# Technical report of changes implemented in the ecoinvent database between v3.7 & v3.7.1

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# 1 Introduction

After releasing v3.7 in September 2020, a critical error was identified that pushed to the publication of v3.7.1 in December 2020. Namely, the iron sinter production dataset included in v3.7 an error in the estimated emissions for dioxins and PM. As iron and steel supply chains are central in the database, issues with such datasets can have implications on the accuracy of the ecoinvent database. Specifically, the error distorts the results of human health & ecotoxicity indicators on most methods. This report details all changes done from v3.7 to v3.7.1, insisting in the effects on results those updates have. <u>Users working with v3.7 already can therefore decide whether their work can be affected by the updates brought by v3.7.1 or not.</u>

# 2 Summary of updates in v3.7.1 and consequences in results

## 2.1 Updates in v3.7.1

### 2.1.1 "Iron sinter production"

The "iron sinter production" activities in RER and GLO contained a mistake in the estimation of the emissions of "Particulates, > 10 um", "Particulates, > 2.5 um, and < 10um" and "Dioxins, measured as 2,3,7,8-tetrachlorodibenzo-p-dioxin". In addition, the datasets lacked emissions for "Particulates, < 2.5 um".

The added and corrected elementary exchange/s and their respective amounts are presented in the table below:

| Elementary exchange name | Corrected amounts v3.7.1 (kg) | Amounts v3.7 (kg) |
|---|---|---|
| Particulates, > 10 um | 9.38E-05 | 1.51E-04 |
| Particulates, > 2.5 um, and < 10um | 1.96E-05 | 1.08E-04 |
| Particulates, < 2.5 um | 1.20E-04 | - |
| Dioxins, measured as 2,3,7,8-tetrachlorodibenzo-p-dioxin | 1.55E-12 | 1.5492E-09 |

### 2.1.2 "Zinc mine operation"

In the activity "zinc mine operation, GLO", the exchange amount of the input from the environment "Gold, in ground" (compartment: "natural resource"; subcompartment: "in ground") has changed from 1.37E-03 kg to 1.04E-06 kg, based on updated data supplied by the data provider, the International Zinc Association.

### 2.1.3 "Ammonium paratungstate production, solvent extraction"

The uncertainty distribution in all exchanges has been changed from "uniform" to "lognormal" in all geographical occurrences of the activity "ammonium paratungstate production, solvent extraction". While this change will not affect calculated results (scores), it will enhance the uncertainty analysis on the datasets and its supply chains.

## 2.2 Consequences in results: differences between v3.7 and v3.7.1 results

272 indicators covering all impact categories were analysed to write this report. The aggregated "total" indicators are not represented in the graphs or text in the following sections, as the change those indicators represent is better captured and understood with the specific indicators from the same method. Using the 258 remaining indicators, changes in results between v3.7 and 3.7.1 have been analysed and are presented in the following sections for each system model. A full numerical report, comparing the scores between the 2 versions for all system models, with all 272 indicators is available as an excel file annex to this file, the "dataset score comparison, for change report (3.7 vs 3.7.1, all system models)".

The results of the database change visibly from v3.7 to v3.7.1 for some indicators and categories, while they remain unchanged for most of the others. Namely, the categories **human toxicity and ecotoxicity, and mineral resources** are affected for most indicators in all system models. On the other hand, the impact categories climate change, water depletion, cumulative energy demand, land use and land use change, fossil depletion, acidification, eutrophication, ionising radiation, renewable resources, stratospheric ozone depletion, photochemical oxidant formation, radioactive substances and ozone layer depletion, remain basically unaffected.

### 2.2.1 Changes in the “allocation, cut-off by classification” system model

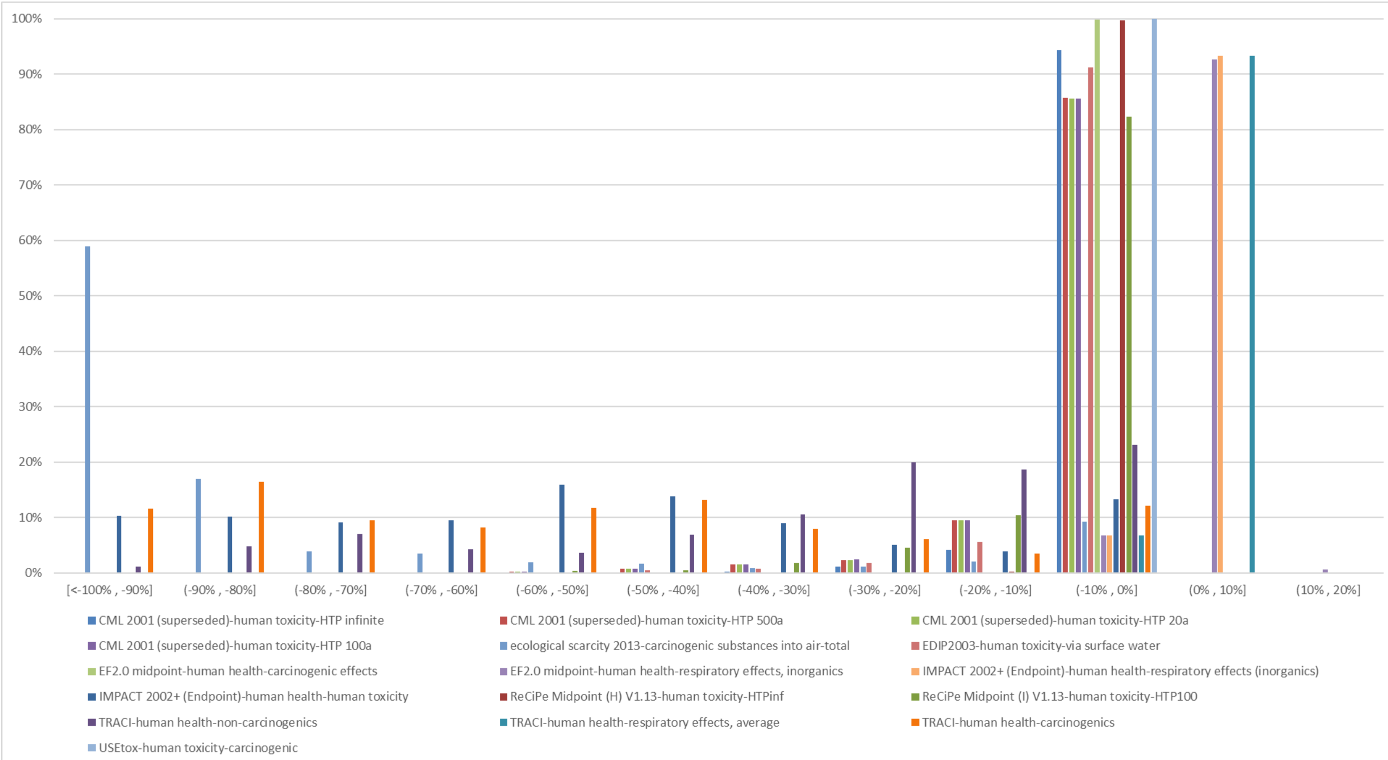
Only 57 indicators changed results between v3.7 and v3.7.1 in the cut-off system model. They all fall into one of the mentioned categories: **human toxicity, ecotoxicity or mineral resources.**

