Global Biodiversity Score (GBS) Independent Review Report

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Prepared by Solinnen for

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1 Introduction

The "Office français de la biodiversité" (OFB, French Office for Biodiversity) is a public institution dedicated to safeguarding biodiversity. One of its priorities is to respond urgently to the challenges of preserving living things. The Office français de la biodiversité is under the supervision of the French Ministry for the Ecological and Inclusive Transition and the French Ministry of Agriculture and Food. This institution is responsible for 5 complementary missions:

- Knowledge, research and expertise on species, environments and their use
- Environmental police and wildlife health police
- Support for the implementation of public policies
- Management and support for managers of natural areas
- Support for actors and civil society mobilisation

"CDC Biodiversité" has been developing the Global Biodiversity Score (GBS), a corporate biodiversity footprint assessment tool, to assess the impact of companies and investments on biodiversity at a corporate level.

CDC Biodiversité and Office français de la biodiversité agreed to have an independent review of the Global Biodiversity Score, with two goals:

- A methodological review, performed by independent scientists with international recognition in their respective fields, aiming at assessing the scientific relevance of the tool's methodology.
- A stakeholder consultation, open to various organisations working on corporate biodiversity footprints, aiming at providing feedback on the usefulness of the tool in the current context and in relationship with other existing tools.

OFB contracted Solinnen to act as the manager of the review process. Solinnen had carried out several critical reviews of life cycle assessment studies, following the ISO/TS 14071 technical specifications. Solinnen has been in charge of assisting OFB in identifying experts and stakeholder for the panels, managing the review process and aggregating the contributions of experts and stakeholder to draft this report. Solinnen has not been expert in the panels.

The present report presents the conclusions of the review process.

2 Methodological review

2.1 Description of the review process

2.1.1 Goals of the methodological review

Prior to the review project, OFB attributed the following tasks to the expert panel:

- Verifying the consistency and quality of the tool regarding:
  - Its stated goals, scope and limits,
  - The approach and assumptions supporting it,
  - Data and databases used,
  - The uncertainty and robustness of results it calculates,
  - The interpretation which can be done from the results,
  - How its results are communicated.
- Suggesting improvements to the tool.

In order to form the expert panel, OFB, CDC Biodiversité and Solinnen defined a list of expertise which would be appropriate to perform a complete review of the tool. Several types of expertise have been identified:

- Expertise on biodiversity pressures:
  - Terrestrial pressures,
  - Freshwater pressures,
  - Chemical pollution,
  - Climate change,
  - Alien invasive species (optional),
  - Marine pressures (optional).
- Sectoral expertise:
  - Agriculture, crop growing,
  - Livestock farming,
  - Mining,
  - Forestry,
  - Oil & gas.
- Environmental modelling expertise:
  - Environmentally Extended Input Output (EEIO) models and economic modelling,
  - Globio,
  - Biodiversity modelling in Life Cycle Assessment (LCA),
  - Ecosystem services,
  - Data quality,
  - Organisational Life Cycle Assessment (optional),
  - Geographical Information Systems (GIS) / spatialization (optional).

OFB planned to have an expert panel composed of 9 to 12 scientists. Expert to be invited in the panel had to meet the following criteria:

- International recognition in their field, meeting at least one required expertise.
- Complete independence from the development of the GBS tool

- Availability to perform the review according to the proposed process and schedule, on a voluntary basis, without any remuneration.

All experts joining the panel were asked to sign a declaration of independence from CDC Biodiversité. Those declarations are available upon request of any stakeholder by contacting OFB.

2.1.2 Overview of the review process

The review process was conducted from November 2019 to May 2020. Prior to this process, two months have been dedicated to the expert panel forming. The main steps of the process have been the following:

- A kick-off meeting has been held on November 20th 2019, to present the GBS tool and the work expected from them as experts. Each expert was assigned reports to review.
- Reports prepared by CDC Biodiversité were reviewed in three batches, always following the same process:
    - Reports were made available to the expert through a web platform. All experts could access any report provided by the review.
    - Expert had 2 to 3 weeks to review the reports and provide comments.
    - A videoconference was organized for expert to discuss their comments with CDC Biodiversité and clarify their comments.
- CDC Biodiversité updated their reports and answered each comment. Experts had 2 weeks to review the updated versions of the reports.
- A final expert meeting was held on April 29th 2020 to discuss remaining comments and present details of how to draft the present review report.
- Experts contributed to the review report during the month of May 2020.

At the kickoff meeting, 8 experts had agreed to join the panel. As several expertise were not well covered at this stage, additional experts have been contacted and invited to join the panel, in order to have a satisfying coverage of expertise. Three new experts joined the panel with expertise in forestry (Lian Pin Koh), crops, and livestock farming (Félix Teillard).

The assignment of tasks planned at the beginning of the review is presented in the table below. Each expert is designated by its initials. During the review, several of the experts asked to withdraw for the expert panel, without having provided any comments on the report. Those experts are designated by "E1" for "Expert 1", "E2" for "Expert 2", etc. In the table, "Main" means the expert agreed to be the main reviewer of the report, in charge of drafting the review report, "Com." means that the reviewer agreed to read and comment on the report. All experts were encouraged to read both the Core concepts and Quality assurance reports in addition to the other ones.

Table 1. Assignment of reports to be reviewed:

	Experts who participated to the kick-off meeting								Joined later		
Report	CB	E1	E2	SH	MH	E3	TK	JLP	LPK	E4	FT
Terrestrial pressures				**Main**	*Com.*	**Main**	*Com.*	*Com.*			
Aquatic pressures			**Main**	*Com.*	*Com.*						
Chemical pressures	*Com.*		*Com.*		**Main**			*Com.*			
Crops		**Main**		*Com.*		*Com.*	*Com.*			**Main**	
Metal ores	**Main**		*Com.*								
Livestock farming							*Com.*	**Main**			**Main**
Wood logs							*Com.*		**Main**		
Fossil fuels											
Input Output Modelling						*Com.*	**Main**				

This initial plan was not entirely followed during the project progress. The table below presents the number of comments actually received from the experts on each report. Due to the tight schedule and the fact that all experts had other assignments, several experts most experts commented only on the report which they were responsible for. Therefore, for 6 reports out of 10, only one expert have reviewed the report.

Table 2: Number of comments received per reports

	Commenters	Comments received	Major comments	*General*	*Methodo.*	*Technical*	*Data*	*Editorial*
Core concepts	SH, TK	8	0	*1*	*0*	*1*	*0*	*6*
Terrestrial pressures	MH, SH, TK	30	13	*2*	*16*	*2*	*3*	*7*
Aquatic pressures	MH	8	8	*3*	*5*	*0*	*0*	*0*
Chemical pressures	MH	5	5	*1*	*3*	*1*	*0*	*0*
Crops	TK	13	-	*8*	*0*	*3*	*2*	*0*
Metal ores	CB	33	16	*9*	*10*	*6*	*1*	*6*
Livestock farming	JLP, FT	43	6	*10*	*11*	*11*	*5*	*6*
Wood logs	LPK	6	6	*0*	*2*	*2*	*0*	*2*
Fossil fuels	-	-	-	-	-	-	-	-
Input Output Modelling	TK	11	-	-	-	-	-	-
Quality assurance	Reviewed by the stakeholder panel							
Total		**157**	**54**	***34***	***47***	***26***	***11***	***27***

After reviewing an updated version of the reports on the GBS methodology, the experts were asked to draft a review report. Five individual reports have been received, which are presented in § 2.2.

2.1.3 Limitations of the review process

OFB, Solinnen, and any expert from the panels cannot be held responsible of the use of their work by any third party. The expert panel conclusions have been made given the current state of the art, the information which has been received about the GBS tool as part of the review process and the time available to perform the review. These expert panel conclusions could have been different in a different context.

2.2 Individual expert reports

The following individual expert reports have been drafted after the review of the following reports:

- CDC Biodiversité. 2019. 'GBS Review: Appendix'. December 2019 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Core Concepts'. May 2020 - Final version.

- CDC Biodiversité. 2020. 'GBS Review: Crops CommoTool'. March 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Ecotoxicity Pressures on Biodiversity'. March 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Freshwater Pressures on Biodiversity'. March 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Input Output Modelling'. May 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Livestock Husbandry and Grass CommoTools'. March 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Mining CommoTool'. March 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Oil & Gas CommoTool'. February 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Quality Assurance'. March 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Terrestrial Pressures on Biodiversity'. March 2020 - Final version.
- CDC Biodiversité. 2020. 'GBS Review: Wood Logs CommoTool'. March 2020 - Final version.

2.2.1 Christopher Bryan

2.2.1.1 Short resume

Christopher Bryan, head of the Geomicrobiology and Environmental Monitoring unit at BRGM, French geological survey: His primary research interests lie in the field of biohydrometallurgy, a multidisciplinary field encompassing the biological, chemical, mineralogical and physical interactions involved in the microbially-mediated dissolution of mineral sulfides. He is interested in the microbial populations associated with mine wastes which cause acid mine drainage (AMD) and those associated with biomining operations where the biooxidation of mineral ores allows the recovery of valuable metals. The structure of these populations, the way they interact and how they can be influenced to augment or retard their actions are particularly important in terms of the bioremediation of mine-impacted environments and the development of environmentally benign biotechnologies for metal recovery. Prior to joining BRGM in 2018 he was Senior Lecturer in Sustainable Mining at the Camborne School of Mines, University of Exeter (UK).

2.2.1.2 Review report

2.2.1.2.1 Preamble

I reviewed the Mining CommoTool, given my background in sustainable mining and understanding of the mining industry. I am not an expert on the global biodiversity methodology used, and have little experience with such macro tools. Therefore, my review focused on how the tool's authors incorporated mining activities into their analyses, the assumptions made and how these could be improved.

I highlighted where global assumptions were incorrect or incomplete, suggested improvements in the comprehension of mining activities and impacts at a generalised level. The aim was not to elaborate on the minutiae as the tool operates a generalised, macro level and minor inconsistencies are probably not important.

2.2.1.2.2 General Appreciations and Limitations

The tool seeks to estimate the impact on biodiversity of mining activities. It necessarily takes a generic approach, trying to define impacts of specific resources types (e.g. coal, copper, gold etc) exploited by

different general methods (underground, open pit etc). The tool takes into account the working parts of the mine (the open pit, the processing plants etc) as well as the storage of wastes onsite. In the first version reviewed, the authors had done an admirable job of generalising mining activities and linking them to biodiversity impacts. Following the review process they had corrected many of the technical issues highlighted. The tool was, and still is, somewhat over reliant on one or two sources of information, but this will be expanded during future editions.

One of the major limitations of the tool is the lack of integration of long-term environmental risks and impacts, for example the generation of acid mine drainage from wastes and voids, and accidental releases due to sudden failures of tailings dams etc. This will be incorporated in later versions, but is currently has to be considered in the interpretation of the final results.

The tool appears to be easy to use, once basic parameters are known. It will be useful to validate the tool with time, to better calibrate the impacts on biodiversity as a function of the parameters chosen. The tool will be further refined in future versions, but is already solid so long its limitations are considered when interpreting the results.

2.2.1.2.3 Conclusion

The GBS is a very important macro-level tool, at the early stages of its lifespan. Its current version is somewhat simplistic in its assumptions and inputs, but already maps well to the mining industry in a broad sense. Such a tool is an essential step in the incorporation biodiversity into investment and decision-making. I hope it continues to improve and grow. The Mining CommoTool report was well-written, and navigates reasonably well what is a very complex topic.

2.2.2 Samantha Hill

2.2.2.1 Short resume

Samantha Hill, senior biodiversity modelling scientist at UNEP-WCMC: she designs and leads projects using empirical modelling tools to investigate anthropogenic impacts to biodiversity. Sam has a particular interest in sustainable agriculture and restoration as well as the integration of biodiversity models with scenarios to examine likely biodiversity futures. For the last eight years Sam has been involved with the PREDICTS project in a collaboration between UNEP-WCMC and the Natural History Museum in London. Prior to her work at UNEP-WCMC, Sam studied an aquatic invasive species as a post-doctoral researcher at Bristol University, worked as a consultant for Natural England and for a private consultancy, was employed in the Persistent Organic Pollutants Branch in Environment Canada, worked for a zoo, and undertook turtle conservation work abroad. Sam's research for her MSc in Environmental Biology focused on marine ecology, and her PhD investigated the conservation of a rare aquatic invertebrate.

2.2.2.2 Review report

As part of the review process, Samantha reviewed and commented two reports :

- Core concepts
- Terrestrial pressures

Samantha withdrew from the expert panel before the end of the review process, and did not draft any review report. Her detailed comments are annexed to the present report, but she did not contribute or validate the content of this report and the conclusions which are stated in it.

2.2.3 Mark Huijbregts

2.2.3.1 Short resume

Mark Huijbregts, Professor Integrated Environmental Assessment at the Department of Environmental Science of Radboud University Nijmegen, The Netherlands: Mark's research deals with the development, evaluation and application of predictive models to assess environmental impacts of multiple stressors in the context of life cycle assessment of products and risk assessment of chemicals. He integrates a combination of concepts, methods and data from various scientific disciplines, including (industrial) ecology, toxicology, statistics, mathematical modelling and environmental engineering. His main aim is to contribute to a more evidence-based way of assessing and improving the environmental performance of chemicals, products, services, and technologies in our society.

2.2.3.2 Review report

As part of the review Process, Mark reviewed and commented on four reports:

- Core concepts
- Terrestrial pressures on biodiversity
- Aquatic pressures on biodiversity
- Ecotoxicity pressure on biodiversity

Mark withdrew from the expert panel before the end of the review process, but provided conclusions in a letter that can be found as an annex to this report. Key elements are provided below:

My arguments why the GBS tool does in my opinion not meet the minimum scientific standards are the following:

(i) the method proposed is in my opinion not a footprint method, as it does not appropriately integrate biodiversity impacts over time nor does it explain why it is an advantage not to do so, except for getting the time dimension out of the unit. The key strength of any footprint method is that it integrates pressures, space and time into a limited set of environmental indicators. You can find more methodological details in many footprints handbooks, including the reports on product and organization environment footprints of the European Commission. The extra documentation that has been provided by the GBS-team explains what has been done for the time dimension and the differences between common footprinting and the new biodiversity footprint method proposed in the GBS-tool, but not why this change is needed, and why the newly proposed method is better and more intuitive for a company to be used in practice. An organizational environment footprint (OEF) represents the life cycle environmental impact that is directly and indirectly caused by the activities of that organization in a certain year, but not limited to the impacts occurring in that specific year. The GBS-tool particularly emphasizes the importance of currently occurring impacts and largely neglects in its reporting the time-integrated impacts of pressures which stay for a longer time in the environment, such as common greenhouse gas emissions, including carbon dioxide, methane and nitrous oxide. This is also shown in the example calculations provided in the new document where in the hypothetical example land use is the single important pressure in the GBS-tool reporting, while according to time-integrated impact calculations, both land use and climate change matters. My biggest concern with the new GBS-tool is therefore that the focus of companies will be on reducing pressures that have an immediate impact, but largely neglecting pressures that may have larger biodiversity impacts on the long run. This is exactly why life cycle methods aim for integration of impacts in three dimensions: pressures, space and time. The new GBS-tool fails in my opinion to address the time dimension in an appropriate way. This is also the reason why I do not agree with your statement that the GBS-tool can be used with sufficient confidence to integrate the impact of land use and climate change

pressures. The best the GBS-tool can offer at the moment is the integration of impacts of different land use types.

(ii) As the GBS-team did not have practical access to the GLOBIO model-codes for both the terrestrial and aquatic environment, the actual calculation of the MSA loss factors for all environmental pressures, except land use, is ill-defined. To calculate MSA loss factors in a scientifically valid way, individual pressures for each region-sector combination need to be excluded one by one. I very well understand this requires substantial effort and intense collaboration with the GLOBIO-team. However, as this has not been done up to know, I can only conclude that the MSA loss factors provided in the GBS-tool are not sufficiently scientific robust to use in practice with the exception of the MSA loss factors for land use.

(iii) The MSA-footprint method proposed for chemicals does not have any empirical underpinning. As far as I know, there is no single study published in the literature that quantified pressure-response relationships for chemicals in relation to MSA loss. I very well understand that practical tools cannot always wait for the 'perfect science' to be developed, but in this case the documentation for chemical impacts lacks any scientific robustness.

I do not recommend to use the tool for current use by companies, also not as a directional compass. The GBStool needs in my opinion (i) a more appropriate strategy to deal with time-integrated impacts, (ii) a better underpinned operational strategy to calculate MSA loss factors in practice for all environmental pressures, except land use, and (iii) major further scientific underpinning of the text on ecotoxicity.

2.2.4 Thomas Kastner

2.2.4.1 Short resume

Thomas Kastner, senior scientist at the Senckenberg Biodiversity and Climate Research Centre (BiK-F) in Frankfurt, Germany. Thomas' main research interest are systemic relations between biomass use, international trade, land use change and species decline; long-term changes in land use systems and in the use of land-based resources; impacts on dietary patterns on land demand and on biodiversity; the role of land use in climate-change mitigation.

2.2.4.2 Review report

As part of the review process, Thomas reviewed and commented four reports :

- Core concepts
- Terrestrial pressures on biodiversity
- Crops CommoTool
- Input-Output Modeeling

Thomas withdrew from the expert panel before the end of the review process, and did not draft any review report. His detailed comments are annexed to the present report, but he did not contribute or validate the content of this report and the conclusions which are stated in it.

2.2.5 Lian Pin Koh

2.2.5.1 Short resume

Lian Pin Koh, Professor of Conservation Science, Technology and Policy at the National University of Singapore. Koh is an applied ecologist whose notable scientific contributions include the study of species

co-extinctions and modeling the environmental impacts of industrial agriculture across the tropics. His research focuses on developing innovative science and science-based decision support tools to help reconcile society's needs with environmental protection. He addresses this challenge through field studies and experiments, computer simulations and modelling, as well as by co-opting emerging technologies for use in environmental research and applications.

