Reproducibility package for: “Global Socio-economic Resilience to Natural Disasters”

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Overview

This package contains the code and data to reproduce the output of the *Policy Research Working Paper* “Global Socio-economic Resilience to Natural Disasters” by Robin Middelanis, Bramka Arga Jafino, Ruth Hill, Minh Cong Nguyen, and Stéphane Hallegatte.

As not all raw datasets are publicly available, this package contains pre-processed data files to reproduce the results presented in the paper. Raw data files are not included in this package, but the sources are indicated in the data availability section.

This package is structured as follows:

```
├── data/                        # data directory
│   ├── raw/                     # directory for raw data (data files not
included)
│   └── processed/               # pre-processed data to run the model
│
├── code/                        # source code
│   ├── model/                   # core model logic and components
│   ├── scenario/                # prepares data for individual simulations
│   ├── misc/                    # utility functions and miscellaneous scripts
│   └── reproduce_results.py     # script to reproduce manuscript results in
headless mode
│
├── results/                     # output directory
│   ├── simulation_output/       # raw simulation output
│   └── figures/                 # manuscript figures and underlying data
│
├── environment.yml              # dependencies
└── README.md                    # this README file
```

Instructions for Replicators

Prerequisites

The model and data processing run on Python. To install the required dependencies, create a conda environment from the `environment.yml` file and activate it:

```
conda env create -n disaster_resilience -f environment.yml
conda activate disaster_resilience
```

General

Executing the model

To run the model, execute

```
python ./code/model/run_model.py <path_to_settings_file>
```

where `<path_to_settings_file>` is the path to a settings file that specifies the model's parameters for simulation, including the parameterization of policy scenarios analyzed in the manuscript. An example settings file is provided in `./code/model/settings_example.yml`.

The model will automatically create scenario model inputs using the script `./code/scenario/prepare_scenario.py`. These model inputs are derived from preprocessed input data in `./data/processed`. Optionally, the preprocessed data can be re-generated by setting the `force_recompute` flag in the settings file. The model will then dynamically download the most recent data available from the World Bank's API, and recompute preprocessed data at runtime from the locally stored raw data in `./data/raw`. Note that raw data files are not included in this package.

After preparing the simulation inputs, the model will run the simulation and generate output files in the directory specified by the settings file.

Output files

The model stores simulation input and output files in the directory specified by the settings file. They are organized as shown below. In the following, the most important of these files are described.

```
── output_directory/                    # output directory as specified in
the settings file
   ├── data_coverage.csv/                # country coverage of input data
used in the simulation
   ├── iah.csv/                          # household-level simulation results
by country, hazard and return period
   ├── macro.csv/                        # country-level simulation results
by country, hazard and return period
   ├── results.csv/                      # country-level annual average
aggregate results across all hazards
```

```
   ├── scenario__cat_info.csv/           # household socio-economic input
data
   ├── scenario__hazard_protection.csv/  # country-level hazard-specific
protection data
   ├── scenario__hazard_ratios.csv/      # exposure and vulnerability by
country, hazard, return period, and household quintile
   ├── scenario__macro.csv/              # country-level macro input data
   └── settings.yml/                     # settings file used for the
simulation
```

The most important output file is `results.csv`, which contains the annual average aggregate results across all hazards. The following table provides a list of the most important columns in this file:

Column name	Description
`iso3`	ISO3 country code
`name`	Country name
`income_group`	Income group of the country according to the World Bank Country and Lending Groups classification.
`gdp_pc_pp`	GDP per capita (PPP)
`gini_index`	Gini index
`self_employment`	Self-employment rate
`owner_occupied_share_of_value_added`	Owner-occupied housing share of value added
`risk_to_assets`	**Risk to assets** as a fraction of GDP
`risk`	**Risk to well-being** as a fraction of GDP
`resilience`	**Socio-economic resilience** as the ratio of the risk to assets to the risk to well-being