From those 57, 13 showed minor changes (under 6%) in only the “iron sinter production” datasets and are therefore not explicitly represented in the following graphs. Those are: CML 2001 (superseded)-freshwater aquatic ecotoxicity-FAETP infinite; CML 2001 (superseded)-freshwater aquatic ecotoxicity-FAETP 100a; CML 2001 (superseded)-freshwater aquatic ecotoxicity-FAETP 20a; CML 2001 (superseded)-freshwater aquatic ecotoxicity-FAETP 500a; CML 2001 (superseded)-marine sediment ecotoxicity-MSETP infinite; eco-indicator 99, (E,E) (superseded)-ecosystem quality-ecotoxicity; eco-indicator 99, (H,A) (superseded)-ecosystem quality-ecotoxicity; EDIP2003-human toxicity-via soil; EDIP2003-human toxicity-via air; ReCiPe Midpoint (E) V1.13-human toxicity-HTPinf; ReCiPe Midpoint (E) V1.13-particulate matter formation-PMFP; ReCiPe Midpoint (H) V1.13-particulate matter formation-PMFP; ReCiPe Midpoint (I) V1.13-particulate matter formation-PMFP.

Finally, 7 indicators are not represented in the graphs as they showed small changes (under 10%) in a very reduced number of datasets (under 17), and were covered by similar indicators. Those are: CML 2001 (superseded)-freshwater sediment ecotoxicity-FSETP infinite; CML 2001 (superseded)-freshwater sediment ecotoxicity-FSETP 20a; CML 2001 (superseded)-freshwater sediment ecotoxicity-FSETP 500a; CML 2001 (superseded)-freshwater sediment ecotoxicity-FSETP 100a; CML 2001 (superseded)-marine aquatic ecotoxicity-MAETP 500a; CML 2001 (superseded)-terrestrial ecotoxicity-TAETP infinite; CML 2001 (superseded)-terrestrial ecotoxicity-TAETP 500a.

The changes in results from v3.7 to v3.7.1 obtained with the remaining 37 indicators are represented in the following graphs.

The correction done in the “iron sinter production” datasets affects elementary exchanges that are important to calculate **human health** indicators (dioxins, PM). As it can be seen in Figure 1, changes in the human health category are the most visible ones in the change between v3.7 and v3.7.1, especially with the ecological scarcity method. With this method, the impacts of around 60% of the datasets in the database are reduced by more than 90% with the indicator “carcinogenic substances into air”. The correction does not drive so dramatic changes in other methods; it can be seen in Figure 1 that most of the other indicators experience changes of around a 10% reduction or increase in scores.



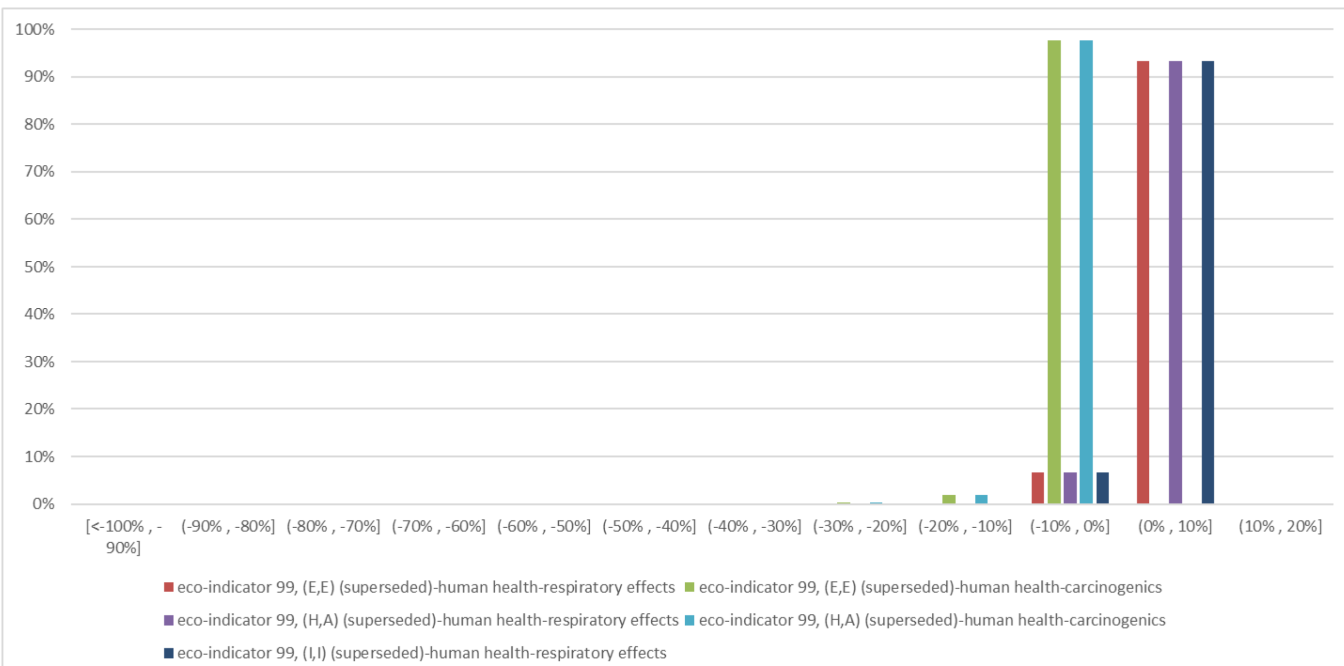




***Figure 1. Changes in results obtained for human health categories between v3.7 and v3.7.1 in the cut-off system model****. As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1 (the ecoinvent database contains more than 19'000 datasets in this system model, 10% of the database covers more than 1'900 datasets). The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*

The correction to the “iron sinter production” also drives changes in the scores calculated for **ecotoxicity** indicators when comparing v3.7 and v3.7.1 as mentioned. In this case, the changes remain more discreet. As can be seen in Figure 2, almost 100% of the datasets in the database experience a 10% decrease in the scores calculated with the indicators listed, when comparing v3.7 and v3.7.1 results.

