give the index a quantitative value, we divided the sectors of each country into four different groups (1: Low social impact and low physical impact; 2: Low social impact and high physical impact; 3: High social impact and low physical impact and 4: High social impact and high physical impact) and then counted the number of times each sector appeared in each group, for all countries in the EU.
6. Made visualisations to show how the different sectors fare along the two dimensions.
7. One could do the same for the different years available in EXIOBASE3, to see changes over time.

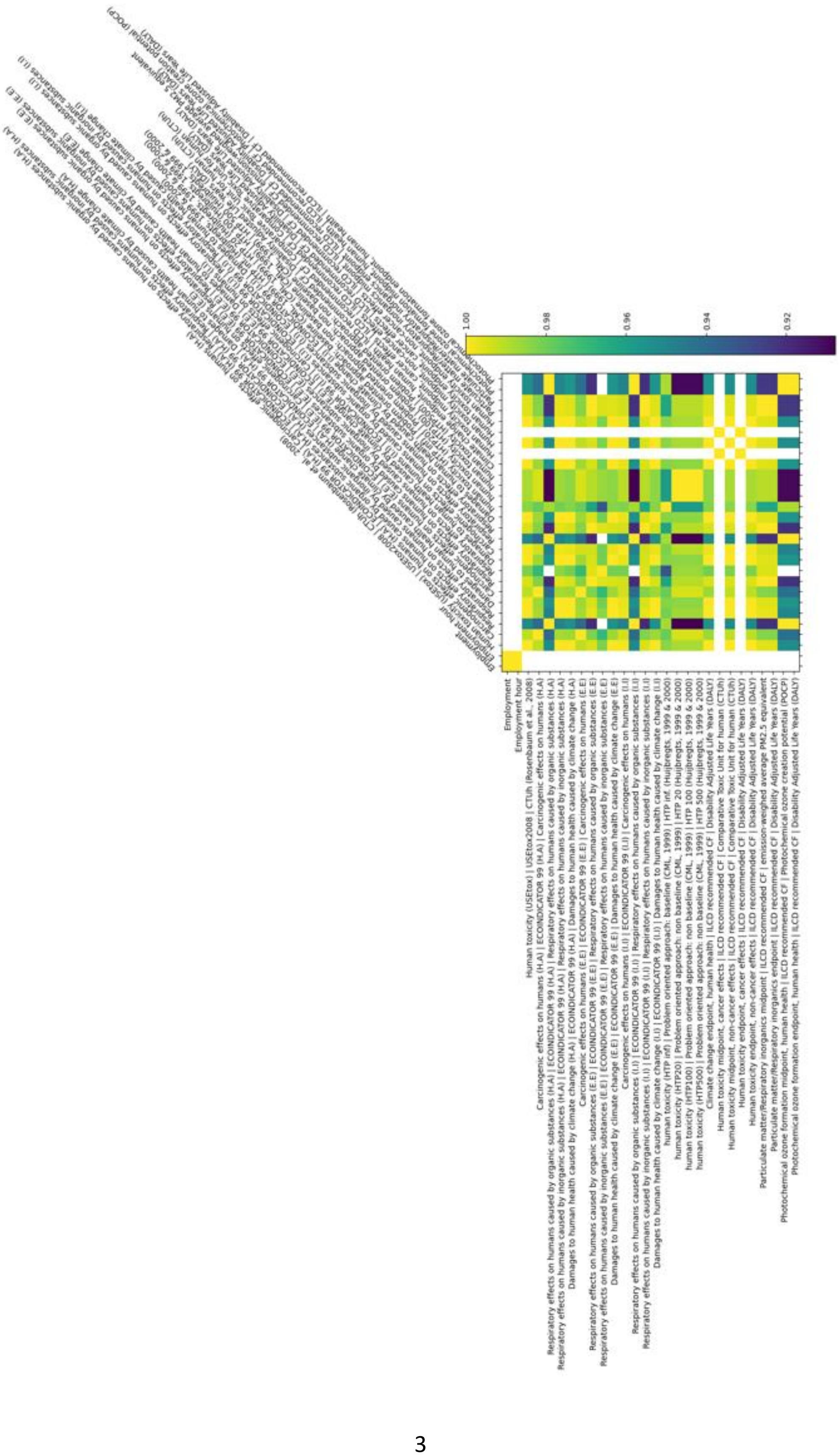
Results

We started by classifying the impacts according to whether they are social or physical impacts. We found that there were 29 social impacts and 98 physical impacts (see Tables 1 and 2 in the Appendix 1). From those, we excluded Value Added, as it was either 1 or 0 (the M matrix gives values of the impact per unit of Value Added), resulting in 28 social impacts.
Then, from the resulting matrix we selected only the data for countries within the EU, and for each country, we removed the sectors which have all impacts equal to 0, which implies that a particular sector does not exist in that specific country.
Upon further analysis of the data, we identified several issues with the different impacts:

