

Reproducibility Package README

Economy-wide Benefits of Improved Hydrometeorological Forecasts and Services in Cambodia

Authors: R. Middelanis, U. Chewpreecha, B. A. Jafino, R. Koh, S. Galelli, M. Sidibe, P. Avner

Publication: World Bank Policy Research Working Paper

1. Overview

This reproducibility package contains all code and data required to replicate the results presented in the paper “*Economy-wide Benefits of Improved Hydrometeorological Forecasts and Services in Cambodia*”. The package uses the Cambodia macroeconomic model (KHM model), built on the World Bank MFMod framework, to simulate economy-wide impacts of improved hydrometeorological forecasts and services. Shocks are applied to the model baseline and results are extracted and compiled into charts for the paper.

2. Software Requirements

The MFMod model runs in EViews. Pre- and post-processing of the model input and output data are done in Python. No specific hardware requirements apply. The full package runs in less than five minutes on a standard computer.

2.1 EViews

The model runs in Eviews with version 9 or above. No additional packages or libraries are required beyond a standard EViews installation.

2.2 Python

The generation of input data and post-processing of model outputs is done in Python. The necessary packages can be installed with

```
conda env create --file environment.yml -n hydromet-khm
```

To activate the environment, execute

```
conda activate hydromet-khm
```

3. Data Availability Statement

All data used in this package are publicly available and are included in this reproducibility package. The authors confirm that they had legitimate access to all data used in the manuscript and have the right to include this data in the reproducibility package. The following sections provide details on the raw data sets used:

Raw data for construction of the KHM model workfile

The Cambodia Macroeconomic and Fiscal Model (MFMod) Dataset (included in the model workfile `Data/KHMSoln_clean.WF1`) was constructed by the authors using the World Bank MFMod standard setup. Documentation of the MFMod framework is publicly available at:

World Bank. *Macro-Fiscal Model (MFMod) Documentation*. Available at: <https://openknowledge.worldbank.org/server/api/core/bitstreams/3ef71fcd-2146-5c61-88af-a2e8453f5486/content>

The following data was used to construct the Cambodia MFMod model workfile:

1. Macroeconomic variables in Cambodia MFMod

- Reference: KHMNY* (GDP), KHMNE* (expenditure side GDP), KHMNV* (production side GDP), KHMGG* (fiscal), KHMBN* (BOP): Note the last second from last letter: X = price deflator, K = real and N = nominal. The last letter: N = m national local currency and D = m of USD
- file: `Data/KHMSoln_clean.WF1`
- URL: https://www.worldbank.org/en/publication/macro-poverty-outlook/mpo_eap
- Accessed: October 2025
- License: World Bank Group
- Access policy: Users must obtain the data directly from the Data URL for the referenced variables.
- Note: Data for Cambodia was manually compiled from the resources available under the data URL. Data was accessed in October 2025. The current data available in the data URL might not match the version of the accessed data.

Raw data for model input generation

1. Monthly river discharge and simulated electricity generation cost for Cambodia

- Reference: Koh, R. & Galelli, S. (2024). Evaluating streamflow forecasts in hydro-dominated power systems—When and why they matter. *Water Resources Research*, 60, e2023WR035825. <https://doi.org/10.1029/2023WR035825>
- files: `Q_m_avg.csv` (discharge) and `syscost_m.csv` (generation cost) in `./Data/raw/Koh_Galelli`
- URL: <https://doi.org/10.1029/2023WR035825>
- Received on: 2025-11-24
- Note: The data was received directly from the authors who granted permission for inclusion in this reproducibility package

2. Temperature projections for Cambodia

- Reference: World Bank (2025). Climate Change Knowledge Portal—Projected Timeseries Anomaly of Average Mean Surface Air Temperature for Cambodia [Dataset].
- files: `./Data/raw/WB_CCKP/projected-average-mean-s.csv`
- URL: <https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-projections>
- Accessed on: 2025-10-29
- License: CC BY 4.0

