

Overview

This folder produces the results from the paper “The Poverty Cost of Greenhouse Gas Emissions” by Stephane Hallegatte, Daniel Gerszon Mahler, and Benoit Decerf.

Data availability

Publicly available data

All publicly available data and direct URLs to the data or website providing the data are given below. We recommend using the copies in 01-inputdata. The public databases we rely upon may have updates in the future that change the data in the link provided.

- 01-inputdata/class/CLASS.dta. Available from the GPID-WB GitHub repository, [here](#).
- 01-inputdata/gdp/gdp.Rda. Downloaded from the World Development Indicators via the wbstats package, 2025.12.16, see 04-code/1h-gdp.R for details.
- 01-inputdata/ghg/*EDGAR*.xlsx (4 files). Downloaded from the Emissions Database for Global Atmospheric Research (EDGAR) database, [here](#).
- 01-inputdata/ghg/iamc*.xlsx (3 files). Downloaded from Shared Socioeconomic Pathways Database Version 2.0, [here](#).
- 01-inputdata/growth/WEEOct2025.csv. Downloaded from IMFs World Economic Outlook Database, [here](#).
- 01-inputdata/growthshocks/AdoufadelAustin/DMSP* (158 files). From the paper Hall, O., Bustos, M.F.A., Olén, N.B. et al. Population centroids of the world administrative units from nighttime lights 1992-2013. *Sci Data* 6, 235 (2019), [here](#).
- 01-inputdata/growthshocks/Fig3sourcedata.xlsx. From the paper Waidelich, P., Batibeniz, F., Rising, J. et al. Climate damage projections beyond annual temperature. *Nat. Clim. Chang.* 14, 592–599 (2024), [here](#).
- 01-inputdata/population/WPP2024_GEN_F01_DEMOGRAPHIC_INDICATORS_COMPACT.xlsx. Downloaded from the UNs World Population Prospects 2024 database, [here](#)
- 01-inputdata/precipitation_inequality/agrint.Rda. Downloaded from the World Development Indicators via the wbstats package, 2025.12.16, see 04-code/1i-precipitation_inequality.Rda for details.
- 01-inputdata/precipitation_inequality/d* (2 files). From the paper E. Palagi, M. Coronese, F. Lamperti, & A. Roventini. Climate change and the nonlinear impact of precipitation anomalies on income inequality, *Proc. Natl. Acad. Sci. U.S.A.* 119 (43) e2203595119, (2022), [here](#).
- 01-inputdata/temperature/_data_gadm0_era_tmp_concurrent__yearly.csv. From the Weighted Climate Dataset, [here](#).
- 01-inputdata/temperature/251210_weather_data_CCKP.dta. Downloaded through the World Bank’s Climate Change Knowledge Platform, [here](#).
- 01-inputdata/temperature_cf/cmip6_pattern_scaling_by_country_mean.csv. From U.S. EPA’s GitHub, [here](#).
- 01-inputdata/temperature_cf/temporal climate impacts.xlsx. From the paper Samuel J.G. Cooper, Rowan Green, Laura Hattam, Mirjam Röder, Andrew Welfle, Marcelle McManus, Exploring temporal aspects of climate-change effects due to bioenergy, Biomass and Bioenergy, Volume 142, 2020, [here](#).

Data not publicly available

- 01-inputdata/welfare/comparable__pref.Rda. This is an output file from this technical note. The data can be made available by request to dmahler@worldbank.org.
- 01-inputdata/growth/path*.mat (2 files). These are output files from this paper. The data can be made available by request to umueller@princeton.edu.

I certify that the authors of the manuscript have legitimate access to and permission to use the data used in this manuscript.