1. For the physical impacts, elevated values typically denote adverse outcomes. However, for the social impacts, higher values can signify both positive outcomes (e.g., Employment, Value Added) or negative ones (e.g., Human Toxicity).
2. Like the previous point, for certain indicators (e.g., Human Toxicity), low values should not necessarily be considered a positive social outcome, but rather the high values should affect the social dimension negatively.
3. Presence of big outliers, corresponding to sectors with very low-Value Added. For instance, the Employment impact for the "Re-processing of secondary plastic into new plastic" sector in Finland gives a value of 120 M people per unit of Value Added (for reference, Finland's population is roughly 5.4 M). This is problematic when normalizing, as we get binary values (either 1 or very close to 0).
4. It is also challenging to define what impact value should become 1 when normalizing. To illustrate this point, let us imagine two sectors that are heavy emitters. However, if one clearly stands out from the other, the latter would get a value smaller than 1, which does not reflect the reality of the situation. In other words, beyond a certain emissions threshold, it becomes less pertinent to distinguish between the severity of emissions. In such cases, both sectors may be assigned the worst normalised impact value (i.e., 1).
5. High autocorrelation between impacts of the two dimensions (e.g., Water toxicity and human toxicity).
6. High autocorrelation between the physical impacts themselves.
7. High autocorrelation between the social impacts (see Figure 1).
8. Some data inconsistencies (e.g. negative Employment values for some sectors in some countries).

9. There are a limited number of social indicators. Some key social indicators such as Education (access to education and level of education), health (physical and mental health, happiness index), Social equality (poverty, income vs living cost, welfare system), and human thriving (job quality, purpose) are not included.

Figure 1: Autocorrelation matrix for social impacts of Estonia, from 2015.



Final approach

The issues highlighted above are intrinsic results of this experiment and independently underscore the limitations of relying on aggregated econometric databases for assessing the sustainability of various economic sectors.
In the upcoming paragraphs, we elucidate the approach taken to address each of the identified issues, along with the necessary compromises made about the initially planned methodology.
For points 1 and 2, the simplest workaround was to subtract the values of social indicators for which high values represent a negative outcome, rather than adding them up, when calculating the social dimension.
To deal with points 3 and 4, before normalizing we replaced the values above a certain percentile (e.g. 90th percentile) by the value of the percentile itself. This way, when normalizing, all values originally above that figure will get a value of 1. This works well to deal with outliers due to low Value Added, and to deal with what should be considered a high value for each specific impact (see issue number 4).
The negative values of Employment (see point 8) were simply fixed by replacing them with 0. Although the solution for this impact was simple, it is prudent to consider the possibility that other discrepancies may exist for other impacts. Consequently, it is advisable to exercise caution when using EE-MRIO data when precision in the results is crucial.
Among all the issues encountered, the most complex to deal with were those of points 5, 6, 7 and 9. Indeed, the number of social indicators included in the impact extension of EXIOBASE3 is limited and may not be easily extended within the context of the current project. On the other hand, the issue of autocorrelation (points 6, 7 and 8), left us with only two independent social indicators, which were Employment and Human Toxicity. While acknowledging that correlation does not necessarily imply causation, the incorporation of correlated parameters in an aggregated index may lead, among others, to skewed weighting, potentially distorting the accuracy and reliability of the index.
Moreover, depending exclusively on these two social indicators could provide a misleading representation if we were to designate the result as the complete "social" dimension. Additionally, introducing several physical indicators in contrast to just two social indicators would create an imbalance between the two dimensions. Therefore, given the focus on climate change in this chapter and as an initial approach, we adhere to the steps outlined in the planned methodology, but we restrict our selection to GWP100 and Employment as representatives of physical and social indicators, respectively.

Example indicator
Figure 2 represents the percentage of times each sector has been placed in the 4 groups detailed in point 5 of the original methodology.