4. Package Contents

```
/
  README.md                                # This file
  KHM_shocks_EWS.prg                      # EVIEWS program: extend standard Cambodia MFMMod model t
  prepare_impact_channel_data.py          # Script to generate MFMMod inputs from raw data
  process_model_results.py                # Script to post-process MFMMod outputs
  environment.yml                          # Conda environment file
  Data/
    raw/                                  # Raw input data files from Koh and Galelli (2024) and W
      Koh_Galelli/
        Q_m_avg.csv                      # Monthyl discharge data
        syscost_m.csv                   # Simulated electricity generation cost
      WB_CVCKP/
        projected-average-mean-s.csv    # Projected future temperatures for Cambodia
*   input_channels/...                   # Input data for individual impact channels (pre-compute
*   Cambodia_MFMMod_inputs.xlsx          # Combined MFMMod inputs (pre-computed)
    KHMSoln_clean.WF1                   # Cambodia MFMMod model solution workfile (baseline)
    results/                             # Output folder
*   display_items/                       # Figures and tables as included in the manuscript (pre-
+   EWS_MFMMod.xlsx                     # Excel file for MFMMod outputs (pre-filled with simulati
```

Files and directories marked with an asterisk * are generated or modified at runtime.

Files marked with a plus sign + require manual editing during the replication process as indicated in the

This reproducibility package contains the full pre-computed and pre-edited outputs.

5. Instructions for Replication

Step 1 — Verify the package folder structure

Ensure the package is organised as described in Section 4. In particular, confirm that: - The `Data/` folder contains both `KHMSoln_clean.WF1` and all necessary input files in `Data/raw`.

Step 2 — Prepare the model input data

To create all model input data from raw inputs, execute

```
python prepare_impact_channel_data.py
```

This will create a single file `./Data/Cambodia_MFMMod_inputs.xlsx` containing all input data for the MFMMod model. Individual impact channel data and corresponding display items (Figures 2—6 and Supplementary Tables 1—4) are written to subdirectories of `./Data/input_channels`. Data is also additionally in machine-readable `.csv` files. Figures and tables are also copied to `./results/display_items`.

Step 3 — Run the shocks program

No manual path changes are required. The program automatically sets the working directory to the folder from which it is run, using the EVIEWS built-in `@runpath` command.

Open EVIEWS 13 and run `KHM_shocks_EWS.prg`

Expected run time is **less than one minute**.

What the program does

The program executes the following steps automatically:

1. Opens the Cambodia model solution workfile (`Data/KHMSoln_clean.WF1`) and imports the damage input data (`Data/Cambodia_MFMod_inputs.xlsx`).
2. Modifies model equations to incorporate climate damage channels: agricultural productivity, labour productivity, health impacts, roads and bridges disruption, and flood damage to capital stock (reparable and permanent).
3. Solves the **baseline** scenario with the updated model structure.
4. Runs **24 shock scenarios** across three dimensions:
 - **Climate scenarios (2):** Optimistic (**Opt**), Pessimistic (**Pes**)
 - **Policy scenarios (3):** Control (**CON**), Status Quo (**STQ**), Improvement (**IMP**)
 - **Impact channels (4):** Flood/Disaster Risk Reduction (**DRR**), Agriculture (**ARG**), Hydropower/Electricity (**HYD**), All channels combined (**ALL**)
5. Displays GDP results (`NYGDPMKTPKN`) for all 24 scenarios plus baseline over 2015–2050 in the EViews output window.

Step 4 — Transfer results to Excel

Copy the GDP results displayed in the EViews output window (2015–2050, all scenarios) and paste them into the highlighted cells of sheet *MFModRaw* in `./results/EWS_MFMod.xlsx` (25 columns for one baseline and 24 scenarios).

Step 5 — Post-process model output

To create Figures 7–11, Supplementary Figures 1–4, and Supplementary Tables 4–11, run

```
python process_model_results.py
```

The script will place all of the above display items in `./results/display_items`.

6. Mapping of Outputs to Exhibits

The table below maps each exhibit in the paper to the file responsible for generating it. All automatically generated display items are placed in `./results/display_items`.

