

README: Unveiling Hidden Hardships: Leveraging Alternative Data To Map Multidimensional Vulnerability In The Central African Republic

Overview

This repository contains all data, scripts, and supporting materials required to fully replicate the empirical analysis, spatial indices, maps, and regression results presented in the paper. It combines alternative data sources to construct high-resolution (5×5 km) measures of economic capacity, service accessibility, and multidimensional vulnerability in the Central African Republic.

The replication package is fully self-contained: all required inputs are provided, intermediary datasets are generated automatically by the scripts, and all figures, maps, and tables are reproduced in the output folder following the instructions below.

Instructions

1. Set the working directory path in section 0 of each of the three scripts in the Scripts folder.
2. Run main.R or all three scripts in the Scripts folder in the order indicated by their numbering.

Requirements for script 1_SectorialGdp_Predictions.R

Script 1 requires the installation of Just Another Gibbs Sampler (JAGS):

<https://sourceforge.net/projects/mcmc-jags/files/JAGS/4.x/>

Installation help:

<https://gist.github.com/dennisprangle/e26923fae7477566510757ab3341f54c>

Data Availability Statement

This study relies on a combination of publicly available data, restricted-access third-party data, and datasets constructed by the authors. All datasets used in the analysis are listed below, together with their sources and access conditions.

Tabular data

1. Base_CAF_v1.csv This dataset contains grid cell-level shares of land use, population, Small and Medium Enterprises (SMEs), mines, and NDVI.

Additional details on the sources of the variables aggregated at the cell level are provided in Section A.1.1 and Table A.1 of the paper.

- Source: Created by the authors using QGIS
- Access date: 20/11/2024
- Access type: Public

2. CAF_Pop_pts_MTI_Flood2.csv This dataset provides population point-level information on exposure to flood risk. Data was extracted at each population point available.

