



Rethinking Trade for the Ecological Transition: Quantifying the Trade Drivers of Planetary Boundaries

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This review verifies the reproducibility of the exhibits included in the paper "*Rethinking Trade for the Ecological Transition: Quantifying the Trade Drivers of Planetary Boundaries*".

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Main findings

- **Every exhibit has been reproduced accurately.**
- The reproducibility verification was carried out in two parts.
- Two scripts were executed on a server due to their high computational demands. This step was performed on the authors' server. The replicators held a virtual meeting with the team on *March 28, 2025*, during which the authors ran the code live. After the meeting, the authors shared the output files with the replication team, who then verified that the results matched those shared at an earlier stage to assess stability.
- The second part of the verification involved taking the outputs generated by the authors and running the `Create figures.R` script. This script either produces the final results directly or generates the inputs needed to create visualizations using Flourish. The verification confirmed that the datasets and values provided successfully reproduced the exhibits presented in the paper.
- For the portion of the code that was run by the replicators, the code was successfully executed on a new computer following these steps:
 1. Opening the R Project file.
 2. Restoring the environment using `renv`.
 3. Running the script `Create figures.R`.
- The output demonstrates consistent stability across multiple runs. Specifically, executing the code two times consecutively yielded identical results.
- The portion of the code executed by the authors takes approximately 10 hours to run. In contrast, the `Create figures.R` script takes about 2 minutes to execute.

- We conducted our reproducibility analysis based on the paper shared by the authors.
- **Reproducibility Summary:**
 - **Data:** Some data is restricted and has not been included in the reproducibility package. For more details, please refer to the README file.
 - **Code:** All code files (from cleaning to analysis) are included in the reproducibility package.
 - **Outputs:** Some outputs are not generated by code (created manually in Excel, ArcGIS, etc) but instructions for producing these outputs are included in the README file.
 - **Reproducibility verification:** Reviewers used data provided directly by the authors to conduct the reproducibility verification, and this is not included in the public reproducibility package. The reviewers did not verify if publicly available data matches the data provided by the authors.
 - **Dependencies environment:** The reviewers created a new environment for dependencies using the latest versions available for each dependency at the moment of the review.

List of exhibits and reproducibility status

Results in the Main Section of the Paper

- **Figure 1 Reproduced with manual edits.** The figure was generated using the output from the R code and visualized with Flourish. We reviewed the Footprints_inTrade dataset, and since the numbers match, we consider this figure reproducible.

Assumptions:

- *Biogeochemical flows* = fertilizers
 - *Change in biosphere integrity* = biodiversity_loss
 - *Land system change* = lands_use
 - *Blue water consumption* = Blue_water_consumption
 - *Water stress* = Water_stress
 - *Climate change* = CHC_Emissions
 - *Novel entities* = Chemicals
- **Figure 2 Reproduced with manual edits.** The figure was generated using the output from the R code and visualized with Flourish.

Notes on minor discrepancies:

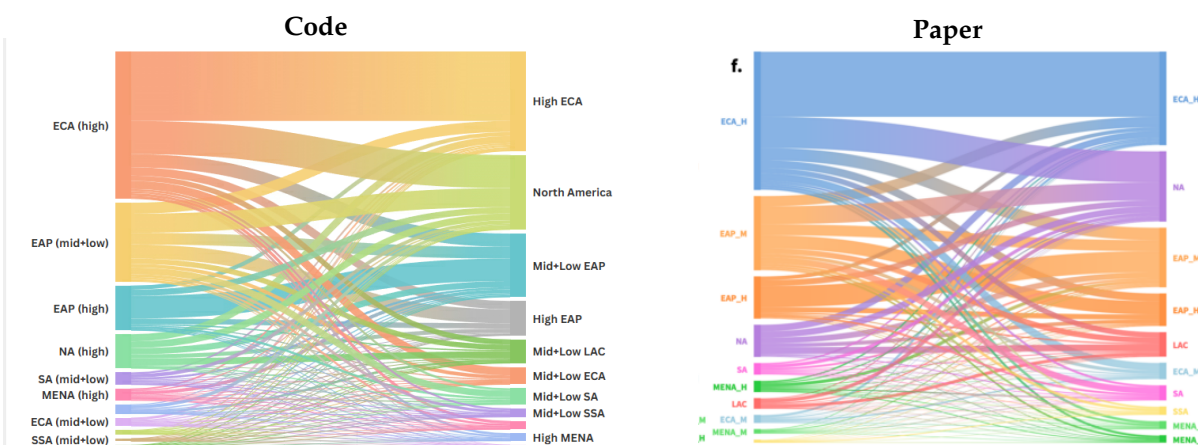
- *Change in biosphere integrity (High income):* The code outputs a value of 41.44, while the paper reports 42. This is a minor difference and does not affect reproducibility.
- *Climate change (High income):* The code outputs a value of 53.35022, while the paper reports 54. This small difference can be attributed to rounding and does not affect reproducibility.