Exhibit	Description	Files	Generated by
Figure 1	Conceptual setup of the study	n/a	compiled manually
Figure 2	Temperature projections for Cambodia	<code>temperature_projections_KHM.pdf</code>	<code>prepare_impact_channel_data.py</code>
Figure 3	Disaster Risk Reduction impact channel	<code>drr_impact_channel_KHM.pdf</code>	<code>prepare_impact_channel_data.py</code>

Exhibit	Description	Files	Generated by
Figure 4	Agricultural Productivity impact channel	agri_impact_channel_KHM.pdf	prepare_impact_channel_data.py
Figure 5	Selection of year subset for hydropower climate change projections	hydropower_cc_year_selection.pdf	prepare_impact_channel_data.py
Figure 6	Hydropower impact channel	hydropower_impact_channel_KHM.pdf	prepare_impact_channel_data.py
Figure 7	Isolated GDP impact of the Disaster Risk Reduction channel	results_DRR_control_rel.pdf	process_model_results.py
Figure 8	Differences in GDP outcomes across hydromet services and climate change scenarios by 2050	results_gdp_differences.pdf; results_gdp_differences.csv	process_model_results.py
Figure 9	Isolated GDP impact of the Agricultural Productivity channel	results_AGR_control_rel.pdf	process_model_results.py
Figure 10	Isolated GDP impact of the Hydropower channel	results_HYD_control_rel.pdf	process_model_results.py
Figure 11	Combined GDP impact with all channels active simultaneously	results_All_control_rel.pdf	process_model_results.py
Supplemental Figure 1	Isolated DRR channel – GDP deviation from baseline	results_DRR_baseline_rel.pdf	process_model_results.py
Supplemental Figure 2	Isolated Agricultural Productivity channel – GDP deviation from baseline	results_AGR_baseline_rel.pdf	process_model_results.py
Supplemental Figure 3	Isolated Hydropower channel – GDP deviation from baseline	results_HYD_baseline_rel.pdf	process_model_results.py
Supplemental Figure 4	Combined GDP impact – deviation from baseline	results_All_baseline_rel.pdf	process_model_results.py
Table 1	Scenario costs	n/a	compiled manually
Supplemental Table 1	Annual average flood damage	drd_impact_channel_KHM.csv; drd_impact_channel_KHM.tex	prepare_impact_channel_data.py
Supplemental Table 2	Agricultural productivity change	agri_impact_channel_KHM.csv; agri_impact_channel_KHM.tex	prepare_impact_channel_data.py
Supplemental Table 3	Electricity generation cost reduction	hydropower_impact_channel_KHM.csv; hydropower_impact_channel_KHM.tex	prepare_impact_channel_data.py
Supplemental Table 4	GDP deviation from control – Disaster Risk Reduction	results_DRR_control_rel.csv; results_DRR_control_rel.tex	process_model_results.py
Supplemental Table 5	GDP deviation from control – Agricultural Productivity	results_AGR_control_rel.csv; results_AGR_control_rel.tex	process_model_results.py
Supplemental Table 6	GDP deviation from control – Hydropower	results_HYD_control_rel.csv; results_HYD_control_rel.tex	process_model_results.py
Supplemental Table 7	GDP deviation from control – all channels combined	results_All_control_rel.csv; results_All_control_rel.tex	process_model_results.py
Supplemental Table 8	GDP deviation from baseline – Disaster Risk Reduction	results_DRR_baseline_rel.csv; results_DRR_baseline_rel.tex	process_model_results.py
Supplemental Table 9	GDP deviation from baseline – Agricultural Productivity	results_AGR_baseline_rel.csv; results_AGR_baseline_rel.tex	process_model_results.py
Supplemental Table 10	GDP deviation from baseline – Hydropower	results_HYD_baseline_rel.csv; results_HYD_baseline_rel.tex	process_model_results.py
Supplemental Table 11	GDP deviation from baseline – all channels combined	results_All_baseline_rel.csv; results_All_baseline_rel.tex	process_model_results.py