- Source: Created by the authors using QGIS, based on flood hazard data from Fathom
- URL: <https://www.fathom.global/newsroom/world-bank-collaboration/>
- Access date: 15/11/2024
- Access type: Restricted
- Variables included: XCoord YCoord Pop_UNAdjusted_const Settleadm0_pcode Settleadm1_name Settleadm1_pcode Settleadm2_name Settleadm2_pcode SettleArea_km2 country Grid3SettleDens Grid3SettleHD_Urb mgrs_code SettlePop_un_adj Grid3Settlepopulation settl_pcod Settle-type SettleUrb SettleUrb_class OCHAadmin0Name OCHAadmin0Pcod OCHAadmin1Name OCHAadmin1Pcod OCHAadmin2Name OCHAadmin2Pcod OCHAadmin3Name OCHAadmin3Pcod OCHAadmin3RefN ADM3Tot_pop_UNAdj ADM3Pop_Prim_MF ADM3pop_Sec_MF ADM3pop_Prim_F ADM3pop_Prim_M ADM3pop_Sec_M ADM3pop_Sec_F admin0Name_1 admin0Pcod_1 admin1Name_1 admin1Pcod_1 admin2Name_1 admin2Pcod_1 admin3Name_1 admin3Pcod_1 admin3RefN_1 Rowcacode1 Rowcacode2 Rowcacode3 Density CP Data_Loc ID_Com CC TauxCouv ADM3Tot_pop_UNAdj_L ADM3Pop_Prim_MF_L ADM3pop_Prim_F_L ADM3pop_Prim_M_L ADM3pop_Sec_MF_L ADM3pop_Sec_F_L ADM3pop_Sec_M_L TT_ft_min_Urb_HD TT_mx_min_Urb_HD TT_mx_min_Urb_SemiHD TT_ft_min_Urb_SemiHD TT_ft_min_HFAC_Hos_priv TT_mx_min_HFAC_Hos_priv TT_mx_min_HFAC_Hos_pub TT_ft_min_HFAC_Hos_pub TT_ft_min_HFAC_Hos TT_mx_min_HFAC_Hos TT_mx_min_HFAC_CS_priv TT_ft_min_HFAC_CS_priv TT_ft_min_HFAC_CS_pub TT_mx_min_HFAC_CS_pub TT_mx_min_HFAC_CS TT_ft_min_HFAC_CS TT_ft_min_HFAC_PS_priv TT_mx_min_HFAC_PS_priv TT_mx_min_HFAC_PS_pub TT_ft_min_HFAC_PS_pub TT_ft_min_HFAC_PS TT_mx_min_HFAC_PS TT_mx_min_educ_tert_priv TT_ft_min_educ_tert_priv TT_ft_min_educ_tert_pub TT_mx_min_educ_tert TT_mx_min_educ_tert TT_ft_min_educ_tert TT_ft_min_educ_sec_priv TT_mx_min_educ_sec_priv TT_mx_min_educ_sec_pub TT_ft_min_educ_sec_pub TT_ft_min_educ_sec TT_mx_min_educ_sec TT_mx_min_educ_prim_priv TT_ft_min_educ_prim_priv TT_ft_min_educ_prim_pub TT_mx_min_educ_prim_pub TT_mx_min_educ_prim_all TT_ft_min_educ_prim_all TT_ft_min_WP_all TT_ft_min_WP_public ad_label pop mo id_ad id_com_1 new_com ad_n milieu display observations label_ad ad_id ad sum_pop ménages zoom ad_iden num CAF_SCIR_2015_2020 CAF_SCIR_2016_2021 CAF_SCIR_2017_2022 CAF_SCIR_2018_2023 CAF_SCIR_2019_2024 FD_2020_baseline_1in5_trim FD_2020_baseline_1in10_trim FD_2020_baseline_1in20_trim FD_2020_baseline_1in50_trim FD_2020_baseline_1in100_trim FD_2020_baseline_1in200_trim FD_2020_baseline_1in500_trim FD_2020_baseline_1in1000_trim FD_SSP1_2_6_2030_1in5_trim FD_SSP1_2_6_2030_1in10_trim FD_SSP1_2_6_2030_1in20_trim FD_SSP1_2_6_2030_1in50_trim FD_SSP1_2_6_2030_1in100_trim FD_SSP1_2_6_2030_1in200_trim FD_SSP1_2_6_2030_1in500_trim FD_SSP1_2_6_2050_1in5_trim FD_SSP1_2_6_2050_1in10_trim FD_SSP1_2_6_2050_1in20_trim FD_SSP1_2_6_2050_1in50_trim FD_SSP1_2_6_2050_1in100_trim FD_SSP1_2_6_2050_1in200_trim FD_SSP1_2_6_2050_1in500_trim FD_SSP1_2_6_2050_1in1000_trim FD_SSP1_2_6_2080_1in5_trim FD_SSP1_2_6_2080_1in10_trim FD_SSP1_2_6_2080_1in20_trim FD_SSP1_2_6_2080_1in50_trim FD_SSP1_2_6_2080_1in100_trim FD_SSP1_2_6_2080_1in200_trim FD_SSP1_2_6_2080_1in500_trim FD_SSP1_2_6_2080_1in1000_trim FD_SSP2_4_5_2030_1in5_trim FD_SSP2_4_5_2030_1in10_trim FD_SSP2_4_5_2030_1in20_trim FD_SSP2_4_5_2030_1in50_trim

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FD	SSP2	4	5	2080	1in50	trim	FD	SSP2	4	5	2080	1in100	trim	FD	SSP2	4	5	2080	1in200	trim
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 PD_SSP5_8_5_2080_1in1000_trim

3. CAF_Pop_pts_MTI_SCIR.csv This dataset contains population point-level information on exposure to conflict. Data was extracted at each population point available.