2.2.5.2 Review report

As part of the review process, Lian Pin reviewed and commented the Wood logs CommoTool report. He observed that the report is largely based on the Life Cycle Assessment (LCA) approach, and declared that he does not have any technical expertise in this area, and therefore that he would only be able to review the report superficially. Lian Pin also suggested that the report should be reviewed by an expert with a good knowledge of LCA applied to forestry. His final evaluation of the report is the following:

> *The Wood logs report is generally well written. Following my suggestions, there were several improvements made in terms of the use of more appropriate data sources and the visualization of the main findings. I have no further comments on the report.*

2.2.6 Jean-Louis Peyraud

2.2.6.1 Short resume

Jean-Louis Peyraud, research director at INRA, French National Institute for Agricultural Research. His main research topics are ruminant nutrition, dairy cattle farming and the links between livestock farming and the environment. Jean-Louis acquired international renown for its works on grassland.

2.2.6.2 Review report

2.2.6.2.1 Preamble

- I reviewed and commented on the Livestock Husbandry and Grass CommoTools report.
- First of all, I indicates I was not familiar with the MSA methodology at the beginning of the project and I learned a lot and consequently my comments are general and cannot question the details of the approach.
- I am really impressed by the amount and the quality of the work provided is such a short period.

2.2.6.2.2 Livestock and biodiversity evaluation: some limits of the current tool

Livestock has ambivalent effects on biodiversity and soil quality. Its role, which can be positive or negative through local and global levels including agricultural land use and land use change mobilized locally or remotely for animal feeding and management of manures. The role of European livestock on deforestation is undisputable but in the same time livestock, especially ruminant, can have a (very) positive impact on biodiversity via the maintenance of permanent grassland and associated hedges. These effects are recognized at European scale where permanent grassland area is protected by EU and national legislations and livestock seems to be concomitant with most of the High Natural Value agricultural areas.

- This ambivalence is now well recognized in the document
- MSA cannot be higher than 1 even when species diversity is higher in grasslands than in forest corresponding to natural vegetation. It is difficult to properly takes into account these effects

and to develop a tool that can integrate performances changes in response to more adequate management. This is now expressed in the text (section 7) but could have been discussed in more details: is the forest corresponding to natural vegetation without agricultural activities the right reference?

- The tool does not consider the role of temporary grassland which are part of crop rotation although such grassland have advantages for biodiversity (number of plant species, reduced use of pesticides, etc.). The link between grassland common toll and crop common tool must be strengthened in a future version to better consider that agriculture is circular by nature (soil, crop/grassland, livestock, manure).

2.2.6.2.3 Use of the tool

- The tool is ready to be used for field testing.
- Given the high complexity, it is actually very instructive to analyze the results of the first evaluation of some great scenarios to validate the robustness / consistency of the tool.

2.2.6.2.4 Quality of the document

- The document is well written and very clear. The adopted calculation hypotheses, their limits and the possibilities of future development of the tool are clearly addressed
- Some factual errors and/or inaccuracies of the first version were now corrected. My comments were considered in detail.
- The literature is very comprehensive and up-to-date

2.2.6.2.5 Conclusion

The GBS provides an ambitious tool. The grazing Common Tool and the Livestock common toll are of good quality and ready to be used for field test.

2.2.7 Félix Teillard

2.2.7.1 Short resume

Félix Teillard, Food and Agriculture Organization of the United Nations: As a livestock production systems analyst, Félix contributes to the development of tools and methods on livestock-environment interactions, specifically the Global model for the assessment of livestock-environment interactions (GLEAM). He also provides support to the delivery of products and services in climate change mitigation and adaptation projects for the livestock sector, and coordinates activities on biodiversity within the multi-stakeholder Livestock Environmental Assessment and Performance (LEAP) partnership. Felix holds a PhD in agroecology, his thesis dealt with reconciling food production and biodiversity in farmlands, by analyzing the role of agricultural intensity and its spatial allocation.

2.2.7.2 Review report

2.2.7.2.1 Scope

I focused my review of the GBS livestock and grazing CommoTools on four main aspects detailed below.

1. Framing of the problem and livestock context. The goas was to make sure that a comprehensive and up-to-date literature review was used to set the context and to consider key aspects that differentiate livestock from other sectors.

2. Relevance, applicability and articulation with other CommoTools. The goal was to assess the readability of the report and the applicability of the tool to the specificities and wide diversity of livestock production systems. Production systems range from grassland-based to landless, for which the Crop CommoTool will play a key role in the assessment.
3. Limitations. The goal was to pinpoint limitations of the tool, to ensure that they are discussed and possibly included in future improvements.
4. Link to other initiatives. The goal was to check whether alignment or discrepancies with other initiatives were identified and discussed in the report.

I did not review in details the technical methodology (Sections 3 to 6 of the report), but I was already familiar with the MSA methodology that I had applied in the past. In addition, I was shifted from the stakeholder to the expert panel after my first set of comments.

2.2.7.2.2 Main points

1. Framing of the problem and livestock context.
   - The first version included a few factual errors that were corrected in the next versions.
   - A key specificity of the livestock sector is that under adequate management it can have neutral to positive impacts on biodiversity (e.g. in semi natural grasslands). Elements were added in the report to recognize this aspect.
2. Relevance, applicability and articulation with other CommoTools.
   - Following my comments, an example and a diagram were added to guide the user in combining CommoTools to assess different livestock production system. These were a useful addition to improve readability and tool applicability to the specificity and diversity of livestock production systems.
3. Limitations.
   - As highlighted above, livestock can benefit biodiversity in certain situations and under adequate management. MSA has a limited ability to reflect such benefits because in its initial calculations based on meta-analysis, MSA values are bounded to 1 even if, for example, higher biodiversity is found in grassland compared a forest reference corresponding to the potential natural vegetation without human activities. Therefore, reflecting benefits for biodiversity can only be achieved through the selection of a alternative reference for comparison (e.g. land use in sustainability scenario vs. business as usual). Discussion elements on this aspect were added to Section 7.
4. Link to other initiatives.
   - The UNEP Life Cycle Initiative and FAO Livestock Environmental Assessment and Performance partnership provide aligned recommendations of biodiversity characterization factors. Those have some advantages compared to MSA (species richness rather than abundance, accounting for endemism and threat status, high level of spatial differentiation) but they focus on land use impacts only unlike the CommoTool. A reference to these initiatives and methodology was added.

2.2.7.2.3 Conclusion

The GBS provides a timely and ambitious tool for the very important topic of biodiversity assessment. The livestock and grazing CommoTool report is of good quality and significant efforts were undertaken to address the comments raised in my review. Given the high level of complexity of the tool and the comments

of other experts in the panel, my suggestion would be to first release the CommoTool as a version for field testing, allowing for future adjustments and methodological improvements.

2.3 Main outcomes of the expert review

Thanks to the many comments from the expert, the general quality of the GBS methodology reports has been greatly improved. The main outcomes of the expert review are the following:

- Three reports have been reviewed following the approach that was initially planned, with detailed comments and a summary of the conclusions: Metal ore, Livestock farming, and to some extend, Wood logs.
- The Core concepts and the three reports dealing with modelling of pressures on biodiversity have been commented by three experts, but only one has provided a summary of the conclusions of those reports.
- Two reports have been commented, but no conclusions are included in this report as expert have withdrawn from the panel before the end of the process: Crops and Input Output Modelling
- Oil & gas: no scientist with the relevant expertise could participate in the defined schedule under the specific conditions of the review process.
- Quality assurance : This report has not been reviewed by the experts as part of this process. EY, who was member of the stakeholder panel, has provided comments on it which helped CDC Biodiversité to improve its content.
- No review of the tool as a whole has been performed. Modules have been reviewed individually by experts, who have not assessed how consistent were the modules interacting with each others.

All the objectives which had been set a the beginning of the project regarding the expert review have not been reached. This is especially the case regarding expertise coverage. CDC Biodiversité is committed to carry out this expert review work for future versions of the tool.

3 Stakeholder consultation

The content of this section has not been reviewed by the expert panel.

3.1 Description of the consultation process

In parallel to the expert review, several stakeholders have been invited to join a consultation process, with the aim to provide feedback on the usefulness of the GBS tool in the context of existing public policies related to corporate biodiversity footprint, and on the complementarity of the tool with other existing tools.

Three stakeholder panel meetings have been held:

- A kick-off meeting in November 2019, for presenting the GBS tool and the review process.
- An intermediary meeting in March 2020, once the first version of all reports had been published and communicated.
- A final meeting in April 2020, to answer comments and questions from stakeholders, after they had the opportunity to go through the reports.

Then, stakeholders were asked to draft a short statement regarding their perception of the tool. Those statements are presented in the following pages. Finally, CDC Biodiveristé was given the opportunity to provide a final feedback to those statement which is included at the end.

3.2 Stakeholder statements

3.2.1 Capitals Coalition

3.2.1.1.1 Global Biodiversity Score: its contribution to business and finance decision making

The Global Biodiversity Score (GBS), developed by CDC Biodiversité, is a powerful tool for businesses and financial institutions to assess their impacts on biodiversity.

This tool can lever the use of capital assessments to inform business decisions and therefore, improve management processes. This in turn will result in risk reduction and the potential to identify new business opportunities, whilst leading to a reduction in biodiversity loss and creating healthier environments, societies and economies, which are all inter-connected.

The use of the Global Biodiversity Score facilitates the systematic assessment of main drivers of biodiversity loss. The Global Biodiversity Score is a tool based in robust scientific analysis of impacts pathways that result on biodiversity loss, which is one of the most challenging impacts to be assessed. These pathways are very complex and only by using a scientifically robust and powerful assessment tool, such as the Global Biodiversity Score, can companies consistently assess their impacts on biodiversity. The tool is designed also to be used by financial institutions to assess the impact of their portfolios.

The Global Biodiversity Score builds on the Natural Capital Protocol and the Supplement for the Finance Sector providing an operational tool for businesses and financial institutions to implement the 'Measurement Stage' of the Protocol, improving their understanding of drivers and impacts on biodiversity. The Global Biodiversity Score does not assess the impacts on people's welfare from biodiversity loss, but it does helps to understand the relative loss in relation to the total stock of biodiversity.

The development of the Global Biodiversity Score has been collaborative. It used engagement with other tool developers and users from the business and finance community, scientific experts, policy makers and nature conservation organizations to reach a consensus.

3.2.1.1.2 Global Biodiversity Score: its role in the landscape of tools

The Natural Capital Protocol framework encourages comprehensive assessment to understand material impacts and dependencies on natural capital. Some of these impacts drivers result on biodiversity loss. Some other drivers also impact on people's welfare (i.e. diseases, decline of agricultural yields).

The Global Biodiversity Score is focusing only on drivers of biodiversity loss. Other tools available in the market, are covering other drivers of natural capital impacts. However, the number of drivers of biodiversity loss covered by the Global Biodiversity Score is remarkable and very exhaustive. Thus the Global Biodiversity Score is complementary to other more comprehensive tools that include impacts beyond biodiversity.

Some methodologies have been developed to value, in qualitative, physical, or monetary terms, the impacts on biodiversity. The Global Biodiversity Score is complementary to these as its results can be used as an input to assess the value of impacts on biodiversity by alternative methodologies.

The ENCORE tool, developed by UNEP-WCMC, helps business and finance community to assess dependencies on natural capital and, therefore, the Global Biodiversity Score and ENCORE tool are complementary when conducting more comprehensive natural capital assessment.

3.2.1.1.3 Global Biodiversity Score: potential future developments

The potential areas that CDC could explore to keep strengthening the Global Biodiversity Score are related to the main points mentioned above:

- Expanding the scope of the impacts to assess other natural capital impacts, besides biodiversity;
- Moving further to measure biodiversity impacts but also value them
- Exploring options for an integration process between the Global Biodiversity Score and ENCORE to provide a full assessment of natural capital impacts and dependencies.

Marta Santamaria
Policy Director
Capitals Coalition

3.2.2 Convention on Biological Diversity

Nature underpins the health of the planet and has a direct impact on human prosperity and wellbeing. It provides the ultimate foundation for economic and social development. We rely on nature for water, food and fiber, and many other services and benefits provided by healthy ecosystems.

The close dependency that economic activities have on biodiversity coupled with repeated calls made by policy makers, the conservation community and businesses to enhance accountability and transparency on biodiversity measurements has sparked increasing interest on measuring and disclosing business biodiversity performance.

The Conference of the Parties in previous decisions has invited Parties and stakeholders to take steps to increase the degree of reporting by businesses and although business disclosures of biodiversity impacts and dependencies remain limited, significant progress has been made on developing approaches to measure and address impacts that will allow increased transparency on biodiversity.

The Global Biodiversity Score focuses on the biodiversity impacts of economic activities across their value chain and can provide an overview of the company's footprint from different perspectives and different applications for businesses and financial institutions. A lot of effort has been made into analysing other tools and building interactions and synergies which is one of the strongest assets of the tool.

At the Secretariat level we have been following the developments in the GBS with enthusiasm and we are convinced that it can be an extremely useful tool to support our efforts on mainstreaming biodiversity into economic and financial sectors. In a few months Parties will come together to craft and adopt the Global Biodiversity Framework that will ignite and guide the transformation we need to safeguard the health of our planet and our future. We need to find common solutions to our problems by re-imagining business models, re-designing value chains, addressing current practices flaws and reach the right level of ambition to reverse nature loss and find sustainable alternatives for our future. GBS is proposing to address this challenge and it is very encouraging to see all progress made to date.

We look forward to continuing supporting CDC Biodiversite into its efforts to further develop, disseminate and strengthen the GBS tool in the years to come.

Bianca Brasil
Programme Manager – Business Engagement
Secretariat of the Convention on Biological Diversity
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3.2.3 European Commission

It is beyond doubt that integrating natural capital and biodiversity into business decision making requires and has to be informed by tools and measurement approaches enabling to understand the impact and dependency of business activities on nature.

As coordinator of the EU B@B platform (which is set up to share best business practice examples) with regards to the GBS developed by CDC Biodiversité I would like to stress that doing the effort of developing such a tool of measuring biodiversity impact is already in itself a best practice.

Against the background of our EU B@B platform work with focus on assessing a range of such biodiversity measurement tools for business we acknowledge that the GBS is without any doubt a method which strives to be scientifically robust on the one hand and pragmatic for business application on the other hand.

We also welcome the transparency of CDC Biodiversité in terms of publishing results of concrete applications of the GBS for different types of business applications and organizational scopes (e.g. sector, corporate, site). Further we very much welcome the constructive cooperation of CDC in the efforts of the Platform and partners to achieve more alignment on these various tools. Your, respectively CDC Biodiversité input is well informed by your concrete experience with the challenge developing a tool like the GBS and it is good that you do not stop there – thankfully your work on the GBS also helps assessing and aligning with other tools.

Therefore it is really extremely helpful and appreciated that you resp. CDC Biodiversité are contributing with the GBS in such an open and constructive way to this effort contributing to enabling integration of natural capital and biodiversity into business decision making.

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3.2.4 EY

3.2.4.1.1 Perimeter

EY's Sustainability Performance & Transformation team reviewed the Quality Assurance document of the Global Biodiversity Score (GBS) developed by CDC Biodiversity. This document describes:

- In what context Biodiversity Footprint Assessments (BFA) using the GBS will be conducted;
- A preliminary reporting framework;
- A description of how to audit a GBS Biodiversity Footprint Assessment;
- An assessment of the current coverage of the GBS.

We reviewed the Quality Assurance document (version March 2020). Our review was desk-based and included group interviews with CDC Biodiversity. Our review did not cover the methodology documents nor the calculation tool.

3.2.4.1.2 Work done by EY

The purpose of our work was to evaluate whether the Quality Assurance document can be used as a reporting framework in a context where an organization calculates its GBS and wishes to have it reviewed by an external reviewer or an auditor. We assessed whether the information in the document was complete, clear, neutral and reliable.

We provided feedback on how to structure the review process and to improve the precision of the scope of the review. Our suggestions were accounted for in the March 2020 version of the document.

The information included in this preliminary framework shows that CDC Biodiversity understands what the Quality Assurance document should include in order to be used as a reporting framework.

3.2.4.1.3 Areas of improvements

- Improve the clarity of the key principles' definition;
- Provide clear data inputs hierarchy;
- Provide sectoral benchmarks listing the most material pressures and orders of magnitude of the values expected;
- Test the reporting framework on real GBS Biodiversity Footprint Assessments.

For more information please contact: Alice Sireyjol (alice.sireyjol@fr.ey.com) or Carter Ingram (Jane.Ingram@ey.com)

3.2.5 Finance for Tomorrow

Finance for Tomorrow considers that CDC Biodiversity, with the Global Biodiversity Score, is providing a key tool to support financial and economic actors in the development of effective environmental strategies. The main strengths of the tool are its broad scope and its practical use. It has been developed directly with its potential users and is fit-for-purpose. It could be particularly relevant in the framework of the European Taxonomy of sustainable economic activities, notably to cover the environmental objective "Protection and restoration of biodiversity and ecosystems".

The GBS tool is a comprehensive indicator that allows for comparability among a large scope of economic sectors and geographic regions in the world. On the one hand, the GLOBIO model was chosen especially for the volume of pressures covered and the information it provides on "cause-effect relationship". On the other hand, the use of the MSA/km2 indicator is aiming to standardize the measure of impact on biodiversity. In addition, the Global Biodiversity Score is designed to integrate impacts over a "Scope 3" in an integrated approach covering the whole value chains of economic actors. Moreover, the GBS tool is calibrated to integrate a dynamic vision of impacts, with future provisions. It enables a long-term perspective on business activities and investment. This set of features is key for investors and asset owners with diversified portfolios, as identified by Finance for Tomorrow with its members in a dedicated workstream "Capital natural and Biodiversity".

