# Implementing 30x30: Lessons From Country Case Studies

## Overview

The code in this replication package constructs the analysis file from the data sources on the World Bank Development Data Hub and local data using R. A main script run all of the code to generate the data for the figures and tables in the World Bank Policy Research Working Paper entitled, "Implementing 30x30: Lessons From Country Case Studies" (No. X). The replicator should expect the code to run for about <2 hours.

## Data Availability and Provenance Statements

### 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.

### License for Data

The data are licensed under a Creative Commons/CC-BY-NC license.

### Summary of Availability

- Some data **cannot be made** publicly available.

## Dataset list

local data directory has three categories: gis_data and tab_data.

| Data file | Source | Notes | Provided |
|---|---|---|---|
| Brazil_full_protection/Brazil_Critical_Species_Max_1.shp | Authors | Local | Yes |
| Brazil_full_protection/Brazil_Critical_Species_Prov_1.shp | Authors | Local | Yes |
| Brazil_full_protection/Brazil_Group_1_Full_Coverage.shp | Authors | Local | Yes |
| Brazil_PA/Brazil_PA.shp | Authors | Local | Yes |
| Brazil_top4/Brazil_Critical_Species_Counts_1.tif | Authors | Local | Yes |
| Brazil_top4/Brazil_Critical_Species_Counts_2.tif | Authors | Local | Yes |
| Brazil_top4/Brazil_Critical_Species_Counts_3.tif | Authors | Local | Yes |
| Brazil_top4/Brazil_Critical_Species_Counts_4.tif | Authors | Local | Yes |
| Brazil_top4/Brazil_Critical_Species_Prov_1.shp | Authors | Local | Yes |
| Brazil_top4/Brazil_Critical_Species_Prov_2.shp | Authors | Local | Yes |
| Brazil_top4/Brazil_Critical_Species_Prov_3.shp | Authors | Local | Yes |
| Brazil_top4/Brazil_Critical_Species_Prov_4.shp | Authors | Local | Yes |

| Data file | Source | Notes | Provided |
|---|---|---|---|
| `Cameroon_full_protection/Cameroon_Critical_Species_Max_1.shp` | Authors | Local | Yes |
| `Cameroon_full_protection/Cameroon_Critical_Species_Prov_1.shp` | Authors | Local | Yes |
| `Cameroon_full_protection/Cameroon_Group_1_Full_Coverage.shp` | Authors | Local | Yes |
| `Cameroon_PA/Cameroon_PA.shp` | Authors | Local | Yes |
| `Cameroon_top4/Cameroon_Critical_Species_Counts_1.tif` | Authors | Local | Yes |
| `Cameroon_top4/Cameroon_Critical_Species_Counts_2.tif` | Authors | Local | Yes |
| `Cameroon_top4/Cameroon_Critical_Species_Counts_3.tif` | Authors | Local | Yes |
| `Cameroon_top4/Cameroon_Critical_Species_Counts_4.tif` | Authors | Local | Yes |
| `China Files/China_PA.shp` | Authors | Local | Yes |
| `China Files/China_RPcts.shp` | Authors | Local | Yes |
| `Costa Rica_PA/Costa Rica_PA.shp` | Authors | Local | Yes |
| `Costa_Rica_top3/Costa Rica_Critical_Species_Counts_1.tif` | Authors | Local | Yes |
| `Costa_Rica_top3/Costa Rica_Critical_Species_Counts_2.tif` | Authors | Local | Yes |
| `Costa_Rica_top3/Costa Rica_Critical_Species_Counts_3.tif` | Authors | Local | Yes |
| `Costa_Rica_top3/Costa Rica_Critical_Species_Prov_1.shp` | Authors | Local | Yes |
| `Costa_Rica_top3/Costa Rica_Critical_Species_Prov_2.shp` | Authors | Local | Yes |
| `Costa_Rica_top3/Costa Rica_Critical_Species_Prov_3.shp` | Authors | Local | Yes |
| `Ecuador_PA/Ecuador_PA.shp` | Authors | Local | Yes |
| `Ecuador_PA/Ecuador_RPcts.shp` | Authors | Local | Yes |
| `India Files/India_PA.shp` | Authors | Local | Yes |
| `India Files/India_RPcts.shp` | Authors | Local | Yes |
| `Madagascar_top4/Madagascar_Critical_Species_Counts_1.tif` | Authors | Local | Yes |
| `Madagascar_top4/Madagascar_Critical_Species_Counts_2.tif` | Authors | Local | Yes |
| `Madagascar_top4/Madagascar_Critical_Species_Counts_3.tif` | Authors | Local | Yes |
| `Madagascar_top4/Madagascar_Critical_Species_Counts_4.tif` | Authors | Local | Yes |
| `Papua_New_Guinea_PA/Papua New Guinea_PA.shp` | Authors | Local | Yes |
| `Papua_New_Guinea_PA/Papua New Guinea_RPcts.shp` | Authors | Local | Yes |