Household-level input data is provided in `scenario__cat_info.csv`. The following table provides a list of the most important columns in this file:

Column name	Description
`iso3`	ISO3 country code
`income_cat`	Household income quintile as cumulative population share, i.e., 0.2 indicates the first quntile, 0.4 the second, etc.
`diversified_share`	Share of household income from social protection, private remittances, and capital income.
`c`	Household consumption (equivalently, income)
`k`	Effective capital (''assets'') used by the household to generate income.
`liquidity`	Household liquidity

Exposure and vulnerability by household quintile, hazard, and return period are provided in `scenario__hazard_ratios.csv`. The following table provides a list of the most important columns in this file:

Column name	Description
`iso3`	ISO3 country code
`hazard`	Hazard
`rp`	Return period
`income_cat`	Household income quintile.
`fa`	Exposure, i.e., the fraction of households exposed by the hazard at the given return period.
`v_ew`	Household vulnerability, accounting for early warning.

Household-level simulation results are provided in `iah.csv`, which contains the following columns:

Column name	Description
`iso3`	ISO3 country code
`hazard`	Hazard
`rp`	Return period
`income_cat`	Household income quintile.
`affected_cat`	Indicates whether this fraction of the population is affected by the hazard or not.
`helped_cat`	Indicates whether this fraction of the population received disaster aid or not (only for simulations with post-disaster support or insurance).
`n`	Fraction of the total population.
`dk`	Effective asset loss.
`dk_reco`	Loss of household-owned assets.
`lambda_h`	Recovery rate.
`dc`	Consumption loss.
`dw`	Well-being loss (in terms of utility).

Reproducing Manuscript Results

Users have the following options to reproduce the manuscript results: * Run all necessary model simulations using the pre-processed data (recommended). In this case, skip step 1

and proceed directly to step 2. * Re-generate all pre-processed data files from raw data (step 1) before running the model (step 2). This requires manual collection of all raw data files. Some data will be dynamically downloaded, which can yield different results than those presented in the manuscript, as data is frequently updated.

Step 1: Re-generate pre-processed data

Obtain the raw data files that are not included in this reproducibility package from the sources indicated in the data availability section section.

The `force_recompute` flag needs to be set for the first simulation run. In the script `./code/reproduce_results.py` change line

```
force_recompute_on_first_simulation = False
```

to

```
force_recompute_on_first_simulation = True
```

Note that existing pre-processed data files in `./data/processed/` will be overwritten upon model execution.

Step 2: Reproduce results

To run all model simulations and generate figures in headless mode, execute the script:

```
python ./code/reproduce_results.py
```

This script will do the following: 1. (only if step 1 was executed) Pre-processed raw data from `./data/raw/` and online sources, and store the results in `./data/processed/`. 2. Run all model simulations using the pre-processed data files. The scenario settings, input data, and results of each simulation will be stored in a separate subdirectory of `./results/simulation_output/`. The following simulations are run:

```
| Subdirectory
| Description                                          |
|------------------------------------------------------------------------------
--|-------------------------------------------------|
| `0_baseline`
| Baseline scenario                                    |
| `1_reduce_total_exposure/0-0.2__0.2-0.4__0.4-0.6__0.6-0.8__0.8-1/0.95`
| Policy option 1 (cf. Fig. 5)                         |
| `1_reduce_total_exposure/0-0.2/0.95`
| Policy option 2 (cf. Fig. 5)                         |
| `2_reduce_total_vulnerability/0-0.2__0.2-0.4__0.4-0.6__0.6-0.8__0.8-1/0.95`
| Policy option 3 (cf. Fig. 5)                         |
| `2_reduce_total_vulnerability/0-0.2/0.95`
| Policy option 4 (cf. Fig. 5)                         |
| `3_scale_income_and_liquidity/0-0.2__0.2-0.4__0.4-0.6__0.6-0.8__0.8-1/1.05`
| Policy option 5 (cf. Fig. 5)                         |
| `4_scale_self_employment/0-0.2__0.2-0.4__0.4-0.6__0.6-0.8__0.8-1/0.9`
```

```
| Policy option 7 (cf. Fig. 5)                        |
| `5_scale_non_diversified_income/0-0.2__0.2-0.4__0.4-0.6__0.6-0.8__0.8-
1/0.9` | Policy option 8 (cf. Fig. 5)                      |
| `6_scale_liquidity/0-0.2__0.2-0.4__0.4-0.6__0.6-0.8__0.8-1/0`
| Simulation without liquidity (cf. Supp. Fig. 9) |
| `7_scale_gini_index/0-1/0.9`
| Policy option 6 (cf. Fig. 5)                      |
| `8_post_disaster_support/0-1/0.4`
| Policy option 9 (cf. Fig. 5)                      |
| `9_insurance/0-1/0.2`
| Policy option 10 (cf. Fig. 5)                                  |
```