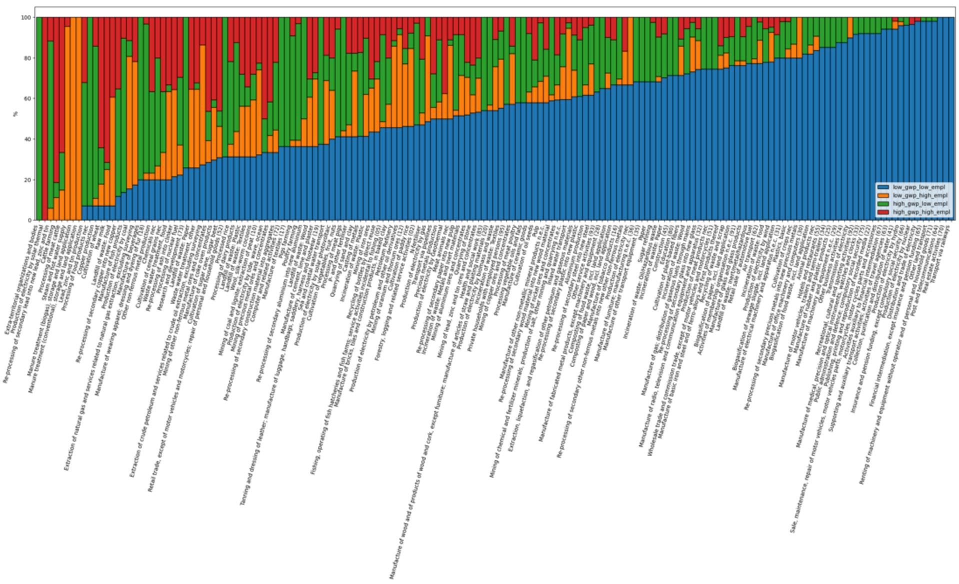


Figure 2: percentage of times each sector has been classified as *low GWP and low Employment (blue)*, *low GWP and high Employment (orange)*, *high GWP and low Employment (green)* and *high GWP and high Employment (red).*

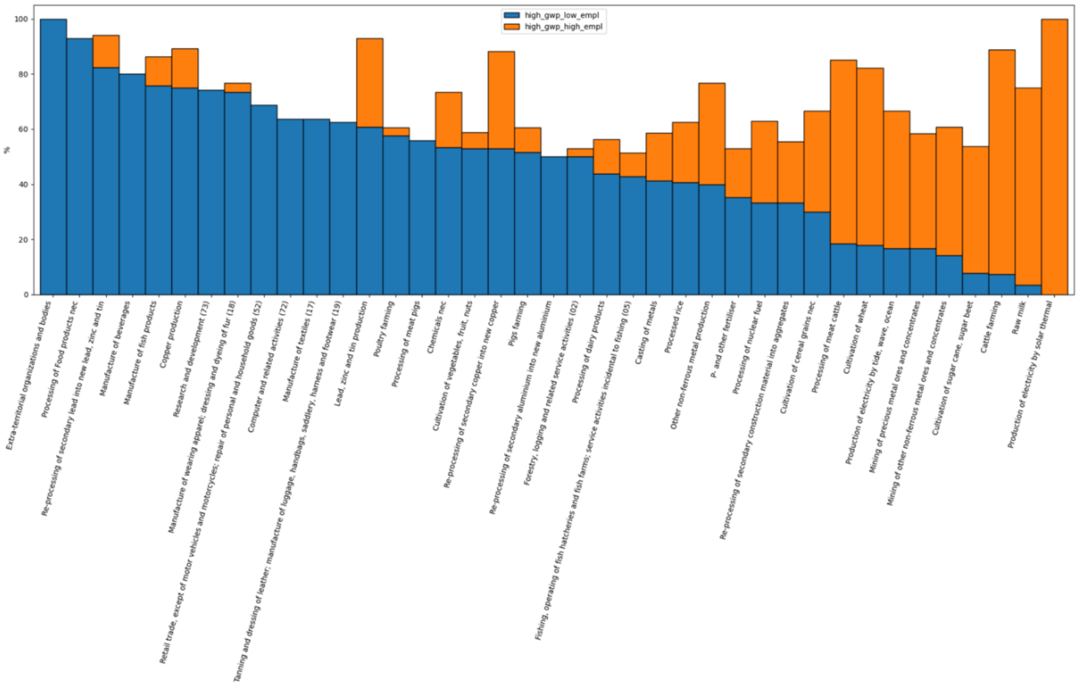


Figure 3: sectors classified as high GWP100 50% of the time or more. Blue bars correspond to *high GWP and low Employment and orange bars correspond to high GWP and high Employment*.

In the previous figure, the bars which are mostly blue correspond to sectors which not only have high GWP100 but also produce low employment. Therefore, if the social and physical dimensions had been obtained by aggregating several impacts each, these would be the sectors that would need to be reconsidered in a future scenario combining ecological sustainability and human well-being.
Hence, though exploring only two impacts per dimension is an oversimplification, this experiment shows the potential interest of this approach for classifying sectors according to their compromise between physical impacts and societal-benefits.

Conclusions

In this work, we have investigated the potential use of EE-MRIO databases to create a sustainability index to illustrate the trade-offs between the concrete environmental impacts and societal advantages linked to diverse economic sectors.
We have presented a methodological approach and shown that, in its current state, the EE-MRIO database from EXIOBASE3 may not be adequate for achieving the specific results we aimed to obtain through this study.
Complemented the methodology with an example of what could be achieved in the future, if more social indicators are added to the EE-MRIO databases but using only one impact per dimension.
This work has demonstrated not only the knowledge gaps and information required for a better characterization of the links between environmental impacts and human/social aspects but also provides insights on how to address such gaps and lack of information. This chapter highlights the advantages of having more information and data to improve understanding of the environment-ecosystem-society-economy links, which is crucial for future evaluations of the necessary socio-economic changes for implementing the transition to a low-carbon society.