Financial actors are looking for a fit-for-purpose, practical tool to help them in decision-making processes. CDC Biodiversity understood this requirement and developed the GBS tool directly with its potential users. This is most noticeable in the software interface design and accessibility. More specifically, one of the features of the tool that stands out is the possibility to create coherent outputs with different volumes of available data. As such, inputs can come from public sources, allowing to formulate hypotheses, but also to consider existing best practices, based on direct data from companies. Considering best practices is an absolute necessity to encourage the concrete transformation of corporate strategies over the long-term. This flexibility enables both to cover the diversity of financial portfolios and to deep dive into assets values with the needed level of granularity.

The structure of the GBS tool is coherent with the design of the European Taxonomy of sustainable economic activities. First, the GBS tool provides numerical information that can be used in the analysis of the "alignment" of an economic activity. As a reminder, the taxonomy is a list of economic activities that contribute substantially to at least one of six environmental objectives, based on performance thresholds and/or processes for risk management defined for each economic activity. Moreover, the GBS tool will rely on the analysis of turnover, as well as inventories. This enables to divides activities as sources of revenues, considering geographic regions. Finally, the Global Biodiversity Score integrates environmental safeguards in its analysis, as a complementary qualitative approach to ensure low impacts. This reasoning fits with the requirements analysis process in the Taxonomy, for the "Do not significantly harm" principle and the "minimum social safeguards".

The tool could benefit further development concerning environmental tipping points and capital expenditures. Firstly, to analyze tipping points in terms of environmental risks, the tool would need to use more precise data from each company, in coherence with the "biodiversity protocol". This could constitute

a key information for decision-makers. Secondly, the analysis of capital expenditures could prove useful, for example in project development or in the context of infrastructure investing.

To conclude, Finance for Tomorrow welcomes the Global Biodiversity Score as a fit-for-purpose tool that should be part of the set of sustainable best practices in the financial sector. The overall process to better understand how to protect biodiversity and to pilot the transformation of industries and their value chains is accelerating. It will require pioneer metrics, trials and errors, and a diversity of partnerships. The Global Biodiversity Score will be a significant element in this dynamic, leveraging with great efficiency on data and transparency.

Finance for Tomorrow is the branch of Paris EUROPLACE launched in June 2017, to make green and sustainable finance a key driving force in the development of the Paris Financial Centre and to position it as a hub of reference on these issues. Members of Finance for Tomorrow are signatories of a common charter to contribute to the transformation of practices in the Paris Financial Centre and to a global shift of financial flows towards a low carbon and inclusive economy, in line with the Paris Agreement and the UN Sustainable Development Goals.

Natacha BORIC
Project Manager
Finance for Tomorrow

3.2.6 World Wildlife Fund

Usefulness of the GBS in the context of existing public policies related to corporate biodiversity footprint

The GBS can be used by companies to assess the biodiversity footprint of their operations. This assessment of the private sector's biodiversity footprint, while not yet subject to any regulatory requirements, is encouraged by many stakeholders and by many voluntary instruments.

The GBS has several advantages in terms of measuring the biodiversity footprint of businesses, in particular: it covers pressures across a large part of the business value chain (particularly the scope 3, which concentrates a significant proportion of pressures for certain key sectors), and it integrates several types of pressures on biodiversity. The metric used, the MSA, is also interesting since it captures changes in ordinary biodiversity based on both specific abundance and richness.

The GBS could thus enable a company to monitor and steer the achievement of "zero net biodiversity loss" type objectives, and so to be aligned with certain ambitious public policies.

Complementarity of the GBS with other existing tools

The GBS is compatible with various instruments commonly used by companies to measure and monitor their environmental impacts, such as environmental management systems and non-financial reporting standards.

It also seems that the GBS could be developed in the future to be compatible with tools oriented towards strong sustainability and the conservation of critical natural capital, including tools designed to set ecological targets aligned with the best scientific knowledge.

Important aspects that are not currently covered by the GBS

Some Important limitations of GBS are linked to the GLOBIO model on which the tool is based.

In particular, GLOBIO does not take into account certain pressures on biodiversity (invasive species, overexploitation of resources), and does not integrate the impacts on marine biodiversity.

Above all, the GLOBIO model was designed with prediction in mind, so as to compare different global development scenarios. While this may be of interest to companies from an investment choice perspective, the disadvantage is that GLOBIO does not represent the actual state of biodiversity but a modelled version - potentially far from reality - and which may lead to significant uncertainties in the GBS footprint measurement. It would be interesting, for the further development of the GBS, to look for alternatives to

the GLOBIO model, or to promote the development of an innovative spatialized model, which reports on the real state of ecosystems at regular intervals.

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3.3 Outcomes of the stakeholder consultation

This section has been drafted by CDC Biodiversité.

We would like to thank all the members of the stakeholder panel, who provided very valuable feedback. This feedback helps us to continue to steer the tools in a direction which meets the needs of users (corporates and financial institutions), in particular the need to pilot their biodiversity strategy and measure how they will be able contribute to the achievement of the future post-2020 global biodiversity framework.

As noted by the Capitals Coalition, the GBS covers the Measurement stage of the Natural Capital Protocol (NCP) and focuses on biodiversity. The GBS should thus be used in conjunction with other tools assessing the other types of natural capitals such as water or soil. The outputs of the GBS, namely biodiversity impacts, can be used in the "Value impacts and/or dependencies" step of the NCP. CDC Biodiversité will seek to facilitate such integration into broader natural capital assessments and linkages with the valuation step. The GBS focuses on impacts on biodiversity, and not on dependencies. In June 2020, we completed preliminary work on the integration of data from ENCORE with sectoral data from EXIOBASE. We will integrate guidelines on how to integrate a qualitative valuation of dependencies based on sectoral data in Biodiversity Footprint Assessments (BFA) conducted using the GBS, and will continue to monitor development in this field to include the best data and methods available.

The Biological Diversity Protocol (BD Protocol) provides useful guidance on how to account for impacts at the level of each ecosystem asset within the assessment perimeter (in particular for Scope 1). Applying the BD Protocol to BFA conducted with the GBS could help identify when companies are breaking local "tipping points" and going beyond the safe operating zone (assessed globally to be below 72% MSA).

We would like to clarify two issues listed by stakeholders. First, the direct exploitation of resources as defined by the IPBES is partly covered as explained in the terrestrial and aquatic review documents: the impacts of extraction of living biomass (crops, wood logs) and non-living materials (metal ores, fossil fuels) and the impacts of over-withdrawal of water beyond the capacity of natural ecosystems are taken into account. Second, the weaknesses of the GLOBIO-IMAGE scenario have no influence on assessments conducted using directly pressure data (*e.g.* on land use change). However, replacing the GLOBIO-IMAGE scenario by – for example – satellite monitoring of land use changes, actual pollution or hydrological disturbance data, while keeping the GLOBIO cause-effect relationships, is a key priority for CDC Biodiversité, as it would indeed benefit assessments conducted without direct pressure data.

We plan to take into account all the improvements suggested by stakeholders in the coming months or years, to the best of our capacity:

- Detail the reporting framework to facilitate audits of BFA, by improving the clarity of the key principles' definition and providing clear data inputs hierarchy;

- Provide sectoral benchmarks listing the most material pressures and orders of magnitude of the values expected: this work is ongoing and a benchmark for the Manufacture of electric equipment industry is under consultation with industry stakeholders;
- Explore how to use capital expenditures (instead of turnover) as financial inputs in the GBS, to better assess project and infrastructure finance.

In July 2020, we will have completed the first full scale BFA with the GBS. By the end of the year, and in 2021, we will keep testing the reporting framework described in our Quality assurance review document BFA. CDC Biodiversité also hopes to conduct a second phase of the review of the GBS, to review new developments and reinforce the existing review.

Annex I: detailed comments from the experts on the reports

Core concepts report

Reviewer	Comment index	Line number	ref to specific item	Comment (Core concepts)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
SH	1	52		The text dives straight into why species extinction risk has not selected as the focus. You seem to assume that readers would suppose that you should be using species extinction risk.	Ge.		Include outline of metrics in common use	A brief mention of the different metrics in use (and link to Mace et al. 2018 for instance) will be added in the introduction.
SH	2	109	Table 1	Please provide references for these data sources.	Ed.			References and links for each data source in the table will be added.
SH	3	109	Table 1	Does LCA belong here? I don't think LCA is a data source..	Ed.			Yes we were probably not rigorous enough in our wording. We mean Life Cycle Inventory data, e.g. from the ecoinvent database or from the Product Environmental Footprint database, together with LCA-methods such as ReCiPe which contains impact factors. More generally, the table will be split between impact factors and data.
SH	4	109	Table 1	I think the LBII is perhaps easier to understand for non-experts than MSA as people can understand what intactness is, but few know how MSA differs from total abundance. Likewise, LBII contains ordinary biodiversity. I think the reason that GLOBIO is preferred in this case over LBII is that it has a greater ability to account for pressure/response due to greater range of pressures included. Same with Ecological Footprint - not as many pressures included. Maybe have a new row for variety of drivers quantified?	Ed.			The name of LBII might be easier to understand but otherwise, from our understanding, LBII and MSA are mathematically the same, except that LBII is not capped at 100%. So you're right that the ease of understanding is indeed the same. This will be corrected in the table. Good point for the number of pressures considered. A row will be added.
SH	5	112	Table 1	Maybe add a row to Table 1 regarding CBD and IPBES use	Ed.			Row will be added.
SH	6	136		A^degraded does not appear in the MSA formula	Ed.			Adegraded replaced by Aobserved in the caption.
SH	7	139		Capping the ratio at one means that perfectly natural increases in abundance are not accounted for. For instance, a recovering forest will have a greater abundance of tree species as saplings take up less room than mature trees. You are assuming a causal relationship between a species that has increased abundance beyond that of pristine and other species in the community that have decreased abundances but this does not necessarily follow. Movement away from one, but allowing ratios to go over one, would perhaps be a more honest way of calculating.	Ed.		Please remove sentence or clarify.	We will clarify the sentence. We were meaning that if ungulates increase in population but overgraze plants, reducing the abundance of plants species, mathematically, the MSA will decrease (because the abundance of ungulate will be capped at 100% in the calculation). But in your example where saplings go beyond 100% without negatively impacting other species, then MSA would not decrease. In this sentence, we do not take sides on whether it is best to cap abundance at 100% as the PBL does (and thus as the GBS does) or not.

Reviewer	Comment index	Line number	ref to specific item	Comment (Core concepts)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	8	156		From the intro document: "Interpreting a loss of x MSA.km2 as the conversion of x km² of undisturbed ecosystem into a completely artificialized one has obvious advantages for communication." I find the MSA km2 metric not very clear. Is that actually MSA loss per km²? or km² where is MSA is lost or occurring? This should be made clearer and unified throughout. - The example on Page 8 (Figure 3) of the intro document shows also a conceptual problem: by expressing the value as area of complete loss of native species, the actual impact becomes obscured: e.g. consider and area of about 544 000 km² that exhibit and MSA loss of 10%. This will result in a value of 54 400 MSA km² in your approach. An area of this size with complete will pose very different conservation challenges than a 10 times larger are with a reduction of only 10%. From the final GBS number there is no way of telling which situation the impacts are closer to.	Te.		Maybe the number can be augmented with some info on the distribution of the relative loss and the total area affected (which moves away from the "one-number" approach of course), but at least this should be discussed made clearer to the users.	Lines 147 and 148 are quite explicit "Through the spatial integration of MSA % over a surface area, it can be expressed as MSA.km². The latter is the product of MSA multiplied by the area to which it applies (expressed in km²).": MSA.km² is a spatially integrated MSA (i.e. roughly multiplication by the area), not MSA per km². We will pay attention if other sections seem to say otherwise, but we believe it is already quite clear throughout. Regarding the 10% over 544 000 km² or 100% over 54 400 km², yes that is exactly right, we cannot know from the final figures. That is the same for a GDP figure or a total GHG emissions figure: you cannot tell from one single figure what is the breakdown of economic activity or emissions by industry, by company, by site. However, just like each company can calculate its value added and break it down by business unit, a company will be able to assess its biodiversity footprint for each component where it has data (potentially site by site) so it should know whether it's 10% over 544 000 km² or 100% over 54 400 km². We will briefly mention that we suggest to report figures in line with the Biological Diversity Protocol, which request reporting by ecosystem asset. Following the Protocol, the area affected and the associated loss for each specific area would be known, as you request.

Terrestrial pressures on biodiversity

Reviewer	Comment index	Line number	ref to specific item	Comment (Terrestrial pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	1	114		The MSA values reported in Table 1 are outdated. Schipper et al (2019) provides updated MSA values for land use and other stressors for warm-blooded vertebrates and plants separately. Alternative is the paper from Marquardt et al. (2019) which provides updated generic MSA factors for land use.	Da.	Yes	Use the most updated MSA values of a specific land use activity in the calculations and keep warm-blooded vertebrates and plants separate in the calculations	We update our values to Marquardt et al. (2019) following your advice. GLOBIO 4's data were released only in November 2019 after the review had started and we have not yet been able to access to the detailed projection data up to 2050 which we have accessed for GLOBIO GBO4 version. It means that we have not yet been able to integrate GLOBIO 4 but this data update is considered for the GBS next version.

Reviewer	Comment index	Line number	ref to specific item	Comment (Terrestrial pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	2	129		I do not understand why and how the Global Land Cover 2000 129 (GLC2000) map was used as a starting point. Starting point for what exactly? Why is the land use information from Exiobase or provided by Wilting et al in his EST-paper not used in the calculations? This land use information is already divided between the different sectors	Me.	Yes	Apply land use information that is already connected to MRIO sectors	GLC2000 is used by the PBL in GLOBIO3 as a reference for land use type classes and as starting point for land use occupation. We will clarify in the report that GLC2000 reference is PBL's and not ours. Using directly land use from EEMRIO is problematic for various reasons. First the EEMRIO land use data is available only at an industry level not at a commodity level which means we would anyway need to assess the land use of commodities on top of the EEMRIO data to conduct refined assessment based on commodity production or purchase from businesses. And it would then make sense to always use the impact factors per tonne to be coherent and homogenous. Secondly, land use data in EXIOBASE is partial, with many industries not covered, meaning land use field left blank, in particular for mining and oil & gas extraction, but also for all factories, and offices (see table S6-1 in EXIOBASE supplementary information). For all those reasons it appeared to us more consistent not to use land use data from EXIOBASE and instead derive land use values from EXIOBASE commodities inventories using our in-house commodity tools. We have conducted analyses to compare our land use figures to EXIOBASE for crops. We plan to expand this comparison to our other commodities
MH	3	157		The dynamic calculation of land use impacts as presented in the equation and related text is in my opinion not recommended to implement. It basically indicates that going from extensive to intensive agricultural land causes less impact as going from natural forest to intensive agricultural land. According to the logic from MSA, the reference is always the natural land. This means that a certainty activity prevents going back to the natural state. If you reward using land from existing anthropogenic activities, indirect land use change is a real danger that may happen and is not accounted for.	Ge.	Yes	Use the MSA of a specific land use activity as such in the calculations	We agree with the risk you mention. That is why we monitor two values, dynamic land use impact which is the cost of the conversion and static land use impact which is the loss relatively to the pristine reference. Converting natural area into intensive agriculture will result in a higher conversion cost (dynamic) than converting extensive to intensive, but the resulting land use will have the same static impact (100% - 10%). We always report both the dynamic and the static impacts to prevent the risk you mention.
MH	5	650		The nitrogen deposition response relationship is updated, as reported in Schipper et al. (2019)	Da.	Yes	Use the most updated MSA response relationship for nitrogen deposition	We can use the updated response relationship for the refined assessment in the case where we know the amount of nitrogen deposition (probably very rare). Otherwise for the same time constrain reason, we didn't integrate GLOBIO's last version data and we are considering to do it in the next GBS version.
MH	6	687		It is incorrect to use the CML eutrophication potential expressed in kg PO4 equivalent to combine impacts on eutrophication. Only nitrogen emissions (in N deposition equivalents) can be assessed with the globio response curves	Me.	Yes	Do not apply the CML conversion factors for eutrophication	We will switch to N weight equivalent. To be clear, by N equivalent we mean using molar masses of a molecule's atoms to evaluate the relative weight of N in the molecule. For instance for 1kg of NH3 is worth 14/17 = 0,82 kg of N-equivalent.
MH	7	689		N2O does not contribute to eutrophication	Me.	Yes	Remove N2O from the eutrophication list	We will remove N2O

Reviewer	Comment index	Line number	ref to specific item	Comment (Terrestrial pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	8	787		The grid allocation of the impact of nitrogen deposition to the emissions is not valid, as N emissions, particularly NOx emissions, can travel far away from the emitting grid cell.	Me.	Yes	Calculate 1 generic MSA impact factor for N emissions (unit MSAloss.km2.yr/kg) by summing the MSAloss of N deposition over all the grids (as MSAloss.km2) and divide this grand total by the total N emissions in a specific year worldwide (as kg N/year). This impact factor can be multiplied with the sector specific emissions to derive the MSAloss due to nitrogen emissions for each sector-region combination	We switch to a global intensity as suggested. For the GBS next version, we are planning to cooperate with the PBL in order to have access to the core of the model and in particular to the fate models for N emissions. This way we should be able to properly evaluate spatially dependent impact factors for N deposition pressure.
MH	9	841		The climate change response relationships are updated, as reported in Schipper et al. (2019)	Da.	Yes	Use the most updated MSA response relationship for climate change	Same as for land use and nitrogen, we are considering introducing it in GBS next version.
MH	10			It is not clear to me from the report whether impacts of land use nitrogen deposition and climate change are summed. Summation is in my opinion only possible for time integrated impacts, so with 'year' in the unit	Me.	Yes	Keep impacts of land use, nitrogen deposition and climate change separated. Alternative is to integrate the impacts of these three drivers, but only if the time-integrated impact of these drivers is quantified	Time integration position will be clarified in the Introduction review document.
TK	11	92		Very unclear what land use data were actually used and how. Reference to IMAGE scenarios is made. What time frame? Where available? What resolution in terms of land use types? What bias do the scenario data introduce? Have you considered using e.g. ESA Land Cover data?	Te.			GLC2000 is used by the PBL in GLOBIO3 as a reference for land use type classes and as starting point for land use occupation. The PBL models land use trends from 2010 to 2050 with the GLOBIO and IMAGE models. We will clarify in the report that GLC2000 reference is PBL's and not ours. The reasons why we use GLOBIO-IMAGE outputs is explained on lines 83-104 and 126-128. Basically, we need measurement of land use and not land cover: land use is the combination of a land cover (forest, agriculture, grassland…) and a management intensity (intensive, extensive, …). ESA-CCI provides only land cover data but not land use data, and so cannot currently be used. Yearly data are also not available so making rough assumptions on management intensity would not provide significant gains. Regarding GLOBIO-IMAGE output, the resolution of land use is the one listed in figure 2. Using GLOBIO-IMAGE land use projections introduce significant bias, especially in some regions where land use trends seem to be incorrectly forecast by GLOBIO-IMAGE. These limitations are detailed on lines 497-516.