3. Generate figures based on the simulation output and save them as `./results/figures/<figure_name>.pdf`. Note that maps for publication were produced by the World Bank's cartography team. However, map outputs can be produced if GADM data is provided (see data availability section for details). The underlying data of each figure is stored as `./results/figures/<figure_name>.csv`.
4. Print data reported in the manuscript to the command line.

The runtime to reproduce the results without the `force_recompute` flat set is less than 15 minutes, tested on a MacBook Air M2 with 16 GB RAM. If the flag is set to false, the compute time is up to one hour. The total storage required (including output and raw data) is up to 10 GB, of which about 8.5GB are the raw datasets.

Data Availability

This section outlines where and how the data supporting the findings of the study can be accessed and used.

Summary of Data Availability

- ☐ All data are publicly available.
- ☒ Some data cannot be made publicly available.
- ☐ No data can be made publicly available.

Statement about Rights

- ☒ I certify that the author(s) of the manuscript have legitimate access to and permission to use the data used in this manuscript.
- ☐ I certify that the author(s) of the manuscript have documented permission to redistribute/publish the data contained within this replication package.

Data Sources

Manually downloaded raw data

This section provides an overview of the raw data used in the model. Each data set must be stored in a subdirectory of `./data/raw/` as described below.

```
  ├── data/
  │   ├── raw/
→ │   │   ├── <...>/
  │   └── processed/
```

[1] Global Financial Inclusion (Global Findex) Database - editions 2011, 2014, 2017, and 2021 - Reference: Development Research Group, Finance and Private Sector Development Unit. (2022). Global Financial Inclusion (Global Findex) Database 2021 [Data set]. World Bank, Development Data Group. - identifiers WLD_2011_FINDEX_v02_M, WLD_2014_FINDEX_v01_M, WLD_2017_FINDEX_v02_M, WLD_2021_FINDEX_v03_M - filenames: `WLD_2011_FINDEX_v02_M.csv`, `WLD_2014_FINDEX_v01_M.csv`, `WLD_2017_FINDEX_v02_M.csv`, `WLD_2021_FINDEX_v03_M.csv` - location: `./data/raw/FINDEX/` - URL: https://microdata.worldbank.org/ - Accessed on: 2025-02-18 - License: World Bank Microdata Research License (https://datacatalog.worldbank.org/public-licenses?fragment=research) under “Public use” classification

[2] General government actual expenditure on social protection including and excluding health care, latest available year (percentage of GDP) - Reference: International Labour Office. (2024). *World Social Protection Report 2024-2026: Universal Social Protection for Climate Action and a Just Transition*. Geneva: International Labour Office. - filename: data export renamed to `ILO_WSPR_SP_exp.csv` - location: `./data/raw/social_share_regression/` - URL: https://www.social-protection.org/gimi/ShowWiki.action?id=52 - Accessed on: 2025-02-25 - License: CC BY 4.0