Bibliography

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Appendix 1. Indicators

Table 1: *Physical impacts list.*

Impact name	**Unit**
GHG emissions (GWP100) | Problem oriented approach: baseline (CML, 2001) | GWP100 (IPCC, 2007)	kg CO2 eq.
Fresh water Ecotoxicity (USEtox) | USEtox2008 | CTUe (Rosenbaum et al., 2008)	PAF m3.day
Damage to Ecosystem Quality caused by ecotoxic emissions (H.A) | ECOINDICATOR 99 (H.A) | Damage to Ecosystem Quality caused by ecotoxic emissions (H.A)	PDF*m2*yr
Damage to Ecosystem Quality caused by the combined effect of acidification and eutrophication (H.A) | ECOINDICATOR 99 (H.A) | Damage to Ecosystem Quality caused by the combined effect of acidification and eutrophication (H.A)	PDF*m2*yr
Damage to Ecosystem Quality caused by ecotoxic emissions (E.E)) | ECOINDICATOR 99 (E.E) | Damage to Ecosystem Quality caused by ecotoxic emissions (E.E))	PDF*m2*yr
Damage to Ecosystem Quality caused by the combined effect of acidification and eutrophication (E.E) | ECOINDICATOR 99 (E.E) | Damage to Ecosystem Quality caused by the combined effect of acidification and eutrophication (E.E)	PDF*m2*yr
Damage to Ecosystem Quality caused by ecotoxic emissions (I.I) | ECOINDICATOR 99 (I.I) | Damage to Ecosystem Quality caused by ecotoxic emissions (I.I)	PDF*m2*yr
Damage to Ecosystem Quality caused by the combined effect of acidification and eutrophication (I.I) | ECOINDICATOR 99 (I.I) | Damage to Ecosystem Quality caused by the combined effect of acidification and eutrophication (I.I)	PDF*m2*yr
Unused Domestic Extraction	kt
Water Consumption Green - Agriculture	Mm3
Water Consumption Blue - Agriculture	Mm3
Water Consumption Blue - Livestock	Mm3
Water Consumption Blue - Manufacturing	Mm3
Water Consumption Blue - Electricity	Mm3
Water Consumption Blue - Domestic	Mm3
Water Consumption Blue - Total	Mm3
Water Withdrawal Blue - Manufacturing	Mm3
Water Withdrawal Blue - Electricity	Mm3
Water Withdrawal Blue - Domestic	Mm3
Water Withdrawal Blue - Total	Mm3
Carbon dioxide (CO2) IPCC categories 1 to 4 and 6 to 7 (excl land use, land use change and forestry)	Gg
Methane (CH4) IPCC categories 1 to 4 and 6 to 7 (excl land use, land use change and forestry)	Gg

Nitrous Oxide (N2O) IPCC categories 1 to 4 and 6 to 7 (excl land use, land use change and forestry)	Gg
Carbon dioxide (CO2) CO2EQ IPCC categories 1 to 4 and 6 to 7 (excl land use, land use change and forestry)	Gg CO2-eq
Methane (CH4) CO2EQ IPCC categories 1 to 4 and 6 to 7 (excl land use, land use change and forestry)	Gg CO2-eq
Nitrous Oxide (N2O) CO2EQ IPCC categories 1 to 4 and 6 to 7 (excl land use, land use change and forestry)	Gg CO2-eq
Carbon dioxide (CO2) Fuel combustion and cement	Gg
Carbon dioxide (CO2) Fuel combustion	Gg
GHG emissions (GWP100) | Problem oriented approach: baseline (CML, 1999) | GWP100 (IPCC, 2007)	kg CO2 eq.
GHG emissions (GWP100min) | Problem oriented approach: non baseline (CML, 1999) | net GWP100 min(Houghton et al., 2001)	kg CO2 eq.
GHG emissions (GWP100max) | Problem oriented approach: non baseline (CML, 1999) | net GWP100 max(Houghton et al., 2001)	kg CO2 eq.
GHG emissions (GWP20) | Problem oriented approach: non baseline (CML, 1999) | GWP20 (IPCC, 2007)	kg CO2 eq.
GHG emissions (GWP500) | Problem oriented approach: non baseline (CML, 1999) | GWP500 (IPCC, 2007)	kg CO2 eq.
ozone layer depletion (ODP steady state) | Problem oriented approach: baseline (CML, 1999) | ODP steady state (WMO, 2003)	kg CFC-11 eq.
Freshwater aquatic ecotoxicity (FAETP inf) | Problem oriented approach: baseline (CML, 1999) | FAETP inf. (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Marine aquatic ecotoxicity (MAETP inf) | Problem oriented approach: baseline (CML, 1999) | MAETP inf. (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Freshwater sedimental ecotoxicity (FSETP inf) | Problem oriented approach: non baseline (CML, 1999) | FSETP inf. (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Marine sedimental ecotoxicity (MSETP inf) | Problem oriented approach: non baseline (CML, 1999) | MSETP inf. (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Terrestrial ecotoxicity (TETP inf) | Problem oriented approach: baseline (CML, 1999) | TETP inf.(Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Freshwater aquatic ecotoxicity (FAETP20) | Problem oriented approach: non baseline (CML, 1999) | FAETP 20 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Marine aquatic ecotoxicity (MAETP20) | Problem oriented approach: non baseline (CML, 1999) | MAETP 20 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Freshwater sedimental ecotoxicity (FSETP20) | Problem oriented approach: non baseline (CML, 1999) | FSETP 20 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Marine sedimental ecotoxicity (MSETP20) | Problem oriented approach: non baseline (CML, 1999) | MSETP 20 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Terrestrial ecotoxicity (TETP20) | Problem oriented approach: non baseline (CML, 1999) | TETP 20 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Freshwater aquatic ecotoxicity (FAETP100) | Problem oriented approach: non baseline (CML, 1999) | FAETP 100 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Marine aquatic ecotoxicity (MAETP100) | Problem oriented approach: non baseline (CML, 1999) | MAETP 100 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.