Reviewer	Comment index	Line number	ref to specific item	Comment (Terrestrial pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	12	114		Figure2: are the presented MSA values constant at the global level? Would it not be expected that they differ depending on location and intensity of use? How is uncertainties communicated in the results?	Te.			In GLOBIO GBO4 version, MSA% does not depend on the biome or climate for a given land use type. This is a limitation of the GLOBIO model due mostly to the lack of literature available. Doing its metanalysis, the PBL was not able to collect enough articles to be able to differentiate land use types in different biomes. This limitation will persist with the potential update to GLOBIO4 data (or, more precisely, the PBL found no significant effect of biomes on land use impacts). Intensity is considered in GLOBIO land use types with 4 intensity levels for agriculture and 4 as well for forestry. For uncertainties we present how we qualify data quality in the quality assurance report and a more in-depth analysis is planned to properly qualify and quantify uncertainties at the different steps of the methodology in future versions.
TK	13	97		general: not always clear what kind of data companies should provide to improve the quality of the assessments. E.g. how realistic is it that companies have land use data? Also you call Tier 5 "direct measurement". Direct measurements of what? Would that really improve results at such a coarse model level? You would still need theoretical models for the attribution of changes				At the moment, land use data from companies are partial but improving, especially for Scope 1. That's why the GBS tool was designed to integrate various types of data with different level of accuracies. Please refer to the Introduction review document for a more detailed explanation on data collection's concept and quality tiers. The idea at the end is for companies to report a footprint associated to a data quality description. In any case, considering actual data availability and methodology uncertainties, at the moment GBS allows companies to have a global picture of their biodiversity impacts and identify high risk parts of their businesses. The “direct measurement” mentioned here is different from the “direct measurement” data quality tier 5 which is about biodiversity state data. The direct measurement mentioned line 98 is direct measurement of land use change inside the geographical perimeter under a company’s control (its Scope 1; so no need for theoretical attribution: 100% is attributed to the company) through satellite data for instance. Pressure-impact relationship would still need to be applied to assess the impact of land use on biodiversity, but measuring directly the land use change is more accurate than modelling as we currently do in the default approach.
SH	14	114	Figure 2	I find it confusing that some land uses are defined by past use and some by present. For instance, forest_harvest, this was clear cut and is now recovering. The MSA value shows 50% impact. Does this 50% never change? I would have expected that right after clear cut the number would be lower, but after many years of recovery the impact would be much reduced. And of your static vs dynamic impacts, where would forest_harvest fall? And do ongoing plantations (i.e. an actively managed plantation with minimal recovery of natural vegetation) fit into agriculture?	Me.	Yes		Clear cut has to be understood as a type of forestry management here, not a punctual action, i.e. over a period of 50 years, when the trees are cut, they are cut through clear-cutting and not selective logging. GLOBIO model does not intend to capture the various phases of a harvested forest. Even though biodiversity level varies over time, it is assumed that in average over time, MSA% is equal to 50%. If land use type does not change, dynamic impact equals 0 and static impact is constant and equal to the difference with the pristine state (100%). So in the clear cut harvesting case, the static footprint from land use pressure is 50 MSA%. Also, to clarify, plantations related to the production of other commodities than wood (palm oil, rubber...) are included in the agriculture land use types. Those actively managed falls therefore is the intensive agriculture land use type with a low 10% remaining MSA associated.

Reviewer	Comment index	Line number	ref to specific item	Comment (Terrestrial pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
SH	15	114	Figure 2	I think this is just a typo but why is 'Pasture - man - made' categorised as 'Non-man-made land'?	Ed.			To be corrected. "Pasture man made" is not a GLOBIO GBO4 land use class and therfore "man-made/ non-man made" classification does not apply. However, it would indeed logically fall under “Man-made” if it applied.
SH	16	125		I am worried about the value of 5% for urban areas. This seems very low to me. Very dependent on what you actually mean by urban areas but I assume that much of the infrastructure associated with businesses would fall into this category? If so, then very important to get right.	Me.	Yes	I suggest that you provide details of the types of land uses covered by the 'urban category' and how significant this is to assessing a business' impact. If it is a significant component then it would be worth investing in examining the biodiversity data available as I believe there is quite a bit available (for instance, the PREDICTS database has three levels of Urban).	Urban areas are defined as areas more than 80% built up in GLOBIO. Compared to PREDICTS, this would fall in the densest category. We are considering using GLOBIO 4 in the GBS next version where MSA% values for land use types derive from PREDICTS. For most businesses, footprint coming from urban land use is not significant as it accounts only for their offices or factories, which in our experience is small relatively to impacts coming from other pressures and supply chain. For sectors where it is significant, such as real estate, the methodology needs to be improved.
SH	17	134		I think FAO 2001 is a bit outdated now. For example, GFW (including forest change, spatial database of planted trees), Potapov et al 2017 Science Advances, work by WCS on Intact Forests, work by IIASA on forest management.	Ed.		Consider replacing this data source in future versions.	This is PBL's methodological choice as it is part of GLOBIO's model. It will be clarified in the report. For information, in GLOBIO4, PBL updates their land use cover map using ESA 2015 instead of GLC2000, but to our understanding they would still use FAO 2000 data to determine areas suitable for forestry.
SH	18	182	Figure 4	How large are the GLOBIO cells? And the EXIOBASE regions? How did you deal with imperfect matches?				GLOBIO cells are 0,5° by 0,5° (around 55km by 55km). EXIOBASE region’s size vary a lot, from a relatively small country (Japan) to a large region (rest of America). Allocation from cells to country is done directly in GLOBIO-IMAGE by the PBL. Then allocation to EXIOBASE regions by CDC Biodiversité is based on country allocation. Please refer to section 1.1 of phase 2's appendix for the matching table between GLOBIO countries and EXIOBASE regions.
SH	19			Try to be consistent when discussing proportions - you switch between % (range 1-100) and proportion (range 0-1)	Ed.			To be corrected
SH	20	303		typo - replace 'aint' with 'in'	Ed.			To be corrected
SH	21	342		How are the varying values (central, optimist, pessimist) calculated? More details required.	Me.			As this issue is transverse to all the modules, we will create a dedicated section in the quality assurance report.

Reviewer	Comment index	Line number	ref to specific item	Comment (Terrestrial pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
SH	22	350	350-353	I don't understand this section. What do you mean by 'is positive'? Do you mean that the amount of that type of land use increases? RPn+1 sounds like it is a later date than RPn, but I think that they are referring to the same year, but one is the land gain and one is the land loss, both occurring at t+1 - is that correct? If this is true then consider changing the RPn notation. If not, then please explain in more detail..	Me.			Will be rephrased in the report. Also figure 4 will be corrected, we will use pie charts instead of boxes to make it clearer that we don't know how each land use from RPn is converted. As a first explanation, the idea is that we look at all land use types variation from year n to year n+1. For a particular land use; if its variation is positive, it means that it extended over the period and therefore it appears in the restricted perimeter for year n+1. The other way around, if its variation is negative, it means that its area reduced and therefore it appears in the restricted perimeter for year n. At the end, by construction the restricted perimeter gives a summary of the land use conversions between n and n+1. Please refer to the section 2.3.A on the restricted perimeter for more details about this concept.
SH	23	319	Figure 7	I don't understand how this is different from Figure 3. I had thought that Figure 7 illustrated the case where you know which land use is converted? So why are you then taking a mean of RPn?	Me.			Report will be corrected so that we identify clearly 2 refined assessment cases, the case where we know the conversion for each land use, and the case where we don't (similar to default assessment).
SH	24	394	394-395	If I understand this correctly, the change from one land use to another comes through in the new average land uses per area, so you calculate an average of what is there at each time step. Therefore that a particular land type is lost, as described in these lines, will be included in the calculation as it contributed to the MSA score in time n but did not contribute to the MSA score in time n+1. If this is correct then I'm not sure you need these lines - it seems overly complicated.	Ed.			This had to do once again with the restricted perimeter. The report will be corrected so that this concept is better explained.
SH	25	408		typo - replace 'thee' with 'the'	Ed.			To be corrected
SH	26	509	509-512	Are the biodiversity models run for each region? Or are the coefficients estimated using global data? If global then please consider using more specific models in the future as we know that biodiversity responses to land use change vary by region. (Even using a simple division such as temperate/tropical or naturally forested/non-forested). If models are run per region then please elaborate on this in the text as it is an important part of the methodology.	Me.			For land use, MSA values are global in GLOBIO 3 version as well as in GLOBIO 4 version. For GLOBIO3, the meta-analysis didn't provide enough literature for the PBL to be able to define significant relationships at the biome level. The final MSA% for land use are computed using results from different biomes and reflect a global average level.

Reviewer	Comment index	Line number	ref to specific item	Comment (Terrestrial pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
SH	27	553	Section 3.2	I don't understand the fragmentation and encroachment impacts. I understand the theory that a patch of natural land will lose biodiversity if it is fragmented and/or if it is close to converted land. And I understand Figure 12 and your assignment of 0.85 reduction in the case of encroachment. But why are you allocating fragmentation impact as in section B? Are you not simply measuring the patch size and converting the MSA as per figure 12? Figure 14 and descriptive text is confusing. Are you showing fragmentation or encroachment or both? In this case would cell 1 receive decreased values of MSA for both? And cell 2 would received decreased values of MSA for land conversion, encroachment, and fragmentation?	Me.	Yes	Please expand your explanation. Providing some worked through examples would help.	We will provide a quantified example in the report to better illustrate the dynamics at play.
SH	28	614		replace 'idealistically' with 'ideally'	Ed.			To be corrected
SH	29	623		Could companies not provide infrastructure maps in the same way that they provide land use data? Why does the data need to be within IMAGE?	Me.			If a company provides infrastructure map that they own we can use such data (it has already been partially done in one case study), but if infrastructures are shared with other economic actors, allocation rules as to be set to distribute the footprint associated to the infrastructure to the different actors. Those rules don't exist yet, for that reason we do not collect infrastructure data. As a reminder, infrastructures are not included in the default assessments.
SH	30	672		Why use Olivier et al. 1994 when more recent updates are available (see EDGAR v4.3.2, Janssens-Maenhout et al. 2019)	Me.			To be corrected.
SH	31	659	section 4.2	I don't think you provide the impact to MSA from eutrophication? Your text describes how you calculate which areas are impacted, but not the relationship between emissions and MSA.	Me.	Yes	Please provide tables to show the relationship between emissions and MSA (as used by the pmap_dbl function (lines 771-774)	Will be changed due to methodology change following MH suggestion for N deposition pressure.

Aquatic pressures on biodiversity

Reviewer	Comment index	Line number	ref to specific item	Comment (Aquatic pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	1			I do not understand why basin intensities for land use are required. How are they connected to an activity? Why are is a static and dynamic calculation required? The same holds for the Exiobase regions. How is the connection made between the sectors in Exiobase and the aquatic MSA losses due to land use?	Ge.	Yes	Better explain how the land use factors fit in the calculation of MSA losses for an activity	Basin intensities are intermediary computation points. We decided for land use in catchment pressures to work at the basin level first to be consistent with GLOBIO which assess impacts from land use areas based on their position within the basin. Therefore, it appeared logical to consider basins for our impact allocations. By construction in GLOBIO, an area with a certain land use creates an impact regarding land use in catchment pressures within the basin it belongs. One limitation in our methodology though is that we do not consider the pressure location within the basin (upstream/ downstream), implying that intensity is constant within the basin. Then, using basin intensities, we compute country and EXIOBASE region intensities by applying a weighting. The weighting differs depending on the pressures: for LUR and LUW, it is the share of the area of human land uses related to each basin in the total area of all human land uses within the country or EXIOBASE region (with an average and conservative calculation modes, see section 2.3). For HD, it is the share of water withdrawal or consumption within the country or EXIOBASE region (see section 5.2). That weighting is applied to the intensity of each basin composing the country or the EXIOBASE region. The aquatic module is focused on building these “impact intensities”. The link with economic activities is done in separate modules: the CommoTools or the Input output module, which are described in separate review documents. In those modules, we apply the intensities from the aquatic module to the spatialized land uses or water consumption or withdrawal linked to economic activities. In some cases, the impact intensities from the aquatic module can also be directly applied to company “inventory” data as shown in Figure 1 (purple box). The static/ dynamic framework applies here for the same reasons as for terrestrial pressures, this partly linked to how we deal with time, please refer to the Introduction review document, section 3.2.B and the update we will bring to it to explain more in details the advantages and drawbacks of dynamic/static vs time integration.

Reviewer	Comment index	Line number	ref to specific item	Comment (Aquatic pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	2			It is not clear to me how the calculation of the impact of flow deviation is done. Is this calculated for one moment in time or is the difference between two time periods calculated? I hope that you included a static calculation, i.e. for one specific year, to allocate the water deviation impact to dams and/or water use and/or climate change.	Ge.	Yes	Better explain how the flow deviation factors fit in the calculation of MSA losses for an activity	To apply the GLOBIO's hydrological disturbance pressure-impact relationships, we would need to know the flow deviation (AAPFD) of the rivers and wetlands involved in assessments. Unfortunately, we do not have the data on the runoff to calculate directly the flow deviation. In the aquatic module of the GBS, we thus seek to approximate AAPFD with other measures. We know that in GLOBIO Aquatic forecasts, implicitly flow deviation is a function of 3 sub-drivers: climate change, water use and occurrence of infrastructure. This function is not parametric and different for each water body. Ideally we would need to get to the core of the GLOBIO model (and in particular LPJml) and assess for each water body, on a monthly basis, what is the flow deviation and what is the weight of each of the sub-drivers regarding that flow deviation. Doing so, we would be able to allocate the MSA impacts due to the AAPFD of that particular water body to each of the sub drivers. We could then sum at the national or EXIOBASE region level to get impacts associated to each of the sub-drivers. This in-depth allocation is planned for the next GBS version, for which we hope to be able to collaborate more directly with the PBL. For this version, as we did not manage to get to the LPJml and PCR-GLOBWB models, we had to make a very rough allocation at the basin level and on an annual basis between the various sub-drivers. Thus, we never directly calculate the AAPFD but rely on allocating the HD static impacts calculated by the PBL in 2000 and 2050 to dams, water use and climate change. As explained section 5.2.C., we consider only static impacts for HD (so we ignore the differences between two years). If we were able to assess changes in flow deviation from years to years, that would amount to dynamic impacts.
MH	3			I do not understand the scientific basis of the division of impacts between dams, water use and climate change, as reported in Figure 11. The assumptions are major and not verifiable	Me.	Yes	Include a much better scientific basis for the calculation of flow deviation impacts caused by dams, water use and climate change.	See above. We acknowledge that the current allocation is not satisfactory and will make clearer in the review documents that the robustness of the HD pressure assessment is currently very low (and that we will improve it in the future as explained above).

Reviewer	Comment index	Line number	ref to specific item	Comment (Aquatic pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	4			I do not understand how the hydrological disturbance due to climate change is calculated. Do you assume that water use and dams are the same in 2050 as in 2000? If so, this is obviously a flawed assumption.	Me.	Yes	Better explain how hydrological disturbance is connected to GHG emissions.	We do not assume water use will remain the same in 2050. The first sentence in 4.1.B will be clarified to explain that we are trying to assume whether to give an allocation of ½ or 1/3 (cf. Figure 11) for the climate change sub-driver in each basin. The quantity of water consumed or withdrawn does not play a role in that allocation, only the occurrence of dams does. In each GLOBIO basin, we check whether a dam is currently present or not in the GRanD database and adjust the weighting factors between water use, dam and climate change accordingly (Figure 11). Implicitly, it indeed assumes that the dam locations in 2050 are unchanged compared to the latest year for which data are available in GRanD (it should be noted that this influences only the allocation of impacts; GLOBIO-IMAGE forecasts do include an updated map of dams for 2050 when they dimension the HD impacts in 2050). This is not satisfactory, and a possible upgrade would be to access dam's map projection used in GLOBIO-IMAGE. This upgrade is included in the broader upgrade planned for hydrological disturbance pressure's impacts allocation, as mentioned in comment #2.
MH	5			I do not understand how the total impact of the nutrient emissions is calculated (both static and dynamic).	Me.	Yes	Provide the concrete numbers and a calculation example	Calculation example will be provided in the report.
MH	6			I do not think that the use of the ReCiPe P-equivalent factors should be used to estimate net emissions to freshwater. The reason is that these factors already contain instream fate removal which result into double counting.	Me.	Yes	Instead, you may work with direct P emissions to water summed with 10% of the P emissions to soil in a region. The 10% is used in ReCiPe as the default P fraction transferred from soil to freshwater	Will be corrected as suggested. We will use "straight" P-equivalent (based on molar masses, without any fate model embedded) to deal with the different P-compounds.
MH	7			It is not clear to me from the report whether impacts of different stressors are summed. Summation is in my opinion only possible for time integrated impacts, so with 'year' in the unit	Me.	Yes	Keep impacts of different stressors separated. Alternative is to integrate the impacts of the drivers, but only if the time-integrated impact of these drivers is quantified	See time integration supplement in the Introduction review document section 3.2.B.