[3] Penn World Table v10.01 - Reference: Feenstra, R. C., Inklaar, R., & Timmer, M. P. (2015). The Next Generation of the Penn World Table. *American Economic Review*, 105(10), 3150–3182. - filename: `pwt1001.xlsx` - location: `./data/raw/PWT/` - URL: https://www.rug.nl/ggdc/productivity/pwt/ - Accessed on: 2023-12-13 - License: CC BY 4.0

[4] Modeled asset losses from the Global Infrastructure and Resilience Index - Reference: CDRI. (2023). *Global Infrastructure Resilience: Capturing the Resilience Dividend - A Biennial Report from the Coalition for Disaster Resilient Infrastructure*. New Delhi. - filename: `export_all_metrics.csv.zip` - location: `./data/raw/GIRI/` - URL: https://giri.unepgrid.ch - Accessed on: 2023-12-21 - License: CC BY 3.0 IGO

[5] Flood protection levels - Reference: Scussolini, P., Aerts, J. C. J. H., Jongman, B., Bouwer, L. M., Winsemius, H. C., de Moel, H., & Ward, P. J. (2016). FLOPROS: an evolving global database of flood protection standards. *Natural Hazards and Earth System*

Sciences, 16, 1049–1061. https://doi.org/10.5194/nhess-16-1049-2016 - filenames: all files in `nhess-16-1049-2016-supplement.zip/Scussolini_etal_Suppl_info/FLOPROS_shp_V1` - location: `./data/raw/FLOPROS/Scussolini_et_al_FLOPROS_shp_V1` - URL: https://nhess.copernicus.org/articles/16/1049/2016/nhess-16-1049-2016-supplement.zip - Accessed on: 2024-01-19 - License: CC BY 3.0

[6] Modeled coastal flood protection layer - Reference: Tiggeloven, T. (2020). Benefit-cost analysis of adaptation objectives to coastal flooding at the global scale (Version 2) [Data set]. Zenodo. - filename: `Results_adaptation_objectives.zip` - location: unzip to `./data/raw/FLOPROS/Tiggeloven_et_al_2020_data/` - URL: https://doi.org/10.5281/zenodo.4275517 - Accessed on: 2024-01-19 - License: CC BY 4.0

[7] GADM global map shapes data - Reference: GADM. (2022). *GADM Admin 0 shapefiles (version 4.1)*. - filename: `gadm_410-levels.gpkg` - location: `./data/raw/GADM/` - URL: https://gadm.org/ - Accessed on: 2022-07-20 - License: CC BY-4.0 (https://creativecommons.org/licenses/by/4.0/) for all shapefiles except for Austria, which is licensed under CC BY-SA 2.0 (https://creativecommons.org/licenses/by-sa/2.0/)

[8] Gridded population density data - Reference: CIESIN. (2018). *Gridded Population of the World, Version 4 (GPWv4): Population Density Adjusted to Match 2015 Revision UN WPP Country Totals, Revision 11 (Version 4.11)*. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). - filename: `gpw_v4_population_density_adjusted_rev11_2pt5_min.nc` - location: `./data/raw/GPW/` - URL: https://doi.org/10.7927/H4F47M65 - Accessed on: 2024-01-15 - License: CC BY 4.0

[9] Global Exposure Model data set - Reference: Yepes-Estrada, C., Calderon, A., Costa, C., Crowley, H., Dabbeek, J., Hoyos, M., Martins, L., Paul, N., Rao, A., & Silva, V. (2023). Global Building Exposure Model for Earthquake Risk Assessment. *Earthquake Spectra*. https://doi.org/10.1177/87552930231194048 - URL: https://github.com/gem/global_exposure_model - clone repository to `./data/raw/GEM_vulnerability/global_exposure_model/` - Accessed on: 2025-01-06 - License: CC BY-NC-SA 4.0