- Source: Created by the authors using QGIS, based on data from the Armed Conflict Location & Event Data Project (ACLED) <https://acledata.com/conflict-data>
- Access date: 15/11/2024
- Access type: Public
- List of variables: XCoord YCoord Pop_UNAdjusted_const Settleadm0_pcode Settleadm1_name Settleadm1_pcode Settleadm2_name Settleadm2_pcode SettleArea_km2 country Grid3SettleDens Grid3SettleHD_Urb mgrs_code SettlePop_un_adj Grid3Settlepopulation settl_pcod Settle-type SettleUrb SettleUrb_class OCHAadmin0Name OCHAadmin0Pcod OCHAadmin1Name OCHAadmin1Pcod OCHAadmin2Name OCHAadmin2Pcod OCHAadmin3Name OCHAadmin3Pcod OCHAadmin3RefN ADM3Tot_pop_UNAdj ADM3Pop_Prim_MF ADM3pop_Sec_MF ADM3pop_Prim_F ADM3pop_Prim_M ADM3pop_Sec_M ADM3pop_Sec_F admin0Name_1

admin0Pcod_1 admin1Name_1 admin1Pcod_1 admin2Name_1 admin2Pcod_1 admin3Name_1 admin3Pcod_1 admin3RefN_1 Rowcacode1 Rowcacode2 Rowcacode3 Density CP Data_Loc ID_Com CC TauxCouv ADM3Tot_pop_UNAdj_L ADM3Pop_Prim_MF_L ADM3pop_Prim_F_L ADM3pop_Prim_M_L ADM3pop_Sec_MF_L ADM3pop_Sec_F_L ADM3pop_Sec_M_L CAF_SCIR_2015_2020 CAF_SCIR_2016_2021 CAF_SCIR_2017_2022 CAF_SCIR_2018_2023 CAF_SCIR_2019_2024

4. CAF_Pop_pts_MTI_stats_wWater.csv This dataset provides population point-level information on access to health facilities, primary schools, and water points. Data was extracted at each population point available.

- Source: Created by the authors using QGIS, based on data from ICASEES Surveys
- Access date: 15/11/2024
- Access type: Restricted
- List of variables: XCoord YCoord Pop_UNAdjusted_const Settleadm0_pcode Settleadm1_name Settleadm1_pcode Settleadm2_name Settleadm2_pcode SettleArea_km2 country Grid3SettleDens Grid3SettleHD_Urb mgrs_code SettlePop_un_adj Grid3Settlepopulation settl_pcod Settle-type SettleUrb SettleUrb_class OCHAadmin0Name OCHAadmin0Pcod OCHAadmin1Name OCHAadmin1Pcod OCHAadmin2Name OCHAadmin2Pcod OCHAadmin3Name OCHAadmin3Pcod OCHAadmin3RefN ADM3Tot_pop_UNAdj ADM3Pop_Prim_MF ADM3pop_Sec_MF ADM3pop_Prim_F ADM3pop_Prim_M ADM3pop_Sec_M ADM3pop_Sec_F admin0Name_1 admin0Pcod_1 admin1Name_1 admin1Pcod_1 admin2Name_1 admin2Pcod_1 admin3Name_1 admin3Pcod_1 admin3RefN_1 Rowcacode1 Rowcacode2 Rowcacode3 Density CP Data_Loc ID_Com CC TauxCouv ADM3Tot_pop_UNAdj_L ADM3Pop_Prim_MF_L ADM3pop_Prim_F_L ADM3pop_Prim_M_L ADM3pop_Sec_MF_L ADM3pop_Sec_F_L ADM3pop_Sec_M_L TT_ft_min_Urb_HD TT_mx_min_Urb_HD TT_mx_min_Urb_SemiHD TT_ft_min_Urb_SemiHD TT_ft_min_HFAC_Hos_priv TT_mx_min_HFAC_Hos_priv TT_mx_min_HFAC_Hos_pub TT_ft_min_HFAC_Hos_pub TT_ft_min_HFAC_Hos TT_mx_min_HFAC_Hos TT_mx_min_HFAC_CS_priv TT_ft_min_HFAC_CS_priv TT_ft_min_HFAC_CS_pub TT_mx_min_HFAC_CS_pub TT_mx_min_HFAC_CS TT_ft_min_HFAC_CS TT_ft_min_HFAC_PS_priv TT_mx_min_HFAC_PS_priv TT_mx_min_HFAC_PS_pub TT_ft_min_HFAC_PS_pub TT_ft_min_HFAC_PS TT_mx_min_HFAC_PS TT_mx_min_educ_tert_priv TT_ft_min_educ_tert_priv TT_ft_min_educ_tert_pub TT_mx_min_educ_tert TT_mx_min_educ_tert TT_ft_min_educ_tert TT_ft_min_educ_sec_priv TT_mx_min_educ_sec_priv TT_mx_min_educ_sec_pub TT_ft_min_educ_sec_pub TT_ft_min_educ_sec TT_mx_min_educ_sec TT_mx_min_educ_prim_priv TT_ft_min_educ_prim_priv TT_ft_min_educ_prim_pub TT_mx_min_educ_prim_pub TT_mx_min_educ_prim_all TT_ft_min_educ_prim_all TT_ft_min_WP_all TT_ft_min_WP_public ad_label pop mo id_ad id_com_1 new_com ad_n milieu display observations label_ad ad_id ad sum_pop ménages zoom ad_iden num