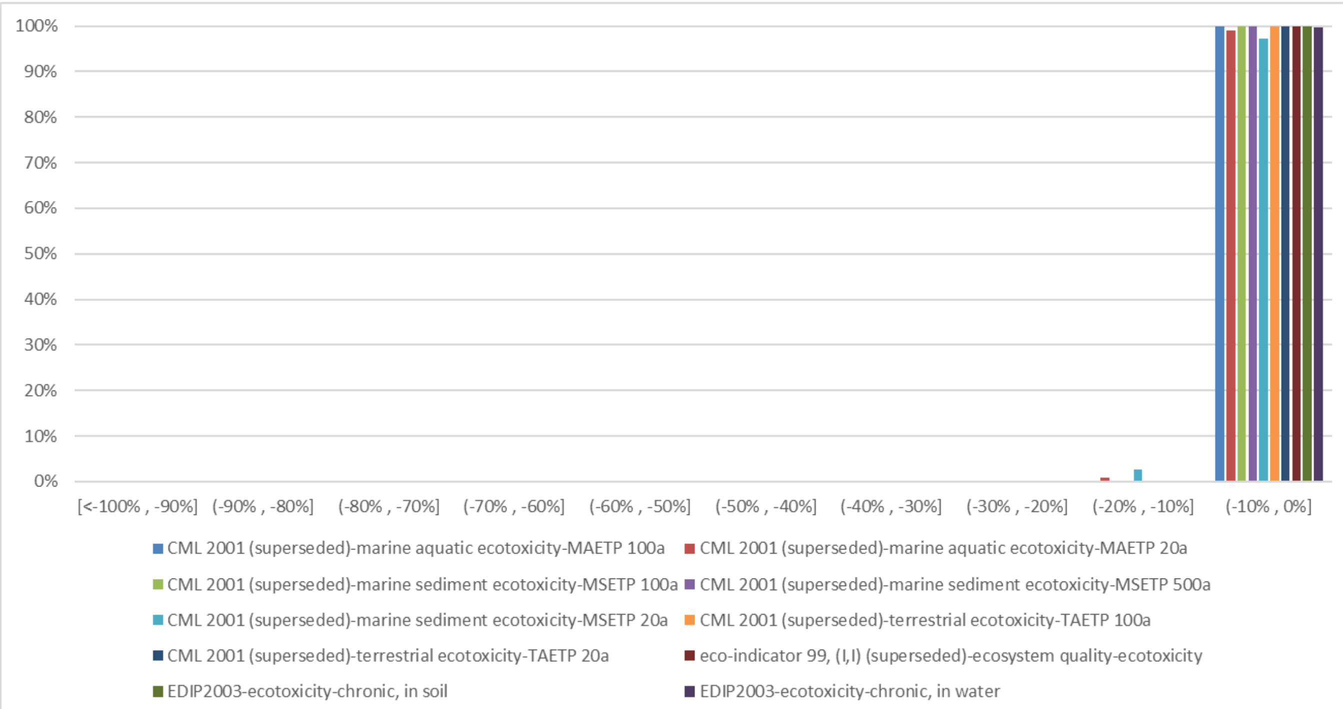



***Figure 2. Changes in results obtained for ecotoxicity categories between v3.7 and v3.7.1 in the cut-off system model.*** *As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1 (the ecoinvent database contains more than 19’000 datasets in this system model, 10% of the database covers more than 1’900 datasets). The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*

The update in the gold intake of the “zinc mine operation” dataset affects the results related to **mineral resources**. It can be seen in Figure 3 that the correction is captured differently by the different methods and indicators, but overall a big part of the database is affected by the change, in different proportions. Most of the changes point at reductions in scores between 10-40% between v3.7 and v3.7.1, although more dramatic reductions are observed with the EF2.0 method (up to 90% for 20% of the datasets in the database). With the CML method, around 95% of the database experience a reduction of maximum 10% in scores, when comparing v3.7 and v3.7.1 results.