Freshwater sedimental ecotoxicity (FSETP100) | Problem oriented approach: non baseline (CML, 1999) | FSETP 100 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Marine sedimental ecotoxicity (MSETP100) | Problem oriented approach: non baseline (CML, 1999) | MSETP 100 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Terrestrial ecotoxicity (TETP100) | Problem oriented approach: non baseline (CML, 1999) | TETP 100 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Freshwater aquatic ecotoxicity (FAETP500) | Problem oriented approach: non baseline (CML, 1999) | FAETP 500 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Marine aquatic ecotoxicity (MAETP500) | Problem oriented approach: non baseline (CML, 1999) | MAETP 500 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Freshwater sedimental ecotoxicity (FSETP500) | Problem oriented approach: non baseline (CML, 1999) | FSETP 500 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Marine sedimental ecotoxicity (MSETP500) | Problem oriented approach: non baseline (CML, 1999) | MSETP 500 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Terrestrial ecotoxicity (TETP500) | Problem oriented approach: non baseline (CML, 1999) | TETP 500 (Huijbregts, 1999 & 2000) TETP 500	kg 1,4-dichlorobenzene eq.
photochemical oxidation (high NOx) | Problem oriented approach: baseline (CML, 1999) | POCP (Jenkin & Hayman, 1999; Derwent et al. 1998; high NOx)	kg ethylene eq.
photochemical oxidation (low NOx) | Problem oriented approach: non baseline (CML, 1999) | POCP (Andersson-Skï¿½ld et al. 1992; low NOx)	kg ethylene eq.
photochemical oxidation (MIR; very high NOx) | Problem oriented approach: non baseline (CML, 1999) | MIR 1997; very high NOx (Carter, 1994, 1997, 1998;Carter, Pierce, Luo & Malkina, 1995)	kg formed ozone
photochemical oxidation (MOIR; high NOx) | Problem oriented approach: non baseline (CML, 1999) | MOIR; high NOx (Carter, 1994, 1997, 1998;Carter, Pierce, Luo & Malkina, 1995)	kg formed ozone
photochemical oxidation (EBIR; low NOx) | Problem oriented approach: non baseline (CML, 1999) | EBIR; low NOx (Carter, 1994, 1997, 1998;Carter, Pierce, Luo & Malkina, 1995)	kg formed ozone
acidification (incl. fate, average Europe total, A&B) | Problem oriented approach: baseline (CML, 1999) | AP (Huijbregts, 1999; average Europe total, A&B)	kg SO2 eq.
acidification (fate not incl.) | Problem oriented approach: non baseline (CML, 1999) | AP (Hauschild & Wenzel (1998).	kg SO2 eq.
eutrophication (fate not incl.) | Problem oriented approach: baseline (CML, 1999) | EP (Heijungs et al. 1992))	kg PO4— eq.
eutrophication (incl. fate, average Europe total, A&B) | Problem oriented approach: non baseline (CML, 1999) | EP (Huijbregts, 1999; average Europe total, A&B)	kg NOx eq.
Climate change midpoint | ILCD recommended CF | Global warming potential 100 years	kg CO2-Equivalents
Climate change endpoint, ecosystems | ILCD recommended CF | Potentially Disappeared Fraction of species (PDF)	PDF
Acidification midpoint | ILCD recommended CF | Accumulated Exceedance (AE)	Accumulated Exceedance (AE)