5. gdpSectLight_1960To2022.RDS This dataset includes historical GDP data disaggregated by sector, together with nighttime lights data.

Sectoral GDP data are drawn from the World Bank World Development Indicators, National Accounts data from the national statistical institute ICASEES, and internal computations for older series.

Nighttime lights are computed using the DMSP series from the Colorado School of Mines Earth Observation Group (EOG).

- Source: World Bank World Development Indicators; ICASEES National Accounts; Colorado School of Mines EOG

- URL: <https://eogdata.mines.edu/products/dmsp/>
- Access date: 05/06/2024
- Access type: Restricted
- List of variables: “export_millionUSDAgriculture” “export_millionUSDMinerals” “export_millionUSDOthers” “export_millionUSDpetroleum” “export_millionUSDWood” “lightB” “lightC” “primary” “real_gdp” “secondary” “shareAgriculture” “shareMinerals” “shareOthers” “sharepetroleum” “shareWood” “taxes” “tertiary” “tot_Xport_millionUSD” “year”. Years included: 1960-2023

6. reg_data_light.dta This dataset results from a spatial join between household-level information from the 2021 Harmonized Household Living Conditions Survey (EHCVM) and the dataset Base_CAF_grid5_all_indexes.csv, produced by the script 2_Vulnerability_indices.R.

- Source: EHCVM data from the World Bank; additional data from authors’ computations
- Access date: 11/03/2025
- Access type: Restricted
- List of variables: sousprefecture commune climatarea residence lhstatut country year grappe menage zaedomaine region prefecture strate milieu statut pov_hhweight hhsizetailm eqadul typ-men dali_nominal dnal_nominal dtot_nominal dali dnal dtot pcexp zref zali0 deflator_temporal deflator_spatial hgender hage htrage hmstat hreligion hnation hethnie halfab heduc hnivins hdiploma hhandig hactiv7j hactiv12m hbranch hsectins hcsp hgse nivie quintile decile sh_id_demo sh_co_natu sh_co_eco sh_id_eco sh_co_vio id X ADM1_FR ADM1_PCODE ADM2_FR ADM2_PCODE Year Area_ADM2 mean_BM_A2 sum_BM_A2 mean_NO2 sum_NO2 tot_sum_BM_A2 share_sum_BM_A2 tot_mean_BM_A2 share_mean_BM_A2 tot_sum_NO2 share_sum_NO2 tot_mean_NO2 share_mean_NO2 tot_pop share_pop all_mines tot_mines share_mines tot_boutiques share_boutiques tot_water share_water tot_grasslands share_grasslands obs_primary primary_min primary_med primary_max obs_secondary secondary_min secondary_med secondary_max obs_tertiary tertiary_min tertiary_med tertiary_max primary_sd secondary_sd tertiary_sd sec_ter_sec_med sec_ter_sec_min sec_ter_sec_max region_no_agri tot_crop tot_share_NDVI tot_grass tot_crop_corr tot_share_NDVI_corr tot_grass_corr tot_NDVI_corr share_crop_corrected share_NDVI_corrected share_grass_corrected Idx_prim Idx_prim_softmax geo_prim_sec_avg3 Idx_sec_ter Idx_sec_ter_softmax geo_sec_ter_avg3 incert_prim incert_sec_ter Max_geo_prim_sec_avg Max_geo_sec_ter_avg geo_GDP_avg3 incert_GDP pop_grid pop_grid_primary UU60_TT_ft HFAC_tot UU60_TT_ft_min WP_all UU60_TT_ft_min_educ_prim_all SCIR_2016_2021 SCIR_2016_2021_popadjusted floods_FU_PU floods_FU_PU_pop_adjusted Idx_GDP Idx_educ_prim Idx_health Idx_water_access Idx_No_conflicts Idx_No_floods BASE COMBSCOR COMBSCOR2