Reviewer	Comment index	Line number	ref to specific item	Comment (Aquatic pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	8			Overall, I consider the calculations with Globio-aquatic too weak to be meaningfully included in an assessment tool to evaluate individual stressors of individual activities/sectors. As you do not have the code to run the model yourself, you basically are not able to derive results that are of use for your assessment tool	Ge.	Yes	Exclude the aquatic biodiversity pressures from your assessment tool or improve the calculations by directly working with the Globio aquatic model code.	We acknowledge the current weakness of the impact intensities calculated with the aquatic module due to a lack of access to the models underlying GLOBIO Aquatic. We agree that we have to work with the GLOBIO Aquatic model code to improve the calculations and we wish to do so for the next version of the GBS. We propose to reframe the value of the aquatic module as a risk screening tool, and not a footprint assessment tool. We believe that the robustness of some pressures such as LUR, LUW and Wetland conversion is relatively higher than for freshwater eutrophication and hydrological disturbance. We also believe that the impact intensities developed are positively correlated with the actual impacts (so that if the GBS assesses an impact as negative, it is not in truth positive). For instance, we know that the more a company withdraw water, the bigger the potential impacts on biodiversity are (and more withdrawal of water will not lead to gains of biodiversity). For aquatic pressures, the GBS has to be considered more as a compass (showing the right direction) than a balance (measuring the impacts precisely), which is still useful. We are and will be very transparent about this.

Ecotoxicity pressures on biodiversity

Reviewer	Comment index	Line number	ref to specific item	Comment (Chemical pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	1	228	230	The conversion factor is not 7.49.10-10 species/m² for freshwater systems in ReCiPe2016, but 7.89.10-10 species/m3. The unit is important here: m3 instead of m2.	Da.	Yes	Change the conversion factor in the correct number and unit.	Thank you for spotting the typo. The factor is now corrected.
MH	2	233		I appreciate the cautious words in the disclaimer, but there is no scientific rationale to assume that MSA = 1 -PDF. The PDF is the fraction of species that is exposed above their acute EC50 at an environmental concentration, while an MSA is the average abundance decline of the original species pool at an environmental concentration. This is a fundamentally different metric, I would not know how they relate beforehand. I would expect that the MSAloss is a more sensitive indicator compared to PDF.	Me.	Yes	There is little you can do about this. It just makes the analysis not scientifically defensible at the moment.	Indeed the relationship is not scientifically based. Since it is not used to derive the MSA-PDF relationship, we moved it to a footnote and emphasize the speculative nature of this relationship, as well as indicate what you write about the difference between both metrics. The objective here is mainly to provide food for thought to the readers and hopefully get feedback on that.

Reviewer	Comment index	Line number	ref to specific item	Comment (Chemical pressures)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
MH	3	285		There is no scientific rationale why the ratio of MSA and PDF found for climate change and land use would qualify to estimate the relationship between PDF and MSA. If there would be a universal relationship between MSA and PDF across all stressors, there is in fact no need to use the MSA as indicator and you directly use the ReCIPe method or any other impact assessment from LCA as default which uses PDF.year (or species loss.year) as unit of impact.	Ge.	Yes	There is little you can do about this. It just makes the analysis not scientifically defensible at the moment.	Yes indeed, hence the fact that we emphasize the preliminary status of this work in the disclaimer. Also, we call for experts from the MSA and PDF worlds to work on this topic which would be valuable to biodiversity assessment in general, as stated within the Aligning Biodiversity Measures for Business initiative. In fact using the MSA-PDF relationship derived on LU and CC to deduce a general relationship may not be possible. Hence we now insist on the fact that the derived PDF.m².yr-MSA.m² relationships are not a "range" for a unique general value but rather 2 different stressor-specific relationships which we use to get an idea of what could be the relationship on other stressors. Anyhow, considering that max(PDF) = 1 and that the time horizon considered in ReCiPe hierarchic scenario is 100 years, is seems that the ratio between MSA.m².yr and PDF.m².yr cannot be >100. Yet, it could likely be <1 for some stressors, especially if their lifespan is very short
MH	4	352	358	I do not understand the units for freshwater ecotoxicity. Why is it MSA.m2? The starting point in ReCiPe is the impact over the water volume, so PDF.m3.yr.	Me.	Yes	Clarify the units	Actually the midpoint-to-endpoint factors used for stressors on terrestrial and freshwater ecosystems in the XL ReCiPe data we have (ReCiPe 2016 v.1.1) are all in species.year or species. For terrestrial and freshwater ecotoxicity, endpoints are both in species.year not in PDF.m3.yr Also, in GLOBIO-Aquatic model, impacts on aquatic biodiversity are given in MSA.m² without consideration of volume. This is certainly due to a will from PBL experts that GLOBIO and GLOBIO-Aquatic models remain compatible, all the more than: 1) the volume of soil matter and the height of trees could argue for using a volumic unit also for terrestrial biodiversity 2) the average depth of freshwater ecosystems considered in GLOBIO-Aquatic (rivers, streams, lakes and wetlands) is likely limited. Based on ReCiPe fw volume of rivers and lakes (126,700 km3) and GLOBIO-aquatic total area of rivers and lakes (2,479,564 km²), the average depth of rivers and lakes on Earth is 51 m. Including wetlands in the perimeter of freshwater ecosystems (wetlands are not included in ReCiPe freshwater ecosystems) will decrease this average depth. To stick with GLOBIO framework, we choose to use MSA.m² for all biodiversity impacts. Considering that the average depth of freshwater ecosystems is 51m, species density in species/m3 should first be multiplied by 51 to get species density in species/m2, which can then be translated into MSA.m² following the methodology proposed in the report. The results in the report were modified in this sense.
MH	5			As discussed earlier in relation to the reports on terrestrial and aquatic ecotoxicty, summation over the different impact categories (land use, climate change, eutrophication, ecotocity) is only possible for time integrated impacts, so with 'year' in the unit. Now, you underestimate the importance of stressors that also have an impact in the years after the emission itself which is notably the case for climate change, but also for some chemical pollutants	Me.	Yes	Use the time-integrated impact across the stressors to arrive an overall impact score	Time integration issues, especially how the dynamic/static framework compares to the time-integrated approach to account for biodiversity impacts over time, will be clarified in the Introduction review document. Advantages and drawbacks of both approaches will be clearly stated, as well as the conditions under which impacts aggregation can be done.

Crops CommoTool

Reviewer	Comment index	Line number	ref to specific item	Comment (Crops CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	1			a main comment: it is unclear why you invested a lot of work in reproducing "old, bad" data on fodder crops that are or no longer covered in FAOSTAT due to very limited data quality (as you mention). The fodder crops category had a very strong overlap with the grassland/pasture land use and previously in FAOSTAT often double-occounting occurred between the two (maybe one reason why it was removed). If a company has data on the fodder crops it grows or purchases, it should also supply data on yields. If they are omitted, I would assume what happens is that pasture / grassland areas needed to produce the livestock products increases if you leave out fodder crops, but the overall result will be robust (I assume if you use a common approach to calculte grassland areas - I have not seen the approach). I would favor this approach over reconstructing bad data with very uncertain assumptions.				EXIOBASE includes data on fodder crops so the inclusion of those data was not our doing but EXIOBASE's. In order to assess the impacts on biodiversity of the tonnages of fodder reported by EXIOBASE, we picked one specific data from FAOSTAT old data: yields. There were gaps so we sometimes used equivalent primary crop yields. If countries wrongly reported some grazing tonnages and areas as fodder crops to the FAO, then the yield calculated by the FAO by dividing the tonnage by the surface area would be inaccurate. All the yields have however been checked for consistency and they seem consistent (around 25 t/ha). The country impact factor depends only on the country yield, the management intensity mix in the country (irrigated, intensive or extensive) and the average land use changes in the country. Thus the double-counting of grazing into the fodder crops category has no influence on the country impact factors, beside its influence on calculated yields. It does have an influence on the impact factors we calculate by EXIOBASE region since we weight the country impact factors by their production. This is an issue and we currently are unsure how to deal with it. However, it is unclear whether there is an actual double-counting or whether EXIOBASE just over-reports fodder crop tonnages and under-reports grazing tonnages (in both case, the EXIOBASE region impact factors would be inaccurate though). Besides, considering that all fodder is grazing would not solve the issue: there would still be double counting in EXIOBASE data and the yields used would be incoherent. Indeed, according to EUROSTAT 2013, grazing yield ranges are at 7 t/ha maximum for improved pastures, whereas for fodder crops, yields are about three times as big: 25 t/ha with data sent by FAOSTAT only on fodder crops, and 18 t/ha with FAOSTAT data and proxy yields. Moreover, grazing yield data are even older and the sources even less robust than for fodder crops yield: uncertainties on grazing yields are higher than for fodder crops yield. Let's take an example of (i) the actual production of a country being 60 t of fodder crops and 40 t of grazing. Since EXIOBASE calculates the tonnages of grazing based on the gap to fill demand, we assume that the total of fodder crops + grazing is actually close to the real value of 100 t. (ii) In EXIOBASE, the data could for instance be wrongly listed as 90 t of fodder crops and 10 t of grazing. (iii) The suggestion you made is to treat those 100 t as grazing . The difference in impacts assessed in the three situations depends on the yields of grazing and fodder crops and the land use change trends in that country. Globally, the default impact intensity in MSA.km2/km2 of land use we calculated in the terrestrial module (CDC Biodiversité 2019) is much lower for cultivated grazing (and thus for grazing) than for agricultural land uses (and thus for fodder crops). Depending on the specific trends of land use changes in each country, the lower impact intensity can counterbalance the lower yield and translate into relatively close impact factors in MSA.km2/t for grazing and fodder crops. The bias introduced by one method over the other will thus differ from countries to countries.
TK	2	54	Figure 1	are these the latest numbers? Maybe cite a more recent GLOBIO version as Mentioned by Mark in the last call				This sectorial contribution analysis to biodiversity loss showed in the Figure 1 is made with GLOBIO3 as part of CBD Technical Series document n°79. To our knowledge, these are the most recent values published by industry and there was no further publication by industry after 2014 (and the underlying data were not updated so there is no reason for the results to change). We are aware that the GLOBIO4 paper had been published but to our knowledge, it does not seem to contain a sectorial contribution analysis to biodiversity loss, rather a pressure contribution analysis. If you have knowledge of sectorial contribution analysis with GLOBIO4, suggestions of references are welcome. Moreover, we have not switched yet to GLOBIO4 so it may be preferable to display GLOBIO3 results until the switch is done.

Reviewer	Comment index	Line number	ref to specific item	Comment (Crops CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	3	71	boxes	unclear what different color of the boxes mean, would be good to clarify				We will add the clarifications in the introductive report of the review documents, thank you for the remark. Green boxes contain hypothesis and assumptions, red boxes contain highlights, and blue boxes describe possible future developments in the GBS.
TK	4	172		what does this mean? That the tool will only work for the most recent year? How does reflect on the different dates other data is representative for?				For the central value, we are going to switch the yield used from “the most recent” to a “running average over the last 5 years”. Our aim with the default approach and the central calculation mode is indeed to assess a risk of impact based on an average situation (for the conservative and optimist calculation mode, we could use another value in the distribution of yields over the last 5 years). This idea to take into account the variability of this parameter was already mentioned in the Limits and perspectives section. It means we will use for instance the 2013-2017 average yield to screen risks of impacts in 2020. To switch to a more “impact assessment” rather than “risk screening” approach, companies would have to access actual yields during the year asssessed (e.g. from their suppliers).
TK	5			there is some elaboration about multi-cropping, but in the end you cannot account for that, is that correct? If the same area is harvested more than once per year, you will overestimate the impacts (as you state later). How large is the problem introduced by this?				Indeed for now we do not take into account the multi-cropping case and occupied areas would be overestimated. We have not have not been able to determine specifically the order of magnitude of this overestimation nor to correct it due to a lack of appropriate data. However, the global tests at the section 2.4B can give us a first idea: on the first 3 lines of Figure 17, we have checked whether the harvested areas reported in FAOSTAT are consistent with the GLOBIO agricultural areas (derived from land cover data). The results showed that the ratio between GLOBIO agricultural areas and FAOSTAT harvested areas was about 114%: the harvested areas of FAOSTAT that are not accounted in GLOBIO may be caused by multi-cropping inter alia.
TK	6	178		in Figure 3 the CommonCrop tool does not cover grasslands / pastures. This is not consistent. (linket to main comment)				This sentence will be removed, indeed grazing is not treated in the Crops CommoTool and is tackled in the Livestock and Grazing CommoTools document.
TK	7	188		EXIOBASE data on fodder crops originate from (and old version) of FAOSTAT, so it is not a different data source (linked to main comment)				This paragraph would be modified to: "The fodder crops items list is based on the items listed in the material account of EXIOBASE3.4, which is from previous reported data in FAOSTAT. Contacting FAOSTAT directly, we were able to retrieve fodder crops production data (tonnage, harvested areas) not displayed on the public website anymore due to low response rates. In the most recent years (ranging from 2014 to 2017) data, only 133 combinations of {fodder crop, country} can be found. For the missing combinations of {fodder crop, country} and for EXIOBASE (previously FAOSTAT) crop fodder items without FAOSTAT direct equivalent in the production data, rules of thumb were used in order to estimate production data. Those rules are detailed in the next sub-section."
TK	8	217	Table 3	using maize yields for silage maize certainly does not make sense (very different water contents!) - linked to main comment				The item "Maize for Forage and Silage" corresponds to maize before the silage process, in the FAOSTAT commodity list, the item CPC.01911 for which the FAOSTAT Statistic Division sent us yield data is described as "Maize cut green as grass" (http://www.fao.org/economic/ess/ess-standards/comm-items/details-items/en/c/1633/), which is not processed / ensiled. Thus the water content should be similar and the yield of “primary maize” can be used.

Reviewer	Comment index	Line number	ref to specific item	Comment (Crops CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	9	271		what do you mean by "construct the crops"??				The whole title of the section is "Methodology to construct the crops CommoTool", expliciting the way we build the impact factor database for the crop commodities.
TK	10	380	Figure 10	why do you call implicit area not harvested area -> seems to be exactly the same!				Indeed conceptually, harvested area and implicit area are the same, however implicit area designates for us a computed area whereas the harvested area data is reported by the FAOSTAT. Moreover, the term of implicit area is more generic and can be (and is) used for other commodities which do not "harvest" (such as in the Mining CommoTool).
TK	11	597	Table 8	would be good to have a column: total impact; using yield data for only one year is not very representative (very much dependent on climate conditions, e.g. Uruguay had more than twice the 2017 yield in 2015) - I now saw that you even mention this, but most likely this reflects drought or something similar - and is problematic to transfer to generic factors				Yes, as noted in comment #4, we are going to recompute impact factors with a running average of the yield over 5 years. And yes, we are going to display the total impact (sum of the impacts).