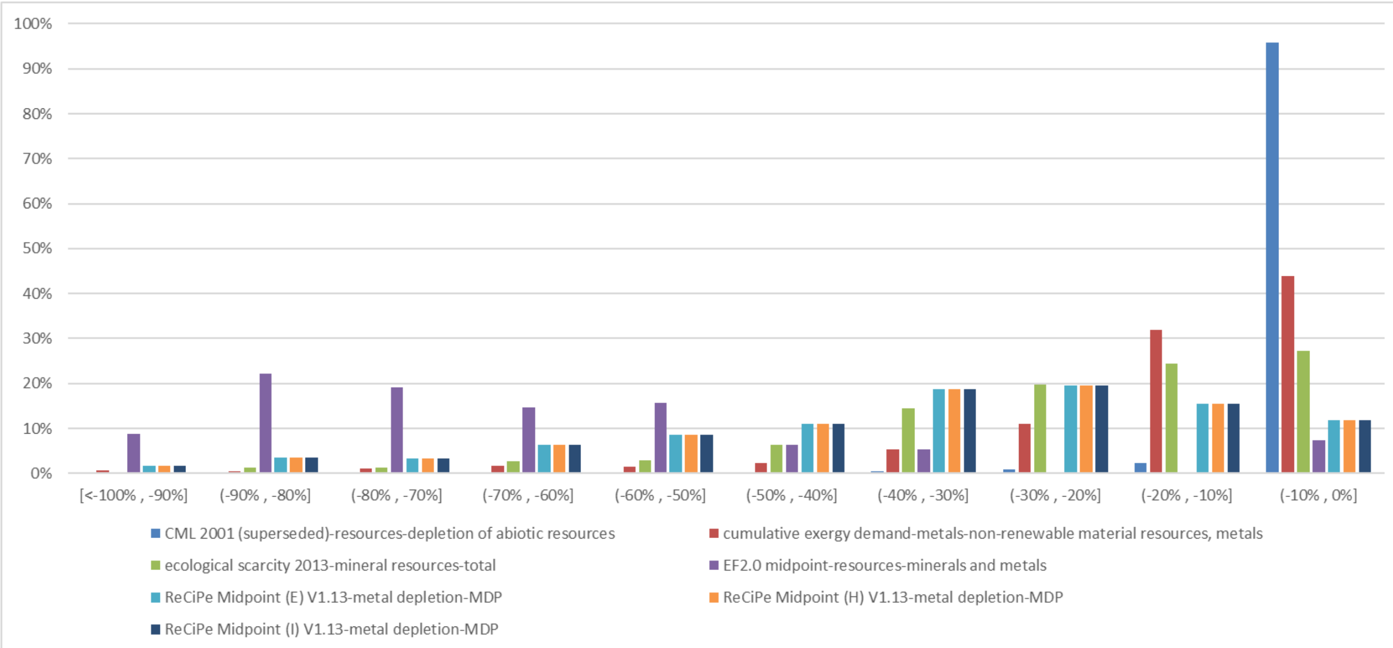



***Figure 3. Changes in results obtained for mineral resource categories between v3.7 and v3.7.1 in the cut-off system model.*** *As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1. The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*

### 2.2.2 Changes in the "allocation at the point of substitution" system model

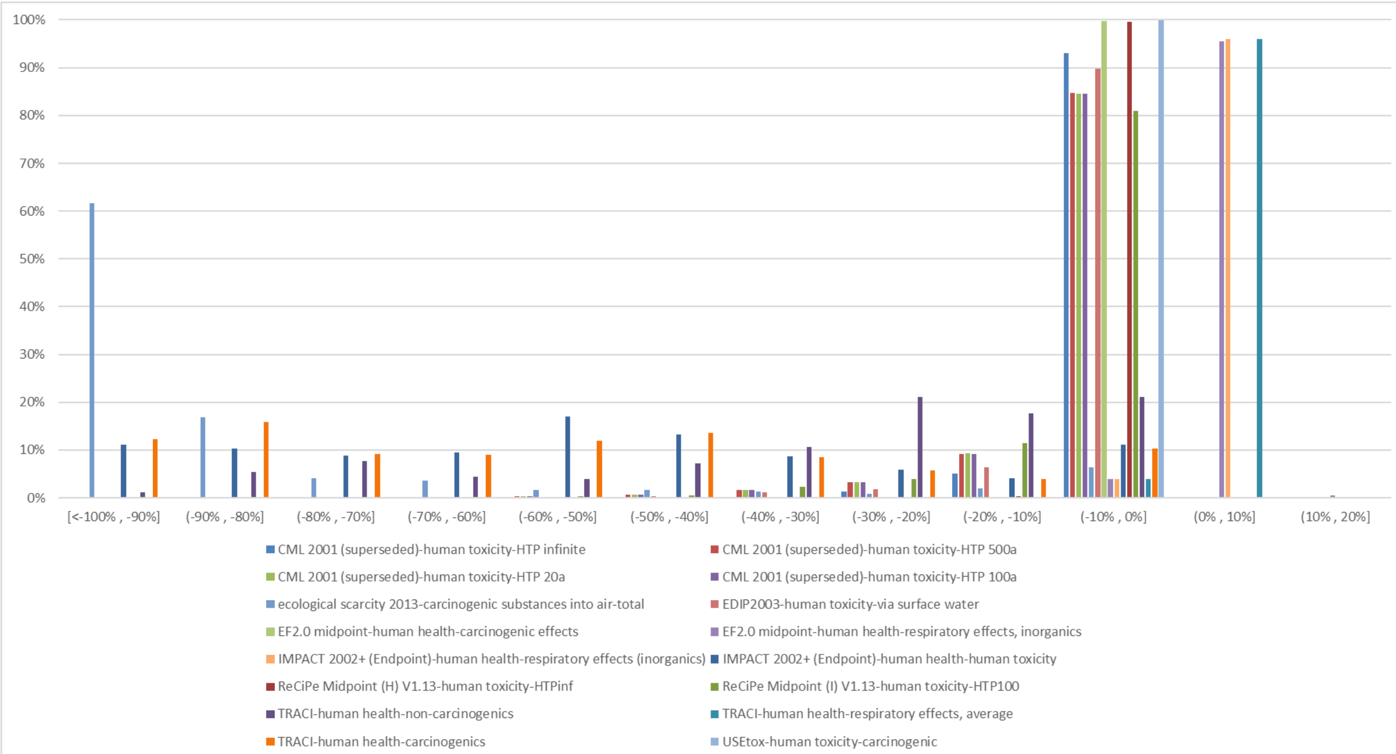
Overall, the changes in results are very similar as what is observed with the cut-off system model. In the APOS system model, changes in scores are observed in 63 indicators.

The 13 indicators that in cut off showed only changes in results of the "iron sinter production" datasets, show here changes in results to more datasets (up to 46), but still very low (under 7% change), and are again not included in the graphs. Similarly, the same 7 indicators mentioned in cut-off are not represented in the graphs as they showed small changes (under 10%) in still a reduced number of datasets and were covered by similar indicators.

The difference with cut-off comes with the results obtained in 6 indicators, where a small number of datasets (up to 9, depending on the indicators) are affected, showing very small changes in scores when comparing v3.7 and v3.7.1 (under 5%): eco-indicator 99, (E,E) (superseded)-ecosystem quality-land occupation; eco-indicator 99, (H,A) (superseded)-ecosystem quality-land occupation; eco-indicator 99, (I,I) (superseded)-ecosystem quality-land occupation; ecosystem damage potential-total-linear, land transformation; EF2.0 midpoint-climate change-climate change biogenic; IMPACT 2002+ (Endpoint)-ecosystem quality-terrestrial ecotoxicity.