Acidification endpoint | ILCD recommended CF | Change in potentially not occuring fraction of plant species per change in base saturation	PDF
Eutrophication terrestrial midpoint | ILCD recommended CF | Accumulated Exceedance (AE)	Accumulated Exceedance (AE)
Eutrophication marine midpoint | ILCD recommended CF | Potentially Disappeared Fraction of species (PDF)	kg-N equivalent
Ecotoxicity freshwater midpoint | ILCD recommended CF | Comparative Toxic Unit for ecosystems (CTUe)	CTUe = PAF.m3.year
Ecotoxicity freshwater endpoint | ILCD recommended CF | Potentially Disappeared Fraction of species (PDF)	PDF.m3.year
GHG emissions AR5 (GWP100) | GWP100 (IPCC, 2010)	kg CO2 eq.
Nitrogen	kg
Phosphorous	kg
PM10	kg
PM25	kg
SOx	kg
NOx	kg
Domestic Extraction Used - Crop and Crop Residue	kt
Domestic Extraction Used - Grazing and Fodder	kt
Domestic Extraction Used - Forestry and Timber	kt
Domestic Extraction Used - Fisheries	kt
Domestic Extraction Used - Non-metalic Minerals	kt
Domestic Extraction Used - Iron Ore	kt
Domestic Extraction Used - Non-ferous metal ores	kt
Unused Domestic Extraction - Crop and Crop Residue	kt
Unused Domestic Extraction - Grazing and Fodder	kt
Unused Domestic Extraction - Forestry and Timber	kt
Unused Domestic Extraction - Fisheries	kt
Unused Domestic Extraction - Coal and Peat	kt
Unused Domestic Extraction - Oil and Gas	kt
Unused Domestic Extraction - Non-metalic Minerals	kt
Unused Domestic Extraction - Iron Ore	kt
Unused Domestic Extraction - Non-ferous metal ores	kt
Land use Crop, Forest, Pasture	km2

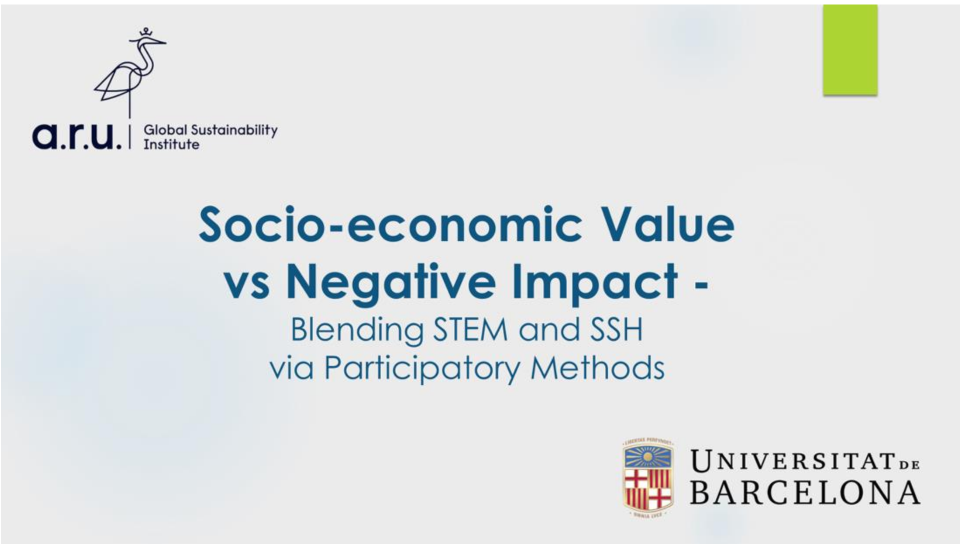
Table 2*: Social impacts list.*

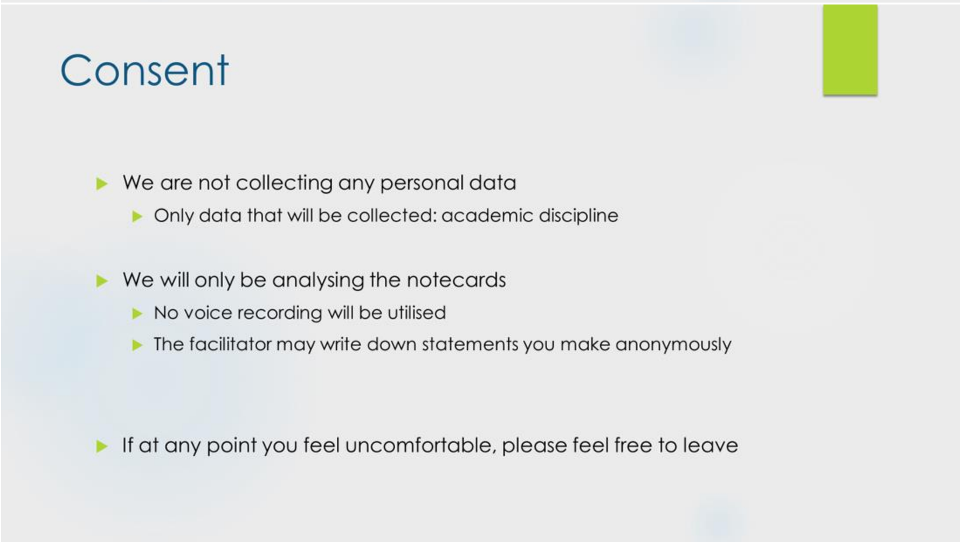
Impact name	**Unit**
Value Added	M.EUR
Employment	1000 p.
Employment hour	hr
Human toxicity (USEtox) | USEtox2008 | CTUh (Rosenbaum et al., 2008)	cases
Carcinogenic effects on humans (H.A) | ECOINDICATOR 99 (H.A) | Carcinogenic effects on humans (H.A)	DALY