[10] Relative per-quintile vulnerabilities derived from the Global Monitoring Database (GMD) - Reference: World Bank. (2023). *Global Monitoring Database (GMD)*. - filename: `Dwelling quintile vul ratio.xlsx'` - location: `./data/raw/GMD/` - Accessed on: 2024-02-28 - not publicly available

[11] Hyogo Framework for Action performance indicators - Reference: UNISDR. (2007). *Hyogo framework for action 2005-2015: building the resilience of nations and communities to disasters*. Geneva: United Nations Office for Disaster Risk Reduction. https://www.unisdr.org/we/inform/publications/43291 - filenames: `HFA_all_2009_2011.csv`, `HFA_all_2011_2013.csv`, `HFA_all_2013_2015.csv` - location: `./data/raw/HFA/` - Compiled list of indicators not publicly available

[12] World Risk Poll - Reference: Lloyd's Register Foundation. (2022). *2021 World Risk Poll*. London: Lloyd's Register Foundation. - filename: `lrf_wrp_2021_full_data.csv.zip` - location: `./data/raw/WRP/` - Accessed on: 2024-01-30 - URL: https://www.lrfoundation.org.uk/en/research/world-risk-poll/

[13] Estimated number of exposed people by poverty line and hazard - Reference: Doan, M. K., Hill, R., Hallegatte, S., Corral Rodas, P. A., Brunckhorst, B. J., Nguyen, M., Freije-Rodriguez, S., & Naikal, E. G. (2023). Counting People Exposed to, Vulnerable to, or at High Risk From Climate Shocks — A Methodology. *Policy Research working paper*, 10619. http://documents.worldbank.org/curated/en/099602511292336760 - filename: `exposure bias.dta` - location: `./data/raw/PEB/` - not publicly available

[14] General government, private, and public-private partnership capital stock data - Reference: IMF. (2022). *Investment and Capital Stock Dataset (ICSD), 1960-2021*. - filename: `IMFInvestmentandCapitalStockDataset2021.xlsx` - location: `./data/raw/IMF/` - Accessed on: 2025-02-13 - URL: https://infrastructuregovern.imf.org/content/dam/PIMA/Knowledge-Hub/dataset/IMFInvestmentandCapitalStockDataset2021.xlsx

Data from the United Nations Statistics Division - [15] "Households in housing units by type of housing unit, tenure of household and urban/rural residence" - filename: data export renamed to `2025-02-18_household_tenure.csv` - Accessed on: 2025-02-18 - [16] "Table 2.4 Value added by industries at constant prices (ISIC Rev. 4)" - filename: data export renamed to `2025-02-13_value_added_by_industry.csv` - Accessed on: 2025-02-13 - URL: https://data.un.org/ - location: `./data/raw/UNdata/`

Data from Eurostat: - [17] "Capital stocks by industry (NACE Rev.2) and detailed asset type" (indicator nama_10_nfa_st) - filename: data export renamed to `eurostat__nama_10_nfa_st__capital_stock.csv` - location: `./data/raw/Eurostat/` - Accessed on: 2025-02-10 - [18] "Gross value added and income by detailed industry (NACE Rev.2)" (indicator nama_10_a64) - filename: data export renamed to `eurostat__nama_10_a64__value_added.csv` - location: `./data/raw/Eurostat/` - Accessed on: 2025-02-03 - [19] "Distribution of population by tenure status, type of household and income group" (indicator ilc_lvho02) - values stored in sheet "Eurostat" of `./data/raw/Home_ownership_rates/home_ownership_rates.xlsx` (ilc_lvho02) - Accessed on: 2025-02-13 - URL: https://ec.europa.eu/eurostat/web/main/data/database - License: CC BY 4.0