Those changes are identified around the value chain for the product "iron scrap, unsorted", and reflect the way APOS results are calculated allocating impacts through the value chain. Although those indicators fall out of the categories human health, ecotoxicity or mineral resources, the change is extremely low and can be considered a consequence of APOS allocation method.

Changes are shown for the remaining 37 indicators in the following graphs, covering the categories **human health, ecotoxicity and mineral resources**. The interpretation and changes in results are extremely similar as those observed with cut-off, and can be read in section 2.2.1.



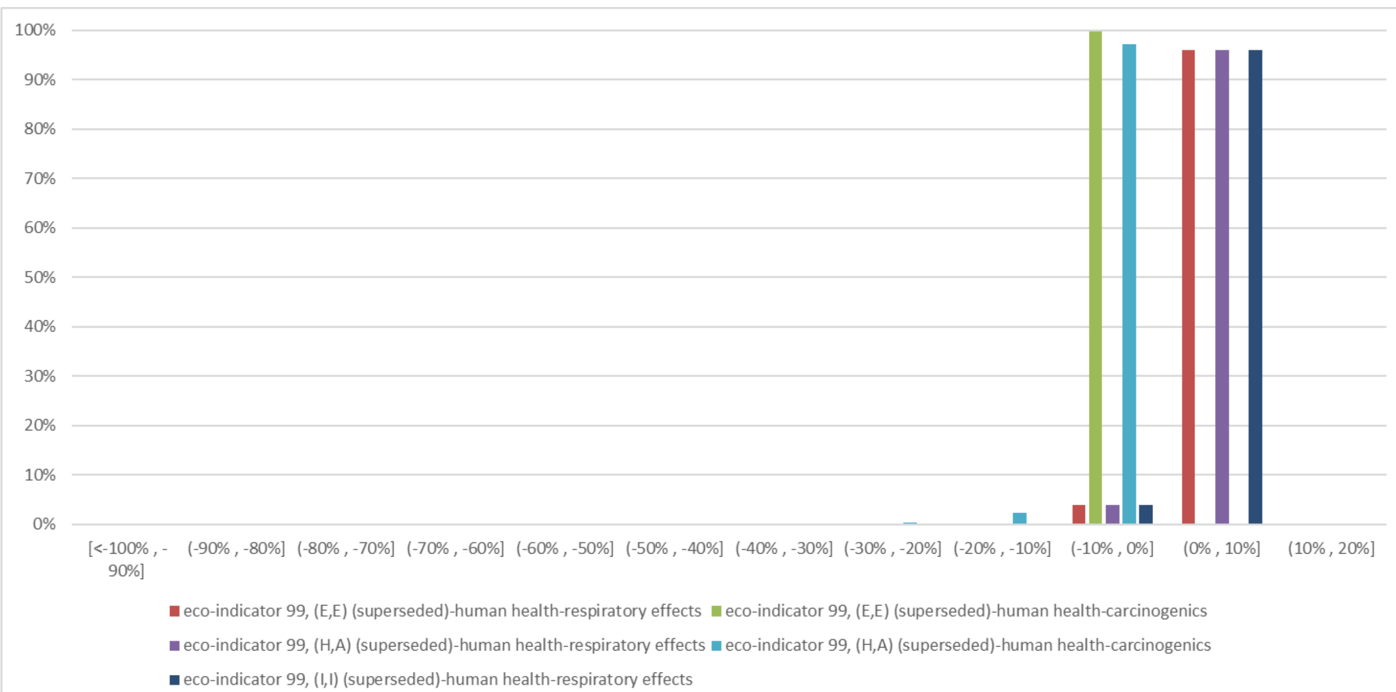




***Figure 4. Changes in results obtained for human health categories between v3.7 and v3.7.1 in the APOS system model.*** *As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1(the ecoinvent database contains more than 19'000 datasets in this system model, 10% of the database covers more than 1'900 datasets). The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*