Mining CommoTool

Reviewer	Comment index	Line number	ref to specific item	Comment (Mining CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
CGB	1	37		Mining is essential for every aspect of our lives - "if it's not grown it's mined".	Ed.	No	"…in almost all our industries and day-to-day lives."	Correction accepted
CGB	2	51		Dam failures do not happen "regularly"; or it depends on our definition of "regular".	Ed.	Yes	Tone down the statement, or be factual - how many per year, per number of dams…	Report correction: Over the last 10 years, tailings dam failures occured in average 3,3 times per year (wise uranium project), with an upward trend, for a total number of dams of around 3500 (Davies 2002).
CGB	3	77		Many of the definitions are arbitrary or confusing.	Te.	Yes	There is not the space here to re-word these definitions, but it would be worth spending time with a mining text book. I would recommend getting a copy of "Mine Wastes" by B. Lottermoser as it is useful for many other aspects of this document.	We will use defintions from "Lottermoser - Mine Wastes: Characterization, Treatment and Environmental Impacts" as suggested
CGB	4	135		Not all peat will become coal.	Ed.	No	"…but rather may be considered a precursor to coal"	Correction accepted
CGB	5	145		Refining and concentration are not the really interchangeable or part of the same step.	Te.	Yes	The generic steps from mine to product should be better defined.	We will use terms from "Lottermoser - Mine Wastes: Characterization, Treatment and Environmental Impacts". We now talk about extraction, mineral processing and metallurgical processing.
CGB	6	149		The text suggests that Cu production always follows the same intermediary steps; this is not true. For example, the production of high grade Cu cathodes following heap leaching.	Te.	No	Reword the text.	To be rephrased

Reviewer	Comment index	Line number	ref to specific item	Comment (Mining CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
CGB	7	157		Figure 4 could be better. There are also some inaccuracies.	Te.	Yes	It is not true that wastes produced during the extractive phase are inert. Indeed, it may be useful to define what is meant by "waste"; it is a purely economic definition. Moreover, mine waste may comprise overburden, but also low grade ore. I can provide a better generic mine schema.	As per comments #3 and #7, layout is changed to be consistent with nomenclature from "Lottermoser - Mine Wastes: Characterization, Treatment and Environmental Impacts".
CGB	8	159		Figure 5 (and throughout): there seems to be an assumption that coal production wastes are inert. This is untrue - many coal waste produce severe environmental impacts due to the formation of acid mine drainage (AMD).	Te.	Yes	Correct the figure, and - ideally - explain in more detail the sources of environmental impacts from various mining activities.	Figure 5 is changed to be consistent with Figure 4. For coal and minerals, the CommoTool perimeter includes only mineral processing that generates waste rocks, the term “inert” is no longer used. Only land use pressure (storage area needed) is taken into account for waste rocks (for both minerals and metals), therefore AMD is not included. This will be clearly stated in the perimeter and limits.
CGB	9	182		Why is the list restricted?	Me.	Yes	Explain the rationale for the choice.	The rationale was, taking into account time constrains, for metals we chose most important ones in terms of volumes (ore volume not metal) and we maximised also the coverage regarding EXIOBASE (all EXIOBASE metals are covered except one, platinum). For minerals, we chose the ones for which a specific PEF process was available
CGB	10	183		Missing space between "1" and "exact list".	Ed.	No		Corrected
CGB	11	188		"To define"	Ed.	No		Corrected
CGB	12			There is no mention of main environmental impacts of mining and mine wastes on the environment - for example, generation of AMD, deportment of dusts/particulates - the two biggest.	Ge.	Yes	It would be good to be more explicit in the mechanisms of mining impacts, and to separate operational vs post-closure impacts.	Environmental impacts will be better described in the context section with as suggested a clear categories: operational vs post-closure and within operational, wastes related vs not wastes related. In the perimeter section, it will be clearly stated which ones of those categories are included.
CGB	13			No link to the established EIA process	Ge.		Should this document lean on the EIA process? When done properly, there are many parallels in the baseline data collection, as well as residual impacts, which might link well with the use of this tool?	A specific section about EIA will be written. We will focus on concepts and data that can be used in the context of the CommoTool.
CGB	14	275		Why does this work rely on USGS data? (Why was your in-country Geological Survey not involved?)	Me.	Yes	Publically-available data are often incomplete, and mining companies notoriously lax in providing data. However, there are commercial data sources available - such as the Raw Materials Group (I think now part of S&P Group). Detailed data on mine reserves, and - I believe - production have to be made available to investors, so it would be understandable that these data are used in the creation and validation of the GBS - and investment tool.	We identified promising privately owned data sets such as the S&P one mentioned. In the future, we are considering exploring further those datasets and eventually offer an optional upgrade (with the associated cost) that would include the data. For the first version of the GBS, our priority is to reach a large number of users in many different contexts, therefore it was important for us not to associate expensive commercial licenses, especially if it might not be critical for the intended use. Also, for transparency reasons, it was important for us that everyone can access the underlying data that we are using.

Reviewer	Comment index	Line number	ref to specific item	Comment (Mining CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
CGB	15	312		Lovelace (2009) concerns just the USA case; how valid is it to extrapolate this to other countries?	Me.	Yes	Too much reliance on a single resource - this needs to be validated - other organisations have also released water-use tools and estimations for other countries, for example, the Minerals Council of Australia… how do these compare?	Good point, we will investigate further to diversify literature sources for water use. At this stage, we could not find any water intensities figures from the Minerals Council of Australia. For the time being, it will be clearly stated in the limits.
CGB	16			There is no consideration of heap leaching, despite accounting for <25% global copper production (mainly in South America). It has a very different flow-sheet to what may be considered 'classical' and usually results directly in the production of copper cathodes on site. For example, at Escondida, nearly 15% of the Cu produced comes from heap leaching.	Da.	No	Should heap leaching be considered?	In this version, heap leaching will not be considered. We have to do more work to better understand what are the contributions of heap leaching to the different pressures in the GBS, mainly land use and ecotoxicity. On a broader perspective, for the next version we are considering introducing more granularity relatively to mining techniques for extracting (mountain top removal, various pit shapes) and processing (heap leaching,...).
CGB	17	396		Escondida may be atypical, given the large area given over to heap leaching (~10 km2)	Ge.	No	Just a comment - maybe a different mine would be a better illustrative choice.	We will switch to the second option, Grasberg mine site which produces both gold and copper. To our knowledge heap leaching is not used on this mine facility, making it more typical for the calibration purpose.
CGB	18	452		The "inert waste" assumption is not correct	Me.	Yes	You should differentiate between inert and reactive waste - or drop the term "inert" altogether.	Inert is no longer used, we use terms from Lottermoser: waste rocks, tailings and slags.
CGB	19	455		Is it a problem that pits are never cone-shaped?	Me.		Question	Cone shape is a simple geometrical assumption implemented to have a first estimate. We are planning to do a sensitivity analysis in future versions to evaluate the importance of the geometrical assumption by trying different geometrical shapes and assess the associated variability on impact factors.
CGB	20	482		Spatial ratios = volume?	Me.		Extracting the material will increase the volume due to the creation of porosity - is this important? It could be as high as 30%...	A new porosity creation adjustement factor will be introduced to take this volume increase into consideration. The default value will be set at 130%. It is indeed important to take this volume increase into account at it implies a larger storage area for waste rocks in the dynamic footprint assessment.
CGB	21			How does the tool consider the long-term impacts? For example, a coefficient for mine pollution? E.g. incorporate a failure ratio for tailings dams, or latent pollution from reactive waste deposition - the long-term prospects for mitigation of AMD etc from stacked mine waste (exl tailings) is fairly dire. Equally, how does the tool factor in mine restoration plans? Many mines keep nurseries of plants to restore the habitat post mining...	Me.		Question	Pollutions, being regular (AMD) or accidental (dams' failure), are not included in the perimeter of the first version of the tool. Post closure impacts are not covered neither. This will be clearly stated in the perimeter section and in the limits. In general though, the accounting framework of the GBS takes into account long-lasting persistent effect through the concept of static impact (see Introduction/Core concepts review document).
CGB	22	521		Formatting error	Ed.	No		Corrected

Reviewer	Comment index	Line number	ref to specific item	Comment (Mining CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
CGB	23	587		Where does this 10 km figure come from?	Me.	Yes	Explain the 10 km figure…	10km is the area within which birds and mammals are assumed to be impacted by the encroachment pressure (hunting and habitat disturbance) in GLOBIO3 cause-effect relationships. This pressure is described in the terrestrial module review document. It is based on unpublished data from Benítez-López et al. (Schipper et al. 2016). GLOBIO4 substantiates this pressure with a meta-analysis (Benítez-López et al. 2017). In GLOBIO-IMAGE outputs, this pressure applies to all land uses where human activity is predominant (agriculture and urban areas). We assumed that mine sites also cause such encroachment.
CGB	24	590		Discount = reduction?				Replaced by "multiplier"
CGB	25	616		Why is this reliant solely on publically-available data?	Ge.	Yes	Question	See our answer for comment #14.
CGB	26	622		aquatic MSA is null or 0?	Te.	Yes	not the same thing…	Will be corrected, the idea is that MSA is 0% on extractive sites.
CGB	27	660		The tool is for a country-by-country basis but the methodology is too centred on US data…	Ge.	No	What bias does this impart?	The data that comes from the US is only about water consumption. We thus have a bias for water use and we are planning to mitigate it in future versions as explained in our answer to comment #15. USGS data which is used for mine sites location and characteristics is from a US source but is not specific to US and covers mines globally.
CGB	28	676		The biggest gold mines in the world (the top five) produce 1 million Oz Au; which is approximately 31t Au	Me.	Yes	Using 1000 t Au in the example is unrealistic, so it is probable that the data seem "odd".	We will state more clearly that this is a fictive example and that we intentionnaly took an unrealistic figure for gold to show the importance of the ore grade in the biodiversity assessment.
CGB	29	685		I do not understand this paragraph	Me.	Yes	It is not clear what was done - what is the difference between pure commodity and refined product - in the case of Au, it's surely more or less the same thing, so how does this impart such a change in the results?	Typo, to be corrected: "pure commodity" will be replaced by "ore" and the ore grade will be reminded in one of the tables.
CGB	30	716		Ore grade and proven reserve data should be available to investors	Ge.	No		See our answer for comment #14.
CGB	31			The integrity check (comparing USGS and BGS) seems useful, but how does CDC propose to validate the results?	Ge.	Yes		We will add a section to explain in details how we use the global production check. The general idea is that if production estimated with USGS mine sites data is below or above 35%, we use a global average for the estimation of the mine's radius (mine site production is only used in the radius computation).
CGB	32	770		Estimates are 3-5% of the world's energy is used for mining, moving and crushing rock - in line with the 5% global GHG emission figure?	Ge.	No		Yes, we are in line on this ciriteria.

Reviewer	Comment index	Line number	ref to specific item	Comment (Mining CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
CGB	33	804		How does the tool cope with multi-produce mining operations?	Ge.	No	Question	Multi-produce mine operations are taken into account in the total mine capacity assessment. All the products are considered to assess the global capacity and afterwards an allocation is done between the various products based on their respective capacity (see section 3.2.B.3, line 529 of the initial PDF). We are not able at this stage to take into account the consequences in terms of processing (mineral and metallurgical) as our source for processing, PEF, does not provide that level of granularity. This will be more clearly stated in the limits.

Livestock husbandry and Grass CommoTools

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
FT	1	54		I would suggest citing FAOSTAT which is the original data source (rather than the image source - more generally if you want the report to be published I am wondering about copyright on all those copied images).	Da.			Well noted, it will be modified.
JLP	2	60		Livestock use three quarters of world land. Yes but most of this is grassland/rangeland and we should also consider the future of these area if livestock number decrease : development of shrub and forest with risk of fire and a risk of loss of biodiversity compared to current situation (at least when there is no overgrazing situations)	Ge.	Yes		Well noted, these elements will be added to the introduction. Do you have any suggestions of references about risk of fire due to devlopment of shrub if pastures are not maintained?

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
FT	3	60		Incorrect (75%?!). The report you cite says "a third of crop production for feed and three quarters of land in total" which isn't clear but most likely means 75% of agricultural lands. It can't be 75% of world land, and the same report says earlier in the section that "Agroecosystems cover close to 40% of lands ". Depending on estimations, the amount of ice-free land used for livestock production varies from 22% (18% for grassland + 4% for feed crops, Mottet et al., 2017 which is actually the same source as FAO 2017 that you cite later) to 30% (25% for crops and 5% for feed crops, Monfreda et al., 2008; Ramankutty et al., 2008) Monfreda, C., Ramankutty, N. & Foley, J.A. 2008. Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. Global Biogeochemical Cycles, 22: GB1022. Ramankutty, N., Evan, A.T., Monfreda, C. & Foley, J.A. 2008. Farming the planet: 1. Geographic distribution of global agricultural lands in the year 2000. Global Biogeochemical Cycles, 22, GB1003. Mottet, A., de Haan, C., Falcucci, A., Tempio, G., Opio, C., & Gerber, P. (2017). Livestock: On our plates or eating at our table? A new analysis of the feed/food debate. Global Food Security, 14, 1-8.	Da.			Well noted, the sentence will be corrected.
JLP	4	61		Livestcok do not represent 25% of global GHG emission (14.5% accoridng to FAO considering both direct emission and indirect (such as deforestation)	Ge.	No		Well noted, the sentence will be corrected (typo error between agriculture and livestock).
FT	5	61		Also incorrect, the report says "About 25% of greenhouse gas (GHG) emissions come from land clearing, crop production, and fertilization, with animal-based food contributing 75% of it." so livesock would be 18.75 but I would suggest using 14.5% from this more detailed assessment on livestock specifically: http://www.fao.org/3/a-i3437e.pdf	Da.			Well noted, the sentence will be corrected (typo error between agriculture and livestock).
FT	6	65	66	Do you mean "direct impacts of livestock and indirect impact of feed"? It is not straightforward. For instance, feed crops cultivated off-farm are probably indirect, but grassland is a feed but impacts are quite direct (livestock graze on it). One could also argue that aquatic nutrient pollution or ghg emissions from animals are also indirect in the sense they occur off-site. I would suggest a table summarizing the impacts that at feed and animal production stages and specifying if you consider them direct or indirect.	Te.			A table summarizing where impacts at feed and animal production stages sit within the CommoTools will be added, and we will rather use the notion of "Scopes" and "value chain" instead of the terms "direct" and "indirect" impacts for now in the report. Scope 1 impacts correspond to direct operation impacts on the area controlled by the entity or directly caused by it, Scope 2 to impacts linked to non-fuel energy generation, and Scope 3 impacts are the other consequences of activities upstream or downstream the entity. We will also add the figure shown during the webinar clarifying the different Scopes and perimeters of the CommoTools.

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
FT	7	79		Related to a previous comment I think a summary of the different commotools, how they articulate and the impacts they consider would be very useful. This should include the crop commotool to have an idea here of what it considers: land use but also climate change, pollution...? Also useful would be example of what tool/combination of tools should be used for what steps of what supply chain? For instance: - a landless pig farm importing 100% of feed - a grassland farm importing some soybean cake from brazil - a dairy farm with some temporary grassland for grazing but also cultivating feed crops (e.g. fodder beets, maize silage), and importing concentrates as well	Te.			A foreword will be added in this document, we advise the readers to consult the other GBS review reports, especially Introduction (renamed Core concepts), Terrestrial and Aquatic modules reports. Thank you for the proposed examples, we will add them and specify the CommoTool involved to treat each case.
FT	8	79		replace by "grassland" or "pasture" or "grazing land". Grazing is an action rather than a feed component.	Ed.			Well noted for the vocabulary changes.
FT	9	89		Not clear what it means: plant biomass, animal products in grassland based systems?	Ed.			We refer here to plant biomass in grassland systems, it is detailed in the section 2.3.
JLP	10	98		The main difference between ruminant and monogastric is not only CH4 emissions. The biggest difference is the nature of the feed (mostly roughages for ruminants, including permanent grassland and associated biodiversity). Well managed ruminant have a positive contribution to biodiversity. It is more difficult for non-ruminants	Ge.	No		Well noted, these elements will be mentioned in the introduction.
FT	11	111		Not clear. A farm producing its own feed items (grass or feed crops) cannot be assessed with this tool? Isn't rather that a combination of tools will be necessary? Cf. previous comments on tool articulation and examples. I guess what you mean is that the assessed system is only the animal husbandry part of the farm, without considering the grassland/feed production part	Ed.			To assess the impact of a farm also producing its feed (crops and pasture parcels), the combination of the crops, grazing and livestock husbandry CommoTools would be needed.
FT	12	115		need for consistent methodology, is it "livestock husbandary commotool" or "livestock commotool" (cf title of section C). I would suggest livestock husbandry because livestock is general and includes grazing which makes it confusing	Me.			Well noted, we will change "livestock CommoTool" to "livestock husbandry CommoTool".

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
JLP	13	119		Again, yes livestock produce GHG but it is one side of the coin. The other side is "shall we gain or losse biodiversity in case of a reduction/dispariton of livstock farming?". Livestock can be very usefull to regain biodiversity and soil quality (see for example : Projet Terraprima (www.terraprima.pt). I do not see these effects are considered	Ge.	Yes		Positive aspects of livestock will be mentioned in the introduction (e.g. on soil biodiversity). The question of whether gaining or losing biodiversity with livestock farming on a parcel, especially with grazing practices, can have different answers depending on which type of biodiversity we look at. If we focus on biodiversity in terms of ecosystem intactness, notably with the MSA metric, this question depends on which reference state of the parcel is considered. As a reminder, the MSA (mean species abundance) is the ratio between the mean abundance of original species in disturbed conditions and their abundance in undisturbed habitat and is an indicator of the degree to which an ecosystem is intact (Schipper et al. 2016). Let's take an example of pasture for livestock grazing (without overgrazing) being converted into a forest. When the parcel is not grazed anymore, most of the grassland-type ecosystem initially present species will progressively disappear in favor of forestry-type ones. A loss of biodiversity in terms of number of species and species population sizes may be registered, however in terms of MSA, this trend may not be observed. A forest can have for example an MSA at 85%, and a pasture at 60%, even though the identified number of species may be lower in the forest, however these species are specific to a forest-type ecosystem and the reference used to compute its MSA are forest-type species.
FT	14	160		I am wondering how the crops tool deals with this but not with oil seed cakes and by products. In both cases it is a matter of allocation: for crop residues as well you need to allocate part of the impact to crop (e.g. maize grains) and part to livestock (e.g. maize stover)?	Te.			C.f. comment 4 and the associated table which will be added. More specifically in the crops CommoTool, we use an economic allocation between the harvested grains or the desired product, and the crop residues. The latter have no impacts allocated to them for now. Other co-products and feed needing further transformation (oil seed cakes for ex.) are not systematiaclly treated now by the GBS, they are not listed in the material account of the environmental extensions of EXIOBASE either, is the base of the default assessments with the GBS. They can be dealt with case by case, if data on feed composition from LCI data are available for ex (e.g. the tonnage of grain needed to produce the transformed feed).
FT	15	161	162	This is an important limitation, I haven't read the limitation section yet but it should be discussed a bit there.	Te.			C.f. comment 4 and the associated table.
FT	16	168		sounds a bit antinomic. "a grassland" or "a grazed area"	Ed.			Well noted, it will be replaced by "grassland".
FT	17	175		What GHG emissions are considered exactly? Are emissions from urine/dung deposition considered here or as part of manure management? Are emissions/sequestration from soil considered?	Te.			This question is answered later in the document, as shown by comment #18. We will refer to the later section here so that the readers know the answers are provided in the document.