Instructions for Replicators

- All the input data files mentioned above are already in the 01-inputdata subfolders. Users should be able to simply run each R script sequentially (by alphanumeric order) or consult 00-master.R, with two important exceptions:
- 04-code/3a-main.R and 04-code/3b-material_methods.R contain instructions for how to modify prior R scripts to generate two specific results. This is to avoid having many long and nearly identical R scripts, while also avoiding multiple very large output data files. Here are instructions for how to replicate these two specific results:
- If users want to replicate the finding that of the 141 million years of future poverty, 93 are expected to occur due to growth shocks to average incomes, they should proceed with the following 7 steps (also outlined in 04-code/3a-main.R line 129-142)
 1. Run files 1a-2e in order, and everything of 3a-main.R above line 128.
 2. In 2a-damages_historical.R, replace line 55
 - from `for(i in 1990:2024) {`
 - to `for(i in 2024:2024) {`
 3. In 2a-damages_historical.R, add `#` before lines 78, 80, 81, and 83
 4. In 2a-damages_historical.R, add `#` before lines 173, 208, 209, 210 and 211
 5. Run 2a-damages_historical.R. It will return an error, that's ok.
 6. When the code has run, execute `sum(damage_country_temp$poor_300_da_df0)/10^6`
 7. Undo steps 2, 3, and 4.
Users can run lines 144-398 of 3a.main.R to generate Figures 3, S4, 2C, S2, 2B, 2A, 1C, and S1 independent of the seven steps above.
- If users want to replicate Figure S5, they should proceed with the following 14 steps (also outlined in 04-code/3b-material_methods.R line 14-52)
 1. Run files 1a-2e in order.
 2. In 1g-welfare.R change line 44
 - from `growth <- growth |> filter(scenario=="med") |> select(-scenario)`
 - to `growth <- growth |> filter(scenario=="low") |> select(-scenario)`
 3. Run 1g-welfare.R
 4. In 2a-damages_historical.R, change line 211
 - from `save(ea_gas, file="03-outputdata/ea_gas.Rda")`
 - to `save(ea_gas, file="03-outputdata/ea_gas_low.Rda")`
 5. Run 2a-damages_historical.R
 6. In 1g-welfare.R change line 44
 - from `growth <- growth |> filter(scenario=="low") |> select(-scenario)`
 - to `growth <- growth |> filter(scenario=="hig") |> select(-scenario)`
 7. Run 1g-welfare.R
 8. In 2a-damages_historical.R, change line 211
 - from `save(ea_gas, file="03-outputdata/ea_gas_low.Rda")`
 - to `save(ea_gas, file="03-outputdata/ea_gas_hig.Rda")`
 9. Run 2a-damages_historical.R

10. In 1g-welfare.R change line 44
 - from `growth <- growth |> filter(scenario=="hig") |> select(-scenario)`
 - to `growth <- growth |> filter(scenario=="med") |> select(-scenario)`
11. Run 1g-welfare.R
12. In 2a-damages_historical.R, change line 211
 - from `save(ea_gas, file="03-outputdata/ea_gas_hig.Rda")`
 - to `save(ea_gas, file="03-outputdata/ea_gas.Rda")`
13. Run 2a-damages_historical.R
14. Run lines 54-108 of 3b-material_methods.R

List of Exhibits

The provided code reproduces all tables and figures in the paper.