- **Figure 3** Reproduced with manual edits. The figure was generated using the output from the R code and visualized with Flourish.

There are two minor differences between the replicated figure and the version in the paper. First, there is a slight variation in color assignment when uploading the CSV files to Flourish. Second, in the paper, Latin America and the Caribbean (LAC) is presented as a single region, whereas in the output generated by the code, LAC is divided into two components: *High LAC* and *Mid+Low LAC*.

However, it is clear that the LAC region in the paper corresponds to the sum of these two components. Therefore, despite these minor differences, the figure is considered reproducible.

For an example comparison between the replicated version (created in Flourish) and the figure in the paper, please see below.



- **Figure 4** Reproduced with manual edits. This figure was generated using the output from the R code and visualized with Flourish. While there are minor formatting differences, these can be manually adjusted in Flourish.

To replicate the figure:

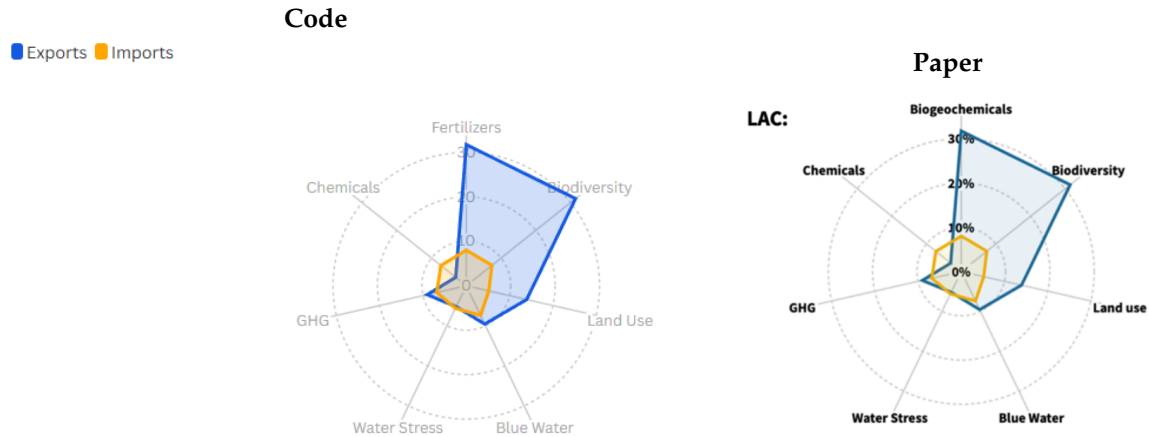
1. Navigate to the Outputs/Radar folder and upload the relevant datasets to Flourish.
2. Create a new radar chart visualization in Flourish.
3. Upload the data and configure the chart so that the **indicator names** are used as labels, and the **chemicals** define the radar axes.

Below is an example comparing the replicator's and the paper's version of the figure for Latin America.

- **Table 1** Does not show analysis results.
- **Table 2** Does not show analysis results.
- **Table 3** Does not show analysis results.

Results in the Annex

- **Figure A.1** Reproduced. This figure is generated and displayed directly in the R plotting window.



- **Figure A.2 Reproduced.** This figure is generated and displayed directly in the R plotting window. To reproduce the correct version of the graph, the user must adjust the input values accordingly.
- **Figure A.3 Reproduced.** This figure is generated and displayed directly in the R plotting window.
- **Figure A.4 Reproduced.** This figure is generated and displayed directly in the R plotting window.
- **Figure A.5 Reproduced.** This figure is generated and displayed directly in the R plotting window. To reproduce the correct version of the graph, the user must adjust the input values accordingly.
- **Figure A.6 Reproduced.** This figure is generated and displayed directly in the R plotting window.

Reproduction Environment

- Paper exhibits were reproduced in a computer with the following specifications:
 - OS: Windows 10 Enterprise
 - Processor: Intel(R) Xeon(R) Gold 6132 CPU @ 2.60GHz, 2600 Mhz, 16 Core(s), 16 Logical Processor(s)
 - Memory available: 105 GB
 - Software version: R version 4.4.0