Respiratory effects on humans caused by organic substances (H.A) | ECOINDICATOR 99 (H.A) | Respiratory effects on humans caused by organic substances (H.A)	DALY
Respiratory effects on humans caused by inorganic substances (H.A) | ECOINDICATOR 99 (H.A) | Respiratory effects on humans caused by inorganic substances (H.A)	DALY
Damages to human health caused by climate change (H.A) | ECOINDICATOR 99 (H.A) | Damages to human health caused by climate change (H.A)	DALY
Carcinogenic effects on humans (E.E) | ECOINDICATOR 99 (E.E) | Carcinogenic effects on humans (E.E)	DALY
Respiratory effects on humans caused by organic substances (E.E) | ECOINDICATOR 99 (E.E) | Respiratory effects on humans caused by organic substances (E.E)	DALY
Respiratory effects on humans caused by inorganic substances (E.E) | ECOINDICATOR 99 (E.E) | Respiratory effects on humans caused by inorganic substances (E.E)	DALY
Damages to human health caused by climate change (E.E) | ECOINDICATOR 99 (E.E) | Damages to human health caused by climate change (E.E)	DALY
Carcinogenic effects on humans (I.I) | ECOINDICATOR 99 (I.I) | Carcinogenic effects on humans (I.I)	DALY
Respiratory effects on humans caused by organic substances (I.I) | ECOINDICATOR 99 (I.I) | Respiratory effects on humans caused by organic substances (I.I)	DALY
Respiratory effects on humans caused by inorganic substances (I.I) | ECOINDICATOR 99 (I.I) | Respiratory effects on humans caused by inorganic substances (I.I)	DALY
Damages to human health caused by climate change (I.I) | ECOINDICATOR 99 (I.I) | Damages to human health caused by climate change (I.I)	DALY
human toxicity (HTP inf) | Problem oriented approach: baseline (CML, 1999) | HTP inf. (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
human toxicity (HTP20) | Problem oriented approach: non baseline (CML, 1999) | HTP 20 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
human toxicity (HTP100) | Problem oriented approach: non baseline (CML, 1999) | HTP 100 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
human toxicity (HTP500) | Problem oriented approach: non baseline (CML, 1999) | HTP 500 (Huijbregts, 1999 & 2000)	kg 1,4-dichlorobenzene eq.
Climate change endpoint, human health | ILCD recommended CF | Disability Adjusted Life Years (DALY)	DALY
Human toxicity midpoint, cancer effects | ILCD recommended CF | Comparative Toxic Unit for human (CTUh)	CTUh/kg = cases
Human toxicity midpoint, non-cancer effects | ILCD recommended CF | Comparative Toxic Unit for human (CTUh)	CTUh = cases
Human toxicity endpoint, cancer effects | ILCD recommended CF | Disability Adjusted Life Years (DALY)	DALY
Human toxicity endpoint, non-cancer effects | ILCD recommended CF | Disability Adjusted Life Years (DALY)	DALY
Particulate matter/Respiratory inorganics midpoint | ILCD recommended CF | emission-weighed average PM2.5 equivalent	kg PM2.5-eq
Particulate matter/Respiratory inorganics endpoint | ILCD recommended CF | Disability Adjusted Life Years (DALY)	DALY

Photochemical ozone formation midpoint, human health | ILCD recommended CF | Photochemical ozone creation potential (POCP)	kg-C2H4 equivalents
Photochemical ozone formation endpoint, human health | ILCD recommended CF | Disability Adjusted Life Years (DALY)	DALY

Appendix 2 – Workshop slides





The project

- Aim:
  - To develop a way to rank EU nations and industries according to a harm/benefit ratio

- Physical impacts
  - Resource consumption
  - Pollution created
  - Impacts on health

- Social impacts
  - Employment
  - Wages
  - Mobility

- Formula to combine various data sets and produce a ranked result

The workshop

- Composed of seven questions
  - Questions asked consecutively
  - Individual responses
  - Collective responses

- Please write down your answers and thoughts

- We will answer questions of clarification

What are the boats for?

- Each prop on the table is there to help with visual representation:

  - **Green** = Why it's good
  - **Red** = Why it's bad
  - **Blue** = What is missing
  - **White** = Other thoughts

  - Postcard = Sustainable future

Notecards

- The notecards are a tool to capture your views and allow you to phrase it exactly as you wish/make edits etc.
- Use as many as you like, do not feel confined to just one
- These can be used for both individual and group responses
- The white ones are for things that don't fit an area, feedback on the workshop itself, reflections, views, feelings etc.

Question 1: What are your views on the existing social indicators listed below?

Please discuss **collectively**.