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
JLP	18	188		You assume that "human" land uses is always negative. I do not think so, notably when considering moderate grazing intensity. Livestock avoid closing landscapes and well anage grassland are habitats for flora and wilkd fauna. Where is ti taken into consideration?	Ge.	Yes		The paragraph you comment talks specifically about the way the encroachment (E), fragmentation (F) and land use change in catchment (LUR and LUW) GLOBIO cause-effect relationships works: only “Human land-uses” cause such pressures. Those land uses include croplands, pastures (excluding natural grassland) and urban areas. Beyond these three pressures, GLOBIO cause-effect relationships do recognize the benefits of moderate grazing intensities: some level of grazing is still associated with a MSA = 100% in the relationships (“natural grassland”) and “cultivated grazing area” have a much higher MSA% than extensive agriculture or single-species plantations of trees for instance. The PBL’s meta-analysis does recognize that moderate grazing can have more benefits on biodiversity than low or over-grazing. The guidelines on the number of heads per hectare will be double-checked in the GBS to reflect that as much as possible.
JLP	19	210	219	text lines 210-219 : not clear for me	Me.	Yes		We will clarify more. This paragraph is written for life cycle analysis (LCA) users, and makes a parallel with the LCA framework. "Endpoints" in LCA designate an impact at the end of a cause-effect chain, and "midpoints" in LCA refers to an impact earlier in the cause-effect chain. Reading the GBS terrestrial and aquatic modules documentation provides more information about "biodiversity impact intensities".
FT	20	229		Not clear. Is that the total plant biomass produced by grassland? Or only the fraction that is actually grazed, i.e. eaten by animals?	Te.			Ideally, we would like to apply a similar methodology than for the Crops CommoTool, in which the tonnages are the harvested tonnages (excluding crop residues). However, the available yield data used for the grazing CommoTool is extracted from EUROSTAT 2013 (on which the material account of EXIOBASE environmental extension is based) and seems to be about the fraction that is actually grazed. In the data collection files for the companies, we will clarify that the tonnages grazed by the animals should be provided.
JLP	21	242		I agree with the table but there is no information on the hypothsis and value for coefficients.	Ge.			The table synthetises the definition of each livestock manure category within the FAOSTAT definition, and the mentioned factors derive from IPCC guidelines of 2006 about National GHG inventories, especially the volume 4, chapters 10 and 11. Detailed references will be added in our report.
FT	22	248		A big limitation is that those factors are "Tier 1", i.e. by head. Meaning that the only way to cut emissions is to have less animals. Emission reduction through better management practices cannot be considered, for this you need a Tier 2 approach (biophysical modeling). This could be discussed in the limitations section, if not done already.	Te.			This limitation will be added in the limits section.
FT	23	284		Again, not clear if grazing yields is the total grassland productivity or related to livestock intake. It is an important distinction because livestock may be present on 1ha of grassland but at low density/for only part of the year so the area calculated from intake could be 0.5 ha.	Te.			C.f. comment 14.

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
JLP	24	292		Table : aerage yield of imporved pasture can be far higher than 7 t. (up to 15-20 t in intensive systems). What are the consequences for MSA evaluaiton ? We can find more precise value (at least for Europe)	Me.	Yes		A higher yield would lead to smaller coefficients in MSA.km²/tonne of grass. During the webinar, we have clarified together that this kind of high-yield pastures have low biodiversity value, and are unlikely to reach an MSA of 60% (level of "cultivated grazing area"). The methodology described in this section will actually be changed: we realized that the FAO pasture country profiles data are not easily retrievable and could be quite old. Therefore we would take instead a world average yield at 2.5 t/ha (15% of moisture content), corresponding to the extensive pasture average yield according in EUROSTAT 2013, and apply to it national land use intensities from the terrestrial module (MSA.km²/km²).
FT	25	295		See also European data https://land.copernicus.eu/global/themes/vegetation It is indeed challenging especially because of the difference between total biomass production and what is actually available (presence of water, accessibility, palatability) and used by livestock.	Da.			Thanks for the suggestion, it will be added.
FT	26	329		Ok it responds to my previous question.	Ed.			NA
FT	27	332		I would use the LCA methodology "to allocate impact", "allocation"	Me.			Here indeed "allocation" in the LCA frameworks can replace "attributing", but we used here the term "attributing" to be consistent with all the other GBS review reports structures, where we used the terms "dimensioning" and "attributing", and also because "attributing" is broader than "allocating". Dimensioning step determines the contribution of each commodity production to the biodiversity impact. Attributing step shares the responsibility of the dimensioned impact not only between the co-products of a same process (such as in the LCA framework), in the terrestrial module of the GBS, notably for the pressure Atmospheric nitrogen deposition for example, the "attributing" step shares the global impacts caused by N volatilization between different economic sectors.
FT	28	337		No clear what is meant by "attributing responsibility to grazing". I understand that a different tool is used for feed crops, animal husbandry and grazing, but it makes little sense to allocate the impact to those things, you would allocated impacts to a product, or maybe a farm, which will actually combine those things	Te.			Indeed, grazing and livestock husbandry CommoTools in practical would not be used separately. The expression may be clumsy, we have done this artificial distinction between grazing and livestock husbandry to avoid double counting. Please refer to comment #4 for the direct/ indirect impacts and the Scope concept.
JLP	29	346		You consider GHG emission from manure left on pasture (and associated loss of bidiversity) but dungs can have positive effect on biodiversity (ressources for insects). More generally the impacts of manure spreading on soil biodiversity is not considered. It could be positive or negative acconding to the intensity and form (liquiid vs solid manures) In addition, some results showed higher biodiversity (invertebrates, insects, microbes) in grassland soils than arable land. How this i taken into account?	Me.	Yes		In general, to put it simply, the GBS can take into account practices more precisely only if they have influences on the following elements: land cover management intensity; GHG emissions; water consumption; and nutrient emissions (nitrogen and phosphorus). In the case of manure spreading practices, with the present available data, we can only account for the parameters GHG emissions and nutrient emissions. Soil biodiversity is not reflected in these parameters and is not considered in GLOBIO cause-effect relationships and thus in the GBS. This limit will be mentioned more precisely in the introduction of the report.

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
FT	30	464		Good to acknowledge this, I think it should also come earlier, in the introduction. Also, an important limitation of MSA is that it can only reflect negative impacts because the best possible value is 100% (no impact). As you just said, grazing can be used for restoration (i.e. positive impact, somehow >100% MSA), and in agroecosystems were grazing has long history and wild herbivore are extinct (e.g. Europe), no livestock would mean no grassland and a loss of biodiversity. This needs to be discussed in the limitations	Me.			A discussion of these topics will be added in the introduction and the limitations. Biodiversity footprint assessment for companies will not just reflect negative impacts. For example if the assessed company has at the beginning of the evaluation a degraded parcel in terms of biodiversity (for example an intensive cropland with a MSA of 10% in the GLOBIO pressure-impact relationships), transforming it to a grazed pasture ("cultivated grazing area" at a MSA at 60% in the GLOBIO pressure-impact relationships), a gain of MSA would be registered. Grazing can thus indeed be used to register gains of biodiversity. In agroecosystems where grazing has a long history and where wild herbivore are extinct, grassland grazed by wild herbivores should be theoretically the “reference” undisturbed state. If livestock is maintained (provided that there is no overgrazing), an overall good MSA would characterize this agroecosystem. Grazing will however not lead to situations where MSA exceeds 100% as there will not be more species or more abundant populations of native species than in the undisturbed ecosystem. Degradation can be registered in case of overgrazing, and thus other more intensive pasture land uses exist in the GLOBIO pressure-impact relationships. For an example comparing pasture and forest biodiversity, please refer to the response to comment #4 addressed by Jean-Louis Perrault. We will acknowledge in the limitations that the undisturbed state against which grassland’s MSA is assessed is subject to debate.
JLP	31	470	473	The classification is not usual. I do not understand why "man-made grassland" has a MSA=30%. Many Permanent grassland are hot spot of biodiviserity (for ex grassland in massif central and humid montain area in general).	Me.			The land use classes defined here may not always have adapted names but basically reflect different level of management intensities over a common land cover: grassland. "Man-made grassland " (term in Alkemade et al. 2013, equivalent to “Pasture – man-made” in GLOBIO 3.6) means intensively managed grassland, while “Pasture - moderately to intensively used” is moderately managed grassland and “Natural grassland” is the grassland associated to a low management intensity. The land use classes are defined in the GLOBIO cause-effect relationships, from meta-analysis results (Alkemade 2013), based on 24 studies with information on species composition in grazed systems and natural rangelands and pasture management practices criteria. "Man-made grasslands" have a MSA value of 30%, and are defined as "rangeland with high degree of human management, including converted forests" (Alkemade et al. 2013). The selected species information from the papers come from parcels with rangeland management, such as "soil disturbance, clearance of vegetation and application of fertilizers, planting or sowing grass or forage crops". Such pastures correspond to highly intensive mown meadows which do not concern permanent grasslands with biodiversity hot spot in Massif Central for exemple.

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
FT	32	472		I would not put these values here, as they are highly context dependent and depend on grassland carrying capacity. In particular, a "natural" livestock density in temperate systems will lead to degradation and biodiversity loss in more fragile ecosystems (e.g. drylands and also tropical areas) (Asner 2004) Asner, G.P., Elmore, A.J., Olander, L.P., Martin, R.E. & Harris, A.T. 2004. Grazing Systems, Ecosystem Responses, and Global Change. Annual Review of Environment and Resources, 29: 261–299.	Da.			We will double check these figures, however they come from the supplementary material of the meta-analysis determining the pressure-impact relationships between grazing intensity and MSA (Alkemade et al. 2013) and were deduced from observations in the papers on which the meta-analysis is based on.
FT	33	474	477	See my previous comment, I disagree with this. Probably a majority of grassland in France for instance, (think massif central, alps, or bocage) have biodiversity levels equal if not higher than "natural" forests	Ge.			C.f. comment 21. It is indeed possible that there are more species in a grassland than a forest. However, do we want to replace all the forests by pastures to maximize the number of pasture species? The MSA of a forest can be higher than the MSA of a pasture because it is assessed against an undisturbed forest (with forest species) and not against an undisturbed grassland (with grassland species).
JLP	34	475	477	Why do you assume that biodiversity of man-made grassland is lower than that of natural grassland (what is natural grassland?)	Ge.			C.f. answers for comments #10 and #11.
JLP	35	477	478	I do not agree with the asumption.	Me.			We seek to build impact factors per tonne for default assessments. We need to associate an average land use to an average tonne grazed. The "Natural grassland" land use class in GLOBIO cause-effect relationships (MSA = 100%) is based on data extracted from papers for the meta-analysis and include for instance undisturbed savanna, natural reserves, without grazing or with very little grazing (wildlife grazing or no grazing). Some grazing intensity figures were given, such as 0.07 animal units per hectare (1 unit = a 455 kg steer). The higher MSA value of “Natural grasslands” is not an assumption but a result from the meta-analysis by the PBL. The land use class "Pasture - man-made" (MSA = 30%) cannot be used as no land use intensity factors are available in the GBS (cf. GBS terrestrial module review document for more details). Therefore, we have chosen "Pasture - moderately to intensively used" (MSA = 60%, also called “cultivated grazing area” in the terrestrial module of the GBS) as the default land use for grazing. It is described as "rangelands with higher stocking rates [than natural rangelands], grazing has different seasonal patterns or vegetation structure is different compared with natural rangelands" (Alkemade et al. 2013). In refined assessments, the other two land uses could also be considered. Besides, a s mentioned during the webinar, we will also investigate the grazing thresholds in the right column in table 8.
JLP	36	530		dairy systems also produce meat	Ge.			Well noted, this could be considered in a future version of the GBS. For now, the allocation between animal products is based on FAOSTAT data about livestock cohorts population data, which separate meat and dairy cohorts.

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
JLP	37	571	577	Allocation remains a major issue. I encourage a biophysic allocation. This might have large effects on the results for ruminants (some of them produce milk and meat in the same time)	Me.			Well noted, this could be considered in a future version of the GBS. For now, the allocation between animal products is based on FAOSTAT data about livestock cohorts population data, which separate meat and dairy cohorts.
FT	38	571		GLEAM only partly follow the LEAP guidelines - a multi stakeholder partnership reflecting consensus among the sector on these aspects (allocation rules are described in details in the GHG emission guidelines for feed and different livestock species)	Te.			We will add these precisions to the paragraph.
FT	39	706		this is like saying "tonnage of forests", it doesn't really makes sense. I did this a bit and I trust members of the expert panel to do it further but I think the language of the document must be carefully checked by a livestock expert	Ed.			It will be replaced by "tonnages of grass".
FT	40	879		The LEAP Principles for the assessment of livestock impacts on biodiversity http://www.fao.org/3/a-i6492e.pdf should be cited here in (or somewhere else in the document). As mentioned before, LEAP is an FAO coordinated multi stakeholder initiative reflecting the sector consensus on how to assess its environmental impact. As such, I think it would be important here to discuss why/why not/which principles were followed. As an example, principles include the recommendation to look at off farm impacts from feed (which you do) and at positive impacts (which you don't, cf. previous comment). Another exercise of international consensus is the UNEP-SETAC life cycle initiative, and the task force on biodiversity impact through land use in LCA. They recommended a specific method (Chaudhary & Brooks 2018) (LEAP aligns with this for LCA in a recent document), and it would also be worse discussing why MSA was used instead of this or another method - although this is not specific for livestock and might already be discussed in another GBS document. https://www.sciencedirect.com/science/article/pii/S0959652615010495 Chaudhary, A. and Brooks, T.M., 2018. Land use intensity-specific global characterization factors to assess 29 product biodiversity footprints. Environmental science & technology, 52(9), 5094-5104.	Te.			These principles apply to the way a Biodiversity Footprint Assessment (BFA) should be conducted (and not just to the way the CommoTool is built). We will add reference to the LEAP overarching principles in the the limits of this document, and in the "Quality Assurance" review document. The livestock husbandry CommoTool and the grazing CommoTool are only a part of the biodiversity assessment, as they are the impact factors linking commodities and biodiversity footprints in MSA.km². However, some points raised by these principles should also be addressed within the CommoTools, such as the reference question. To clarify again our answer to comment 21, positive impacts are taken into account in the GBS and the grazing CommoTool.

Reviewer	Comment index	Line number	ref to specific item	Comment (Livestock husbandry and Grass CommoTools)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
JLP	41	898		DO you expect to consider the roel of grassland in regulatingwater flow?	Me.			We are open to take into account the benefits of grasslands regarding water regulation but we have not identified any data source so far. Databases such as ones on water footprint would more likely contain direct water consumption or withdrawal, but not the role of water flow regulation.
JLP	42	911		Livestock biodiversity (I mean animal breeds and species) are not considered. It is typically a human production of biodiversity and a positive contribution of livestock farming	Me.			The focus of the GBS is on wild biodiversity and not breeding biodiversity: genetic diversity and cultivated biodiversity are not included in the GBS (including in modules such as the Crops CommoTool for plant cultivation). This will be clarified in the limits.
JLP	43	911		The landscape dimension is not catched although it could be a contribution of livestock farming. For example, Temporary grassland increases the richness and diversity of habitat in mixed farming landscapes and therefore positively influences biodiversity at the territorial level. Or, the specific richness (gamma) of a heterogeneously managed landscape exceeds the specific richness (alpha) of a plot.	Ge.			Concerning the land use pressure of the GBS, the landscape dimension is indeed not systematically treated in each underlying papers used by the PBL for the meta-analysis of pasture land uses in GLOBIO linking grazing intensity and MSA values (Alkemade et al. 2013). Some studies have observed this aspect, including a higher biodiversity value in some grazed areas compared to abandoned pastures. Aside from the land use pressure, the GBS deals with Fragmentation and Encroachment pressures, which are an aspect of landscape biodiversity. But overall, it is true that the interactions of pressures in a landscape are not taken into account by GLOBIO cause-effect relationships: this will be clarified in the limits.

Wood logs CommoTool

Reviewer	Comment index	Line number	ref to specific item	Comment (Wood logs CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
LPK	1	47		Reliance on the WWF report for context is problematic for several reasons: 1) data was published in 2015 and rather outdated; 2) uncertain whether the data is peer reviewed; 3) the X million ha of forests and deforestation fronts do not seem to correspond to the size of the green and red areas illustrated in Figure 1 (e.g. the 22 million ha in Borneo appears to be smaller than the 7 million ha in New Guinea)	Te.	Yes	Use a more recent, peer reviewed reference for setting the context.	We will use data from FAO FRA as a source for past forest area loss (global and identification of the most impacted regions). We found no reviewed paper analyzing predicted forest loss at a global scale to replace the WWF report. Considering that trends are very important regarding the aim of the tool and biodiversity erosion, we stick to WWF report for the paragraphs of the context section dealing with global deforestation trends and highlight the non-reviewed status of this study which serves only to provide the readers with generic information regarding the state and trends linking raw material extraction and biodiversity issues. The caption will clarify that red areas correspond to areas where deforestation is predicted to occur, not to the total area which will be deforested. GBS reports are technical manuals of the tool rather than scientific publications, thus the constraints to rely on peer-reviewed materials is less stringent for us and should be balanced with providing general understanding to the readers (who are often non-experts).