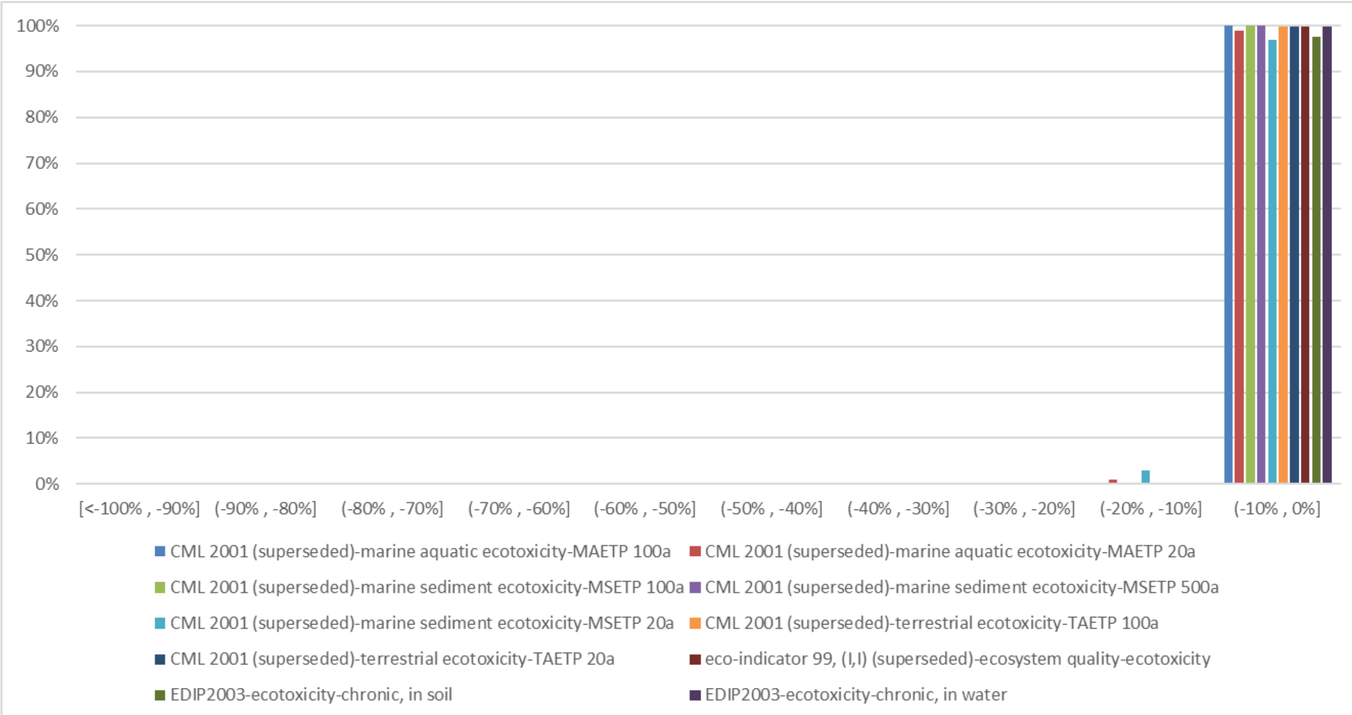



***Figure 5. Changes in results obtained for ecotoxicity categories between v3.7 and v3.7.1 in the APOS system model.*** *As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1 (the ecoinvent database contains more than 19'000 datasets in this system model, 10% of the database covers more than 1'900 datasets). The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*

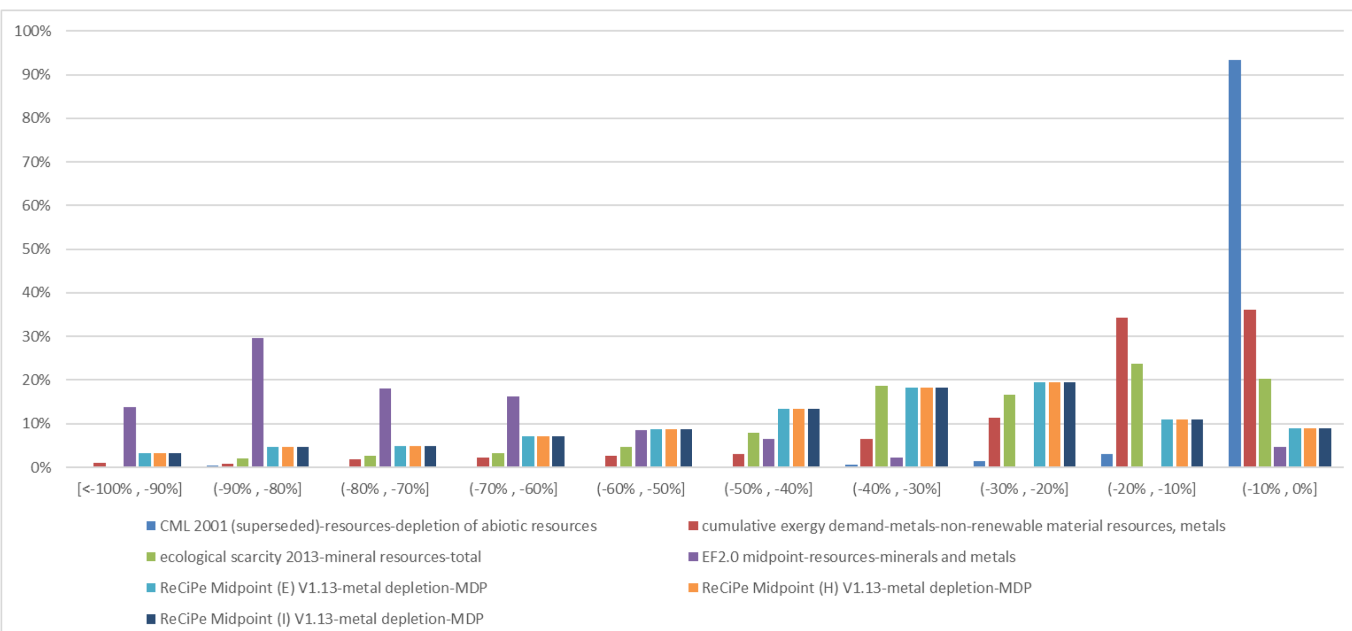



***Figure 6. Changes in results obtained for mineral resources categories between v3.7 and v3.7.1 in the APOS system model.*** *As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1 (the ecoinvent database*

*contains more than 19'000 datasets, 10% of the database covers more than 1'900 datasets). The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*

### 2.2.3 Changes in the "substitution, consequential, long-term" system model

Although the amounts of the corrected elementary exchanges have decreased from version 3.7 to 3.7.1, the LCIA scores of some datasets in the Consequential system model have increased. This is the result of substitution, whereby processes get credited with negative impact scores associated with products that are produced as by-product. As the LCIA scores generally decreased between versions 3.7 and 3.7.1, this means that the processes that are credited with negative impact scores get a smaller credit in version 3.7.1, resulting in an increase of their LCIA scores.

For two datasets, "helium, crude stockpiling" in the US and the GLO "market for helium, crude" (which is supplied by the first), the LCIA scores fluctuate greatly (in relative terms) between versions 3.7 and 3.7.1 for all indicators. This is due to numerical rounding. Based on the modelling of the US dataset for "helium, crude stockpiling", its impact scores are actually meant to be equal to 0 for all indicators, as the scores of its contributors are supposed to cancel each other out. However, due to numerical rounding, the contributions do not cancel each other out, and the resulting scores of the two datasets are never exactly 0. Although the LCIA scores are very close to 0 in both version 3.7 and 3.7.1, they have very large relative changes, therefore those relative changes are considered irrelevant for this analysis.

For some processes in the Consequential system model, the credits from avoided by-products are so large that the LCIA scores of the credited process are close to 0, or even negative. This leads in some cases to the total LCIA score of the process being quite small in spite of large contributions (both positive and negative) from the inputs from the technosphere and the elementary exchanges contained in the process. This means that even very small changes in the scores (or characterization factors) of the contributing exchanges can lead to noticeable relative changes in the total LCIA scores of the process.

In this system model, 61 indicators change for more than 4 datasets in the database, all of them under the categories **human health, ecotoxicity or metal depletion.** From those, the indicators: ReCiPe Midpoint (E) V1.13-particulate matter formation-PMFP; ReCiPe Midpoint (H) V1.13-particulate matter formation-PMFP; ReCiPe Midpoint (I) V1.13-particulate matter formation-PMFP change less than 9% for a reduced number of datasets (19), so they are not shown in the following graphs.