[20] OECD home ownership rates - Reference: OECD. (2025). *OECD Affordable Housing Database*. Paris: OECD. - URL: https://webfs.oecd.org/Els-com/Affordable_Housing_Database/HM1-3-Housing-tenures.xlsx - filename: `HM1-3-Housing-tenures.xlsx` - location: values stored in sheet "OECD" of `./data/raw/Home_ownership_rates/home_ownership_rates.xlsx` (ilc_lvho02) - Accessed on: 2025-02-13 - License: CC BY 4.0

[21] CAHF home ownership rates - Reference: Centre for Affordable Housing Finance in Africa. (2024). *2024 Yearbook: Housing Finance in Africa*. Johannesburg: Centre for Affordable Housing Finance in Africa, 2024. - URL: https://housingfinanceafrica.org/ - location: values stored in sheet "CAHF" of `./data/raw/Home_ownership_rates/home_ownership_rates.xlsx` (ilc_lvho02) - Accessed on: 2025-02-13 - License: CC BY 4.0

[22] World Bank Country and Lending Groups - Reference: World Bank. (2024). *World Bank Country and Lending Groups*. Washington, D.C.: World Bank. - URL: https://datacatalogfiles.worldbank.org/ddh-published/0037712/DR0090755/CLASS.xlsx - filename: `CLASS.xlsx` - location: `./data/raw/WB_country_classification/` - Accessed: 2024-01-12 - License: Terms and Conditions

[23] Population headcount at various poverty lines - Reference: World Bank (2025), *Poverty and Inequality Platform (version 20250401_2021_01_02_PROD)* [data set]. - URL: https://pip.worldbank.org - filenames: data exports renamed to `<pl>_povline.csv` with `<pl>` being one of [215, 320, 325, 365, 430, 545, 550, 685, 700, 750, 1000, 1500], corresponding to poverty lines of 2.15, 3.20, 3.25, 3.65, 4.30, 5.45, 5.50, 6.85, 7.00, 7.50, 10.00, and 15.00 USD per day - location: `./data/raw/PEB/poverty_data/` - Accessed on: 2025-02-05 - License: CC BY 4.0

[24] Mapping of the GEM Building Taxonomy to the HAZUS Building Taxonomy - Reference: Brzev, S., Scawthorn, C., Charleson, A.W., Allen, L., Greene, M., Jaiswal, K., Silva, V. (2013). *GEM Building Taxonomy Version 2.0, GEM Technical Report 2013-02 V1.0.0*. Pavia, Italy: GEM Foundation. doi: 10.13117/GEM.EXP-MOD.TR2013.02 - URL: https://cloud-storage.globalquakemodel.org/public/wix-new-website/pdf-collections-wix/publications/GEM%20Building%20Taxonomy%20Version%202.0.pdf - filename: data from Table D-2 stored as `hazus-gem_mapping.csv` - location: `./data/raw/GEM_vulnerability/` - Accessed on: 2023-12-19 - License: CC BY 3.0 Unported

Dynamically downloaded raw data

The following data sets are downloaded from the World Bank DataBamk by the model when the `force_recompute` flag is set to `True` in the settings file.

- Datasets used:
    - [25] "Income share held by lowest / second / third / fourth / highest 20%" (identifiers SI.DST.FRST.20, SI.DST.02nd.20, SI.DST.03rd.20, SI.DST.04th.20, SI.DST.05th.20)
    - [26] "Population, total" (identifier SP.POP.TOTL)
    - [27] "Personal remittances, received (% of GDP)" (identifier BX.TRF.PWKR.DT.GD.ZS)
    - [28] "Self-employed, total (% of total employment) (modeled ILO estimate)" (identifier SL.EMP.SELF.ZS)