Exhibit name	Script	Output filename
Fig 1a	04-code/3a-main.R, line 12	05-figures/Fig1a.jpg
Fig 1b	04-code/3a-main.R, line 12	05-figures/Fig1b.jpg
Fig 1c	04-code/3a-main.R, line 139	05-figures/Fig1c.jpg
Fig 2a	04-code/3a-main.R, line 188	05-figures/Fig2a.jpg
Fig 2b	04-code/3a-main.R, line 211	05-figures/Fig2b.jpg
Fig 2c	04-code/3a-main.R, line 244	05-figures/Fig2c.jpg
Fig 3a	04-code/3a-main.R, line 294	05-figures/Fig3a.jpg
Fig 3b	04-code/3a-main.R, line 294	05-figures/Fig3b.jpg
Fig S1	04-code/3a-main.R, line 139	05-figures/FigS1.jpg
Fig S2	04-code/3a-main.R, line 244	05-figures/FigS2.jpg
Fig S3	04-code/3b-material_methods.R, line 219	05-figures/FigS3.jpg
Fig S4a	04-code/3a-main.R, line 294	05-figures/FigS4a.jpg
Fig S4b	04-code/3a-main.R, line 294	05-figures/FigS4b.jpg
Fig S4c	04-code/3a-main.R, line 294	05-figures/FigS4c.jpg
Fig S5	04-code/3b-material_methods.R, line 10	05-figures/FigS5.jpg
Fig S6	04-code/3b-material_methods.R, line 97	05-figures/FigS6.jpg
Fig S7	04-code/3b-material_methods.R, line 141	05-figures/FigS7.jpg
Fig S8	04-code/3b-material_methods.R, line 183	05-figures/FigS8.jpg
Table S1	04-code/1k-elasticities, line 32	Not produced as a table

Requirements

Computational Requirements

- The code was done in Positron where no file path is needed. If run in RStudio, it is necessary first to set the directory or create an Rproject.

Software Requirements

- R 4.4.1

- Packages required: countrycode, DescTools, forcats, dplyr, ggalluvial, ggplot2, haven, joyn, lme4, pipr, R.matlab, readr, readxl, scales, sf, stringr, tidyr, wbstats, zoo.

Memory, Runtime, and Storage Requirements

- 04-code/2a-damages-historical.R and 04-code/2b-damages__future.R take several hours to run.
- The only sizeable file is 02-intermediatedata/welfare.Rda, which takes up 179 MB.

Code Description

All code is in the 04-code folder.

- Files starting with 1 clean input data and produce the data files necessary to compute the poverty cost of greenhouse gas emissions
- Files starting with 2 produce the data files with our main results
- Files starting with 3 produce the exhibits

In more detail:

- 04-code/00-master.R: This is the main script that calls all the remaining scripts
- 04-code/1a-class.R: This script prepares the data with World Bank income groups and regions
- 04-code/1b-population.R: This script prepares the population data
- 04-code/1c-ghg.R: This script prepares the greenhouse gas emissions data
- 04-code/1d-temperature.R: This script prepares the temperature data
- 04-code/1e-temperature__cf.R: This script prepares the counterfactual temperature data
- 04-code/1f-growth.R: This script prepares the growth projections
- 04-code/1g-welfare.R: This script prepares the welfare data
- 04-code/1h-gdp.R: This script prepares the GDP per capita data
- 04-code/1i-precipitation__inequality.R: This script prepares the elasticities between precipitation GDP shocks and bottom 50 welfare shares
- 04-code/1j-growthshocks.R: This script prepares growth shocks from temperature changes and other climate channels
- 04-code/1k-elasticities.R: This script calculates growth-emission elasticities
- 04-code/2a-damages__historical.R: This script calculates the welfare damages by emissions from 1990-2024. It takes several hours to run
- 04-code/2b-damages__future.R: This script calculates the welfare damages by emissions from 2025-2100. It takes several hours to run.
- 04-code/2c-welfare__cf.R: This script calculates emission-adjusted welfare indicators
- 04-code/2d-gamma.R: This script calculates gamma

- 04-code/2e-cost_benefit.R: This script calculates impacts on emissions-adjusted welfare from 1% growth
- 04-code/3a-main.R: This script plots figures with the results and produces other key statistics mentioned in the main body of the paper
- 04-code/3b-material_methods.R: This script creates the figures and statistics used in materials and methods

Folder structure

- 01-inputdata contains the raw data gathered from other sources
- 02-intermediatedata contains cleaned and processed versions of these data files
- 03-outputdata contains the final data files used to produce the key results
- 04-code contains all the code needed to execute the results
- 05-figures contains the figures used in the paper