- Social
  - Employment
  - Human toxicity

- Indicators? - These are data sets used to give a view on the current state of things, and can be used to predict the future state of things via scenarios (e.g. carbon emissions per country)
- We have 36 physical indicators

Question 2: How would you describe your needs?

Please rank them **individually**

Question 3: How would you describe your needs?

Please rank them

collectively

Scenario: The world has changed

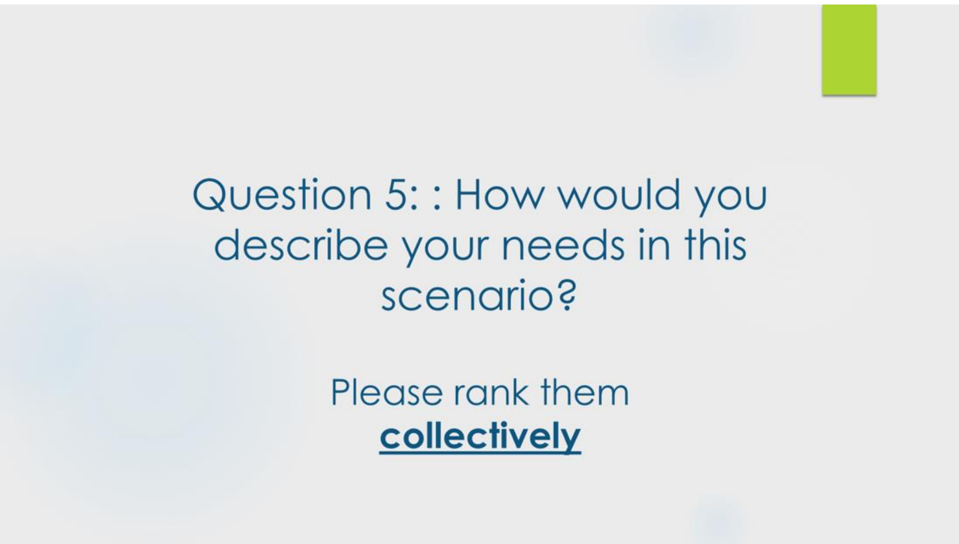
- **Regional Rivalry** – **SSP3 - IPCC**

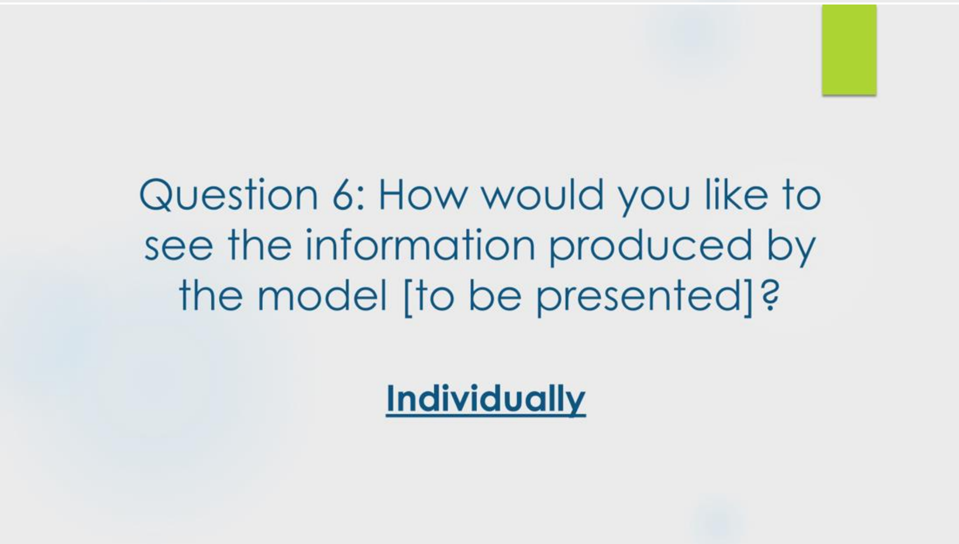
- A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic/regional issues.
- Policies shift toward national and regional security issues.
- Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development.
- Investments in education and technological development decline.
- Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time.
- A low international priority for addressing environmental concerns leads to strong environmental degradation.

Question 4: How would you describe your needs in this scenario?

Please rank them

individually


Question 5: : How would you describe your needs in this scenario?
Please rank them collectively


Question 6: How would you like to see the information produced by the model [to be presented]?
Individually


Question 1 (again): What are your views on the existing social indicators listed below?
Please discuss collectively.
Social
Employment
Human toxicity
Indicators? - These are data sets used to give a view on the current state of things, and can be used to predict the future state of things via scenarios (e.g. carbon emissions per country)
We have 36 physical indicators

Questions

- Please feel free to also raise any points/statements you may have that you did not get the chance or feel able to make today via email
- Email me at **pr479@pgr.aru.ac.uk**
  - Twitter: @PiersReilly
- Thank you for your attendance and participation

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Socio-economic Value vs Negative Impact -

Blending STEM and SSH via Participatory Methods

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