    - [29] “Unemployment, total (% of total labor force) (modeled ILO estimate)” (identifier SL.UEM.TOTL.ZS)
    - [30] “GDP per capita, PPP (constant 2017 international $)” (identifier NY.GDP.PCAP.PP.KD)
    - [31] “GNI per capita, PPP (constant 2017 international $)” (identifier NY.GNP.PCAP.PP.KD)
    - [32] “Coverage in 1st / 2nd / 3rd / 4th / 5th quintile (%) -All Social Protection and Labor” (identifiers per_allsp.cov_q1_tot, per_allsp.cov_q2_tot, per_allsp.cov_q3_tot, per_allsp.cov_q4_tot, per_allsp.cov_q5_tot)
    - [33] “Adequacy of benefits in 1st / 2nd / 3rd / 4th / 5th quintile (%) -All Social Protection and Labor” (identifiers per_allsp.adq_q1_tot, per_allsp.adq_q2_tot, per_allsp.adq_q3_tot, per_allsp.adq_q4_tot, per_allsp.adq_q5_tot)
    - [34] “Coverage in 1st / 2nd / 3rd / 4th / 5th quintile (%) - All Private Transfers” (identifiers per_pr_allpr.cov_q1_tot, per_pr_allpr.cov_q2_tot, per_pr_allpr.cov_q3_tot, per_pr_allpr.cov_q4_tot, per_pr_allpr.cov_q5_tot)
    - [35] “Adequacy of benefits in 1st / 2nd / 3rd / 4th / 5th quintile (%) - All Private Transfers” (identifiers per_pr_allpr.adq_q1_tot, per_pr_allpr.adq_q2_tot, per_pr_allpr.adq_q3_tot, per_pr_allpr.adq_q4_tot, per_pr_allpr.adq_q5_tot)
- Accessed on: 2025-04-01
- URL: databank.worldbank.org/
- License: CC BY 4.0

Pre-processed data

Preprocessed data to reproduce the manuscript results are provided as `.csv` files in `./data/processed`:

```
   ├── data/
   │   ├── raw/
→  │   └── processed/
   │       └── <...>.csv
```

All files are re-generated from the raw data files or from dynamically downloaded data when the `force_recompute` flag is set to `True` in the settings file.

A set of pre-processed data is provided in this package, allowing to reproduce the findings of the study. The following table provides information on this data, The data in the present files correspond to variables in the manuscript as follows:

/	Description	Paper Variable	Raw data sources
hazard_ratios.csv	Exposure, not accounting for exposure biases.	f^a	[4, 9,

/	Description	Paper Variable	Raw data sources
/ fa	See equation (8).		10]
hazard_ratios.csv / v	Vulnerability, not accounting for early warning. See data sections “Country-level vulnerability” and “Household-level vulnerability”.	$V_{GEM} \cdot v_{q,rel}$	[9, 10]
avg_prod_k.csv / avg_prod_k	Average productivity of capital. See data section “Capital productivity”.	Π	[3]
capital_shares.csv / self_employment	Self-employment rate. See data section “Asset shares”.	γ_s	[28]
capital_shares.csv / real_est_k_to_va_shares_ratio	Ratio of real-estate capital share to real-estate value added share. See data section “Asset shares”.	κ^r	[17, 18]
capital_shares.csv / k_labor_share	Share of capital used for self-employed or employed labor. See data section “Asset shares”.	$1 - \kappa^p - \kappa^r \cdot \gamma_h$	[14-21]
capital_shares.csv / owner_occupied_share_of_value_added	Share of value added from owner-occupied housing. See data section “Asset shares”.	$\kappa^r \cdot \gamma_h$	[15, 17-21]
disaster_preparedness.csv / ew	Availability of early warning systems. See data section “Early warning”.	q_{EW}	[11, 12]
exposure_bias_per_quintile.csv / exposure_bias	Exposure bias by income quintile and hazard type. See data section “Exposure bias”.	EB_q	[13, 23]
findex_liquidity_and_axfin.csv / liquidity	Estimate of available savings / liquidity. See data section “Household liquidity”.	S_q^{sav}	[1]
findex_liquidity_and_axfin.csv / axfin	Fraction with savings at a financial institution. See data section “Diversified income”.	γ_q^{fin}	[1]
flopros_protection_processed.csv / MerL_Riv	Protection level against riverine floods. See data section “Hazard protection”.	HP_{Flood}	[5, 7, 8]
flopros_protection_processed.csv /	Protection level against coastal flooding. See	$HP_{\text{Storm surge}}$	[6, 7,