Reviewer	Comment index	Line number	ref to specific item	Comment (Wood logs CommoTool)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
LPK	2	62		A similar point to above, in that the Kok et al. 2014 reference is old and not from a peer reviewed scientific journal.	Te.	Yes	Use a more recent, peer reviewed reference for setting the context.	We were not able to find more recent peer-reviewed work estimating future biodiversity impacts due to wood production. In our opinion, the most interesting part of this figure is the predicted impacts under b-a-u scenario more than the impacts computed for the year 2010. We will clarify the status of this work in the report
LPK	3	90		Parts of the figure are obscured by the labels "CommoTools: From product inventories…" and "Tables derived from EXIOBASE…"	Ed.	Yes	Rework figure.	Indeed. The figure will be reworked to ensure that labels do not hide the text
LPK	4	156		It is not clear at all how the tool measures the impact of climate change on biodiversity. Is biodiversity impact evaluated based on changes in the range of species due to climate change?	Me.	Yes	Needs elaboration.	The detailed methodology to account for the impact of climate change is provided in the Review report dedicated to Terrestrial pressures. A sentence advising readers to first read the Introduction, Terrestrial pressures and Aquatic pressures reports was added at the very beginning of the Woodlog report since those reports are indeed required for a good understanding. Also, the methodology is now briefly exposed in the Wood logs report at line 156
LPK	5	203		Figure 6 is confusing. Why are some "pressures" (e.g. Terrestrial spatial) driving "Forestry systems", but other "pressures" (e.g. climate change, aquatic) a result of "Forestry systems"? Instead of helping clarify the relationship of the different factors, the figure is causing more confusion.	Ed.	Yes	Rework figure.	Indeed. The figure will be reworked. All Scope 1 impacts will be moved into the central box (forestry system) for more clarity. Thus direct impacts of forestry systems will be inside the box, and indirect impacts (Scope 2 and 3) will be outside
LPK	6	533		Related to comment #4 above, it is unclear what assumptions are made in assessing the impacts of GHG emissions on biodiversity. The material refers to CDC Biodiversite 2019f and 2019b only. I think it would be helpful to restate the main concepts and assumptions of this GHG-biodiversity impact methodology here as well.	Me.	Yes	Needs elaboration.	Linked to the answer to comment #4. The assumtions and limitations regarding the way pressures are handled in the GBS are detailed in the Terrestrial and Aquatic reports but will be mentioned also in the Wood logs report (and reports on the other CommoTools where needed)

Input-Output modelling

Reviewer	Comment index	Line number	ref to specific item	Comment (Input-Output modelling)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	1			For me it was not clear if these documents are meant as internal documentation or will be available For a wider audience. In the latter case, language revision and restructuring For clarify / consistency would be very helpful. E.g. I was often not follow the arguments / approaches presented and terms were often ambiguous / not clearly introduced.				The review reports will be publicly available. Indeed reading this report on its own is not easy, but in fact it is not meant to be a standalone document. Readers of the review reports will be advised to read at least the Introduction, Terrestrial pressures and Aquatic pressures reports. We consider the review documents mainly as technical documents with a lower threshold for editorial style. We will howver try as much as possible to conduct a final editorial check on the review report but we acknowledge that its editorial style may be of lower quality than our “official reports”. Reading difficulties may also stem from the fact that the practical part (computation of D and M matrices for crops, metals, etc.) is sometimes separated from the reports dealing with these subjects. The phase 2 and phase 3 reports dedicated to other CommoTools integrate a section "Linkage with the IO approach" on the computation of the corresponding D and M matrices. It is currently a duplicate to the “D and M for commodity XX” sections in this report.
TK	2			It remained a bit unclear why the IO modelling framework was chosen. Intrinsically it will create many, many links for the supply of any given product, some of them can be very indirect. E.g. the food of a worker in a Chinese coal plant (if bought by the company) that provides coal to a factory that produces goods that are exported and bought by company x in Europe. This would be included in scope 3 if I understood correctly. While this is scientifically interesting, it is not evident what is the added value for a company of such a detailed information? Where are points of intervention for improvement here.				The use of IO modelling is not to integrate such detailed information. It is based on the reasons introduced on lines 36-39 and 107 to 127 (also line 872). Basically, IO modelling allows the assessment of the footprint of companies and their value chains based on limited and publicly available financial information. As such, IO modelling allows the computation of sectoral benchmark values, the assessment of default impacts for any company, and the assessment of investment portfolios and financial institutions. Also, IO modelling seemed the best fit to assess companies Scope 3 impacts with limited data, although some non-material elements like the one you mention will necessarily be introduced. Distinguishing between impacts related to direct suppliers (tier 1) from suppliers further in the value chain is a way to quickly distangle relations like the one you mention: impacts due to coal production is in company's tier 1, while impacts due to the production of the worker's sandwich are not.
TK	3	111		what does this mean exactly? By using monetary logic IO models can introduce quite some biases if products within one sector do not follow the homogenous price assumption (which should be discussed). Also the monetary logic creates issues with price fluctuation/inflation.				It refers to consistency between the monetary part and the physical amounts documented in the extensions (emissions and material extraction especially). Yes these biases and issues regarding price fluctuation are discussed in the limitation section and we propose to explore translating monetary data into 2005 euros (used in EXIOBASE) to correct for inflation.
TK	4	132		EXIOBASE has the highest level of detail for EU countries -> are those the primary target for the GBS application?				The scope of the GBS is global, and not a particular geography like the EU. Yet, detailed data on EU countries are valuable. While EXIOBASE does not cover some countries in Africa very well for instance, no other EEMRIO model covers those countries well either, as far as we know. The homogenous and detailed industrial coverage and detailed environmental extensions were the main reasons explaining the choice of EXIOBASE (vs alternative EEMRIO models).
TK	5	183		why was this input from CML required? Was this a one time request?				The matrix inversion was not doable with R, due to memory limitations. Yes it was a one time request

Reviewer	Comment index	Line number	ref to specific item	Comment (Input-Output modelling)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	6	219		Page 10: footnote: using the same term for two different concepts is highly confusing. Consider renaming one.				Actually it is not exactly the same term since we always use the full expressions "data quality tier" when referring to data quality and "tier N suppliers" when referring to suppliers tiers
TK	7	134		Often references to other documents that are not available are inserted (e.g. list of sectors etc.)				Yes, this is the issue with parallel document writing. It is was easier for us to directly insert references to future documents during redaction. In the end, of course, all documents will be available and this issue will be solved. Especially, the document referenced here is the Appendix, which is completed as main reports are written.
TK	8	331		unclear what non-primary crop means. Why is fodder not primary?				Following FAO, EXIOBASE calls crops dedicated to human consumption "primary crops". By extension, we called the rest "non-primary" but we could in fact stick to "primary" and "fodder"
TK	9	366		Section 2.1.B.2.3: would be good to have input by mining expert here.				Yes we agree. This part on the construction was also integrated in the Mining report, which was reviewed by a mining expert.

Reviewer	Comment index	Line number	ref to specific item	Comment (Input-Output modelling)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	10			The fine resolution of crops vs. the EXIOBASE sector resolution might be problematic. The land use accounts in EXIOBASE match the sectors in the MRIO model. The material extensions are much finer (e.g. match the availability of FAOSTAT data for crops). What kind of bias will this introduce? This should be discussed and explored. For instance in EXIOBASE Cassava, Avocados and Apples are in the same group (with many other items), i.e. within the MRIO model homogenous prices will be assumed and it will not possible to distinguish monetary flows between these products. Similar issues will arise in non-primary sectors where I have less insight.				The limitation section will integrate these elements. In the GBS, monetary flows are always translated into raw material flows. Thus, euros of production or purchases are transformed into tonnes of apples and avocados, and this number of tonnes is different for the two products. Combined with the material account, the IO table thus provides a "price vector" rather than a homogenous price for all products extracted by the industry. Indeed, this price vector is fixed and corresponds to the year of the data (2011). Hence, changes in the material flows or relative prices of products extracted by an industry indeed cause the inventories computed through the IO model to be flawed. Two options exist to overcome this limitation: replacing default inventories computed through the IO module by real inventory data provided by the company assessed (refined assessment) and working with more recent IO data. EXIOBASE will soon release the 2016 update, which will be integrated into the GBS. In our opinion, EXIOBASE sectors provide acceptable details of the products value chain, i.e. distinguishing raw material extraction from processing, manufacturing, distribution, waste treatment/recycling etc. Yet, it is true that: 1) production of/purchases to an industry will always be considered to concern all the materials extracted by the sector (no possibility to buy only apples and no avocados) 2) monetary flows between apple producers and avocados producers cannot be isolated. Hence we insist (line 116 for instance and in the Introduction report) that IO data are simple averages, so that the use of IO modelling only provides a sectoral benchmark and default value of a company's footprint. If a company can provide real data related to its production and purchases (for instance showing that it produces only apples), then this data and the related impact are used to replace the default value in the results (the default impact of the production of avocados is set to 0). Also, it is more suited to the assessment of large companies, which activities better match the delineation of EXIOBASE industries. We added a section in the "Limitations" to underline this fact.

Reviewer	Comment index	Line number	ref to specific item	Comment (Input-Output modelling)	Type of comment	Major comment	Suggestion by the reviewer	Answer by CDC
TK	11			Linked to the previous point, it would be good to have more complex examples than “production of 1 MEUR of wheat” -> e.g. look at products in aggregated categories (see above avocados, cassava, etc). And look at higher processed products higher up the value chain. E.g. company buying wheat, a company buying bread etc. Also as mentioned in the first comment: the results will show links between many countries and sectors. How are these presented to the companies? Only in aggregated form? Maybe a “real-life” example with a test company would be good. Also, can the results also be presented as a map? where do the impacts occur?				The example of the fictitious portfolio (starts line 816) is indeed meant to also show the typical results obtained for companies operating higher in the value chain (FOOD1 and FOO2 operate partly in processing industries). We will insert the default inventory computed for FOOD2, so that a more complete vision of the IO results is given to the reader. We will also specify what would happen if the real price of one of the items in the inventory changed: the computed impact would remain the same since the change is not reproduced in EXIOBASE data, so that the computed impact would be overestimated (the price increase causes less tonnes to be bought, so that the true impact is smaller after the increase). The case studies presented in our publications also illustrate other cases, for instance the case study with BNP Paribas Asset Management involves companies operating in the distribution sector with large purchases to the food processing sectors. Case studies partly demonstrate how results can be presented to the companies. Not everything is set up now since the methodology is still under development, but we plan to be very flexible with the presentation of the results to suit companies specificities and the objectives of the assessment. The computed results are thus very disaggregated, and can be aggregated in various ways according to the analyses required. For instance, they can be presented by industry, region (a map is indeed envisaged), pressure, commodity, sourcing location... We agree that tracing flows is one of the key feature allowed by MRIO models, thus we have an experimental tool allowing to trace the flows and associated impacts between regions and industries

Annex II: Letter from Mark Huijbregts and answer from CDC Biodiversité

Mark Huijbregts was part of the expert panel for this review. He commented on several reports, but asked to withdraw before the end of the review process. He was not involved with drafting the present report. The conclusions that are presented as his in this report have been extracted from a letter from March 22 2020, addressed to Antoine Cadi, Head of Research & Innovation at CDC Biodiversité. His integral letter and the answer from CDC Biodiversité are presented in the following pages.

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Our reference	Your reference	Telephone	Date
MH/20.223		+31 24 365 28 35	22 March 2020

Subject	E-mail
Scientific concerns about the GBS-tool	M.Huijbregts@science.ru.nl

Dear Antoine Cadi,

Thank you for your letter 3rd March 2020 with your request for further explanation why I consider the GBS tool not sufficiently scientific robust to be recommended for practical use.

My arguments why the GBS tool does in my opinion not meet the minimum scientific standards are the following:
(i) the method proposed is in my opinion not a footprint method, as it does not appropriately integrate biodiversity impacts over time nor does it explain why it is an advantage not to do so, except for getting the time dimension out of the unit. The key strength of any footprint method is that it integrates pressures, space and time into a limited set of environmental indicators. You can find more methodological details in many footprints handbooks, including the reports on product and organization environment footprints of the European Commission. The extra documentation that has been provided by the GBS-team explains what has been done for the time dimension and the differences between common footprinting and the new biodiversity footprint method proposed in the GBS-tool, but not why this change is needed, and why the newly proposed method is better and more intuitive for a company to be used in practice. An organizational environment footprint (OEF) represents the life cycle environmental impact that is directly and indirectly caused by the activities of that organization in a certain year, but not limited to the impacts occurring in that specific year. The GBS-tool particularly emphasizes the importance of currently occurring impacts and largely neglects in its reporting the time-integrated impacts of pressures which stay for a longer time in the environment, such as common greenhouse gas emissions, including carbon dioxide, methane and nitrous oxide. This is also shown in the example calculations provided in the new document where in the hypothetical example land use is the single important pressure in the GBS-tool reporting, while according to time-integrated impact calculations, both land use and climate change matters. My biggest concern with the new GBS-tool is therefore that the focus of companies will be on reducing pressures that have an immediate impact, but largely neglecting pressures that may have larger biodiversity impacts on the long run. This is exactly why life cycle methods aim for integration of impacts in three dimensions: pressures, space and time. The new GBS-tool fails in my opinion to address the time dimension in an appropriate way. This is also the reason why I do not agree with your statement that the GBS-tool can be used with sufficient confidence to integrate the impact of land use and climate change pressures. The best the GBS-tool can offer at the moment is the integration of impacts of different land use types.

(ii) As the GBS-team did not have practical access to the GLOBIO model-codes for both the terrestrial and aquatic environment, the actual calculation of the MSA loss factors for all environmental pressures, except land use, is ill-defined. To calculate MSA loss factors in a scientifically valid way, individual pressures for each region-sector combination need to be excluded one by one. I very well understand this requires substantial effort and intense collaboration with the GLOBIO-team. However, as this has not been done up to know, I can only conclude that the MSA loss factors provided in the GBS-tool are not sufficiently scientific robust to use in practice with the exception of the MSA loss factors for land use.

(iii) The MSA-footprint method proposed for chemicals does not have any empirical underpinning. As far as I know, there is no single study published in the literature that quantified pressure-response relationships for chemicals in relation to MSA loss. I very well understand that practical tools cannot always wait for the 'perfect science' to be developed, but in this case the documentation for chemical impacts lacks any scientific robustness.

I hope this letter further clarifies my three main scientific concerns with the GBS-tool and why I do not recommend to use the tool for current use by companies, also not as a directional compass. The GBS-tool needs in my opinion (i) a more appropriate strategy to deal with time-integrated impacts, (ii) a better underpinned operational strategy to calculate MSA loss factors in practice for all environmental pressures, except land use, and (iii) major further scientific underpinning of the text on ecotoxicity.

This letter with my main concerns about the GBS-tool can be published as part of the review process, as well as actively shared with any potentially interested party, including the rest of the review committee.

Yours sincerely.

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Mark Huijbregts
Professor
Radboud University

Paris, 3 March 2020

Dear Mark,

We would like to thank you again for your very valuable feedback, which in any case will improve the GBS. We acknowledges the fact that for some pressures on biodiversity, the assumptions initially proposed are not satisfactory and cannot be considered rigorous based on best scientific practices. As a consequence, we suggest to clarify the objectives of the tool as providing a screening of the risk of impacts on biodiversity for companies and financial institutions, with more or less uncertainties depending on the pressures assessed. It considers that, as you highlighted, the initial assumptions for the following pressures are arbitrary: atmospheric nitrogen deposition, hydrological disturbance, freshwater eutrophication and ecotoxicity. The communication around the tool would be adjusted in line with this aim of risk screening: the GBS can be considered as a compass to guide companies in the right direction, and not a balance to weigh the exact impacts caused by their activity.

We have not yet had the opportunity to provide answers to your comments. The aim of the webinar you joined was to clarify our understanding of your comments. As a consequence, during that webinar, we mainly discussed what we had not understood from your comments and tried to clarify elements you had not understood. We did not seek to answer your comments directly. You can find our answers to your comments in the Excel files attached. Edits and changes in the review documents will follow shortly.

The GBS aims to be as rigorous as possible and has not yet reached the level of rigour CDC Biodiversité would like to achieve over the next few years. The current level of scientific research and the limited access provided to us to some models up to now causes, in some cases, some not very rigorous shortcuts and assumptions to be made to link robust pressure-impact relationships from GLOBIO to company data. Access to these models may be granted to CDC Biodiversité in the near future. In particular, your feedback may help highlight to the PBL the interest and need to facilitate access to the IMAGE component which model atmospheric nitrogen depositions and to the PCR-GLOBWB and LPJmL-hydrology models regarding the amended annual proportional flow deviation. We would be very happy to find ways to integrate intermediary calculations from these models – and others – to come up with more solid assumptions regarding impact attribution. Some researchers at the PBL had also shown interest in collaborating on such topics, and your feedback might positively catalyse such a collaboration. Your feedback also allowed us to directly correct some assumptions. For instance, for atmospheric nitrogen deposition, following your feedback, a global average impact factor is now used.

Regarding time integration, a specific explanation has been added to the Introduction review document to clarify the consequences of the approach we chose compared to a time integrated approach, making the advantages and drawbacks clear.

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Finally, and importantly, the criticisms you formulated and which we were not able to fully address focus on some pressures and less on others. Land/Sea Use Changes and Climate Change represent about 44% of the contribution of all drivers of biodiversity loss according to the IPBES (Díaz et al. 2019) and the feedback you provided has mostly been addressed by CDC Biodiversité. Invasive Alien Species accounts for 11% and is not covered by the GBS. Direct Exploitation (23%) and Pollution (14%) are partially covered by the GBS and its assessment of those pressures is a lot less robust. The tool can thus be broken down into a component including Land use and Climate change with a higher degree of confidence, and a component including the rest with a lower degree of confidence. The first component represents a higher contribution to the drivers of biodiversity loss than the second. CDC Biodiversité believes that the first component can be used with enough confidence to report changes in biodiversity losses or gains caused by businesses related to the Land use and Climate change pressures. Would you agree that the degree of confidence varies for different pressures? We believe your feedback in the review's Excel forms was more detailed and specific than your latest email and it could be valuable for everyone involved to differentiate more between pressures in your final feedback on the GBS.

Thank you for the time and commitment already spent on this review.

Best regards,

Antoine Cadi
Head of Research and Innovation
CDC Biodiversité