GIS data

The following GIS layers are used for spatial analysis and map production. All GIS files are provided in the input/GIS/ folder.

1. gadm41_CAF_1_2020.shp Administrative boundaries for level 1 in the Central African Republic.

- Source: Global Administrative Areas (GADM)

- URL: https://gadm.org/download_country.html
- Access date: 02/05/2024
- Access type: Public

2. Grid_5km_CFA_v4.shp Gridded coverage of the Central African Republic at a 5 km spatial resolution.

- Source: Created by the authors using QGIS by applying a grid function over the full country shapefile available here : https://geodata.ucdavis.edu/gadm/gadm4.1/shp/gadm41_CAF.shp.zip.
- Access type: Public

3. BaseGrid_NewPrefs.shp Simplified version of Grid_5km_CFA_v4.shp for mapping purposes, containing fewer administrative variables.

- Source: Created by the authors using QGIS
- Access type: Public

3. caf_admbnda_adm3_200k_sigcaf_reach_itos_v2.shp Administrative boundaries for level 3 (communes) in the Central African Republic.

- Source: United Nations Office for the Coordination of Humanitarian Affairs (OCHA)
- URL: <https://data.humdata.org/dataset/cod-ab-caf>
- Access date: 22/13/2023
- Access type: Public

4. CAR_main_cities.shp Spatial layer of main cities in the Central African Republic.

- Source: Created by the authors using QGIS
- Access type: Public

Data Inputs

All necessary input data are provided in the input folder.

All intermediary datasets generated by the scripts are automatically saved in the same input folder.

The input folder also contains a GIS subfolder that includes all spatial layers required to generate the maps used in the analysis.

Main input files

1. gdpSectLight_1960To2022.RDS
2. Base_CAF_v1.csv
3. CAF_Pop_pts_MTI_stats_wWater.csv
4. CAF_Pop_pts_MTI_Flood2.csv
5. CAF_Pop_pts_MTI_SCIR.csv
6. reg_data_light.dta

Outputs

All outputs are stored in the output folder, including:

- All figures generated by the scripts
- All maps produced in the output/Maps subfolder
- All regression tables exported in the output/RegTables subfolder

Maps structure

All maps displayed in the paper are produced in Section 3 of the script 2_Vulnerability_indices.R using the GIS layers provided in the input/GIS folder.

Main paper maps (Figures 3–10)

- Base layer: BaseGrid_NewPrefs.shp
- Administrative borders: gadm41_CAF_1_2020.shp
- Cities: CAR_main_cities.shp

Annex maps (Figures A1–A7)

- Base layer: caf_admbnda_adm3_200k_sigcaf_reach_itos_v2.shp
- Administrative borders: gadm41_CAF_1_2020.shp
- Cities: CAR_main_cities.shp