/	Description	Paper Variable	Raw data sources
MerL_Co	data section “Hazard protection”.		8]
wb_data_cat_info.csv / income_share	Share of national income by income quintile. See data section “Income shares”.	$\frac{c_q}{\sum_q c_q}$	[25]
wb_data_cat_info.csv / transfers	Income share from social protection and private remittances, not accounting for financial inclusion. See data section “Diversified income”.	$\gamma_q^{sp,pt}$	[2, 27, 29, 32-35]
wb_data_macro.csv / gdp_pc_pp	GDP per capita (PPP). See data section “GDP and population”.	$\sum_q n_q \cdot c_q$	[30]
wb_data_macro.csv / pop	Population. See data section “GDP and population”.	P	[26]
wb_data_macro.csv / gni_pc_pp	GNI per capita (PPP). See data section “Household liquidity”.	$GNIpc$	[31]
wb_data_macro.csv / region	Region.		[22]
wb_data_macro.csv / income_group	Income group.		[22]

List of Exhibits

The provided code reproduces:

- ☐ All numbers provided in text in the paper
- ☐ All tables and figures in the paper
- ☒ Selected tables and figures in the paper, as explained and justified below

The table below provides a list of all exhibits in the manuscript. Checkmarks indicate those exhibits that are reproduced by this reproducibility package. Figure outputs are stored in `./results/figures/`. Table data reproduced by the code are shown as command-line output in the terminal. All outputs are generated with script `./data/misc/plotting.py`, which is called by the script `./code/reproduce_results.py`.

	Exhibit name	Output	Footnotes
[x]	Figure 1, panels a-h	fig_1_1.pdf	
[x]	Figure 1, panels i, j	fig_1_1.pdf	

	Exhibit name	Output	Footnotes
[x]	Figure 2	fig_2.pdf	[1]
[x]	Figure 3	fig_3.pdf	
[x]	Figure 4	fig_4.pdf	[2]
[x]	Figure 5	fig_5.pdf	
[ ]	Supplementary Figure 1	n/a	[3]
[x]	Supplementary Figure 2	supfig_2.pdf	
[x]	Supplementary Figure 3	supfig_3.pdf	[4]
[x]	Supplementary Figure 4	supfig_4.pdf	
[x]	Supplementary Figure 5	supfig_5.pdf	
[x]	Supplementary Figure 6	supfig_6.pdf	
[x]	Supplementary Figure 7	supfig_7.pdf	
[x]	Supplementary Figure 8	supfig_8.pdf	
[x]	Supplementary Figure 9	supfig_9.pdf	
[x]	Supplementary Figure 10	supfig_10.pdf	
[ ]	Supplementary Table 1	n/a	[5]
[ ]	Supplementary Table 2	n/a	[6]
[ ]	Supplementary Table 3	n/a	[7]
[ ]	Supplementary Table 4	n/a	[8]
[x]	Supplementary Table 5	command line	
[x]	Supplementary Table 6	command line	
[x]	Supplementary Table 7	command line	[9]

[1] Maps for publication were recreated by the World Bank's cartography unit.

[2] Maps for publication were recreated by the World Bank's cartography unit.

[3] Compiled manually.

[4] Maps for publication were recreated by the World Bank's cartography unit.

[5] Compiled manually.

[6] Compiled manually.

[7] Compiled manually.

[8] Compiled manually.

[9] Only when `force_recompute` flag is set.

	Exhibit name	Output	Footnotes
[ ]	Supplementary Table 8	n/a	[10]

[10] Compiled manually.