The remaining 58 indicators are represented in the following graphs.

The correction of "iron sinter production" datasets drives the changes in results under **human health** categories between v3.7 and v3.7.1. For consequential, similarly as in the other two system models, it is the ecological scarcity method that most dramatically reflects those changes (Figure 7). More than 60% of the database (the consequential system model contains around 17'300 datasets) experiences a reduction of more than 90% on the results obtained with the indicator "carcinogenic substances into air" between v3.7 and v3.7.1, as a consequence of the correction in the "iron sinter production" datasets. The effects of the correction are also more visible than in the attributional system models when using TRACI and IMPACT 2002+; up to 20% of the database experiences a 90% reduction in scores using those methods when comparing v3.7 and v3.7.1.

Most of the other indicators point at changes in scores of around 10% (increase or decrease) affecting between 70% and 90% of the database, due to the same correction on the "iron sinter production" datasets.

The correction to the “iron sinter production” also drives changes in the scores calculated for **ecotoxicity indicators** when comparing v3.7 and v3.7.1 as mentioned. In Figure 8 almost 100% of the datasets in the database change their scores with the mentioned indicators, in the direction of a 10% decrease or increase. Some indicators bring larger changes, but to very small parts of the database. The full details of the changes can be seen in the annex excel file “dataset score comparison, for change report (3.7 vs 3.7.1, all system models)”.

Finally, the update in the gold intake of the “zinc mine operation” dataset affects the results related to **mineral resources**. It can be seen in Figure 9 that the correction affects the results obtained with different methods and indicators to different levels, in this system model. Around 20% of the datasets in the database will have scores reduced between 30-40% in the ReCiPe and EF2 mineral resources indicators due to the update, when comparing v3.7 and v3.7.1 calculated with the consequential system model. With the EPS200 and the CML method, more than 90% of the database experience a reduction of maximum 10% in scores, when comparing v3.7 and v3.7.1 results.

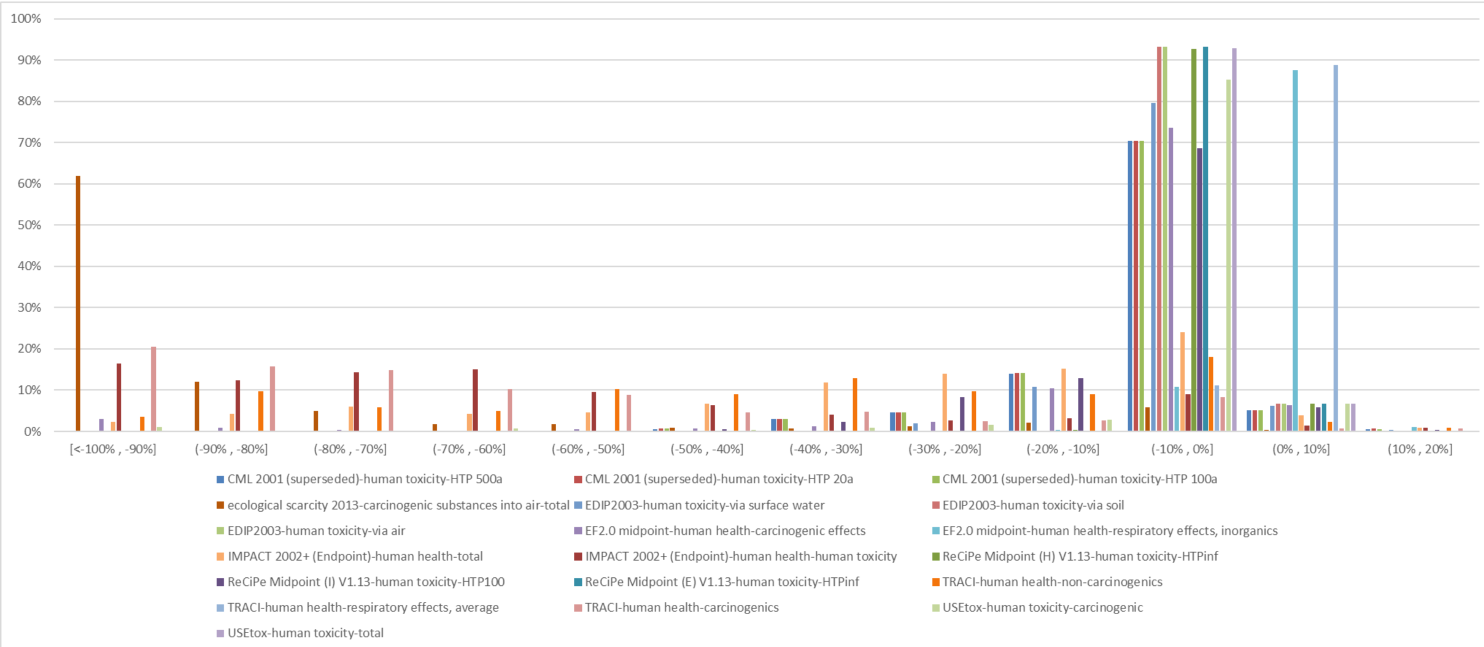




***Figure 7. Changes in results obtained for human health categories between v3.7 and v3.7.1 in the consequential system model.*** *As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1 (the ecoinvent database contains more than 17'000 datasets in this system model, 10% of the database covers more than 1'700 datasets). The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*

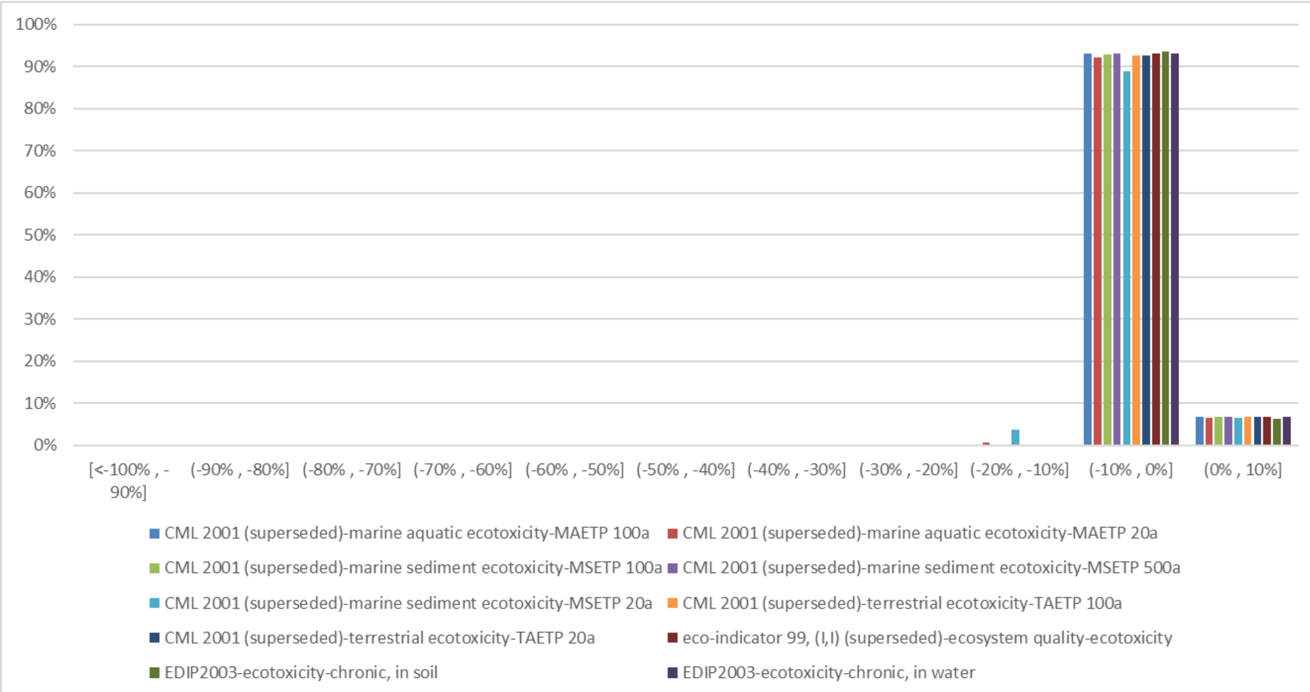




***Figure 8. Changes in results obtained for ecotoxicity categories between v3.7 and v3.7.1 in the consequential system model.*** *As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1 (the ecoinvent database contains more than 17'000 datasets in this system model, 10% of the database covers more than 1'700 datasets). The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*

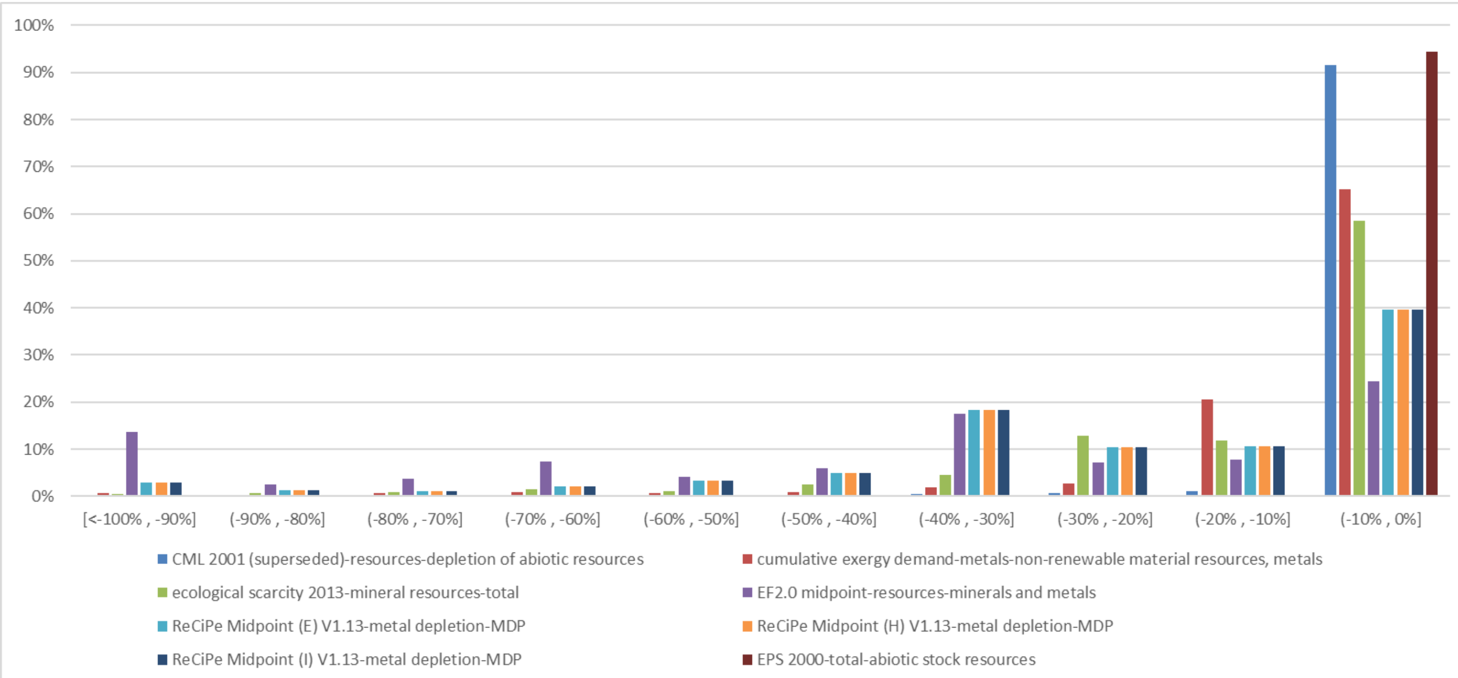



***Figure 9. Changes in results obtained for mineral resources categories between v3.7 and v3.7.1 in the consequential system model.*** *As described in the text, indicators were selected to capture the change in results under this category. The vertical axis represents the proportion of datasets affected by a change in scores between v3.7 and v3.7.1 (the ecoinvent database contains more than 17'000 datasets in this system model, 10% of the database covers more than 1'700 datasets). The horizontal axis shows the changes in scores between v3.7 and v3.7.1, grouped in intervals.*