| Data file | Source | Notes | Provided |
|---|---|---|---|
| `Philippines_top4/Philippines_Critical_Species_Counts_1.tif` | Authors | Local | Yes |
| `Philippines_top4/Philippines_Critical_Species_Counts_2.tif` | Authors | Local | Yes |
| `Philippines_top4/Philippines_Critical_Species_Counts_3.tif` | Authors | Local | Yes |
| `Philippines_top4/Philippines_Critical_Species_Counts_4.tif` | Authors | Local | Yes |
| `Philippines_top4/PhilippinesMarine_PA.shp` | Authors | Local | Yes |
| `South Africa_PA/South Africa_PA.shp` | Authors | Local | Yes |
| `South_Africa_top3/South Africa_Critical_Species_Counts_1.tif` | Authors | Local | Yes |
| `South_Africa_top3/South Africa_Critical_Species_Counts_2.tif` | Authors | Local | Yes |
| `South_Africa_top3/South Africa_Critical_Species_Counts_3.tif` | Authors | Local | Yes |
| `brazil_species.xlsx` | Authors | Local | Yes |
| `cameroon_species.xlsx` | Authors | Local | Yes |
| `species/species_fig03a.Rdata` | Authors | Local | Yes |
| `species/species_fig03b.Rdata` | Authors | Local | Yes |
| `species/species_fig03c.Rdata` | Authors | Local | Yes |
| `Boundary_Data_10mil/WB_Admin0_boundary_lines_10m.shp` | WB | Private | No |
| `Boundary_Data_10mil/WB_countries_Admin0_10m.shp` | WB | Public | API |

| Data file | Source | Notes | Provided |
|---|---|---|---|
| `local/tab_data` | | | |
| `China_Circles.csv` | Authors | Local | Yes |
| `Country Results 87% New Species Coverage.csv` | Authors | Local | Yes |
| `Ecuador_Circles.csv` | Authors | Local | Yes |
| `India_Circles.csv` | Authors | Local | Yes |
| `Madagascar_Marine_RCells.csv` | Authors | Local | Yes |
| `Papua New Guinea_Circles.csv` | Authors | Local | Yes |
| `Philippines_Marine_RCells.csv` | Authors | Local | Yes |
| `tbl02_species.xlsx` | Authors | Local | Yes |
| `Total Country Parks.csv` | Authors | Local | Yes |

Files listed as authors can be found here:
https://datacatalog.worldbank.org/search/dataset/0066734/Implementing-30x30--Lessons-From-Country-Case-Studies---replication-data-files

The files that are not provided (Boundary_Data_10mil) were provided by the Map team directly to the authors, and there is no documented way to access the data. However, this only limits the reproducibility of figures 20 and 22, which are included in the package for direct verification.

## Computational requirements

### Software Requirements

- The replication package contains one or more programs to install all dependencies and set up the necessary directory structure.

- R 4.3.1 attached base packages: [1] parallel tools stats graphics grDevices utils datasets methods base

other attached packages: [1] patchwork_1.2.0 raster_3.6-26 sp_2.1-2 ggpubr_0.6.0 colourvalues_0.3.9 XML_3.99-0.14
[7] dplyr_1.1.3 stars_0.6-4 abind_1.4-5 gt_0.10.0 xfun_0.40 modelsummary_1.4.5 [13] ordinal_2023.12-4 terra_1.7-55 archive_1.1.8 RColorBrewer_1.1-3 R.utils_2.12.2 R.oo_1.25.0
[19] R.methodsS3_1.8.2 ggplot2_3.5.1 renv_1.0.5 tidyr_1.3.0 foreign_0.8-84 doParallel_1.0.17 [25] iterators_1.0.14 foreach_1.5.2 data.table_1.14.8 readr_2.1.4 Hmisc_5.1-2 stringr_1.5.1
[31] httr_1.4.7 sf_1.0-19

loaded via a namespace (and not attached): [1] DBI_1.2.3 gridExtra_2.3 readxl_1.4.3 rlang_1.1.5 magrittr_2.0.3 e1071_1.7-16
[7] compiler_4.3.1 systemfonts_1.0.4 vctrs_0.6.3 crayon_1.5.2 pkgconfig_2.0.3 fastmap_1.1.1
[13] backports_1.4.1 lwgeom_0.2-13 utf8_1.2.3 rmarkdown_2.25 tzdb_0.4.0 ragg_1.2.5
[19] purrr_1.0.2 broom_1.0.5 cluster_2.1.4 R6_2.5.1 tables_0.9.17 stringi_1.7.12
[25] car_3.1-2 rpart_4.1.19 cellranger_1.1.0 numDeriv_2016.8-1.1 Rcpp_1.0.11 knitr_1.44
[31] base64enc_0.1-3 Matrix_1.6-1.1 nnet_7.3-19 tidyselect_1.2.0 rstudioapi_0.15.0 codetools_0.2-19
[37] curl_5.0.2 lattice_0.22-5 tibble_3.2.1 withr_3.0.0 evaluate_0.21 units_0.8-5
[43] proxy_0.4-27 xml2_1.3.5 pillar_1.9.0 carData_3.0-5 KernSmooth_2.23-21 checkmate_2.3.1
[49] insight_0.19.10 generics_0.1.3 hms_1.1.3 munsell_0.5.0 scales_1.3.0 class_7.3-22
[55] glue_1.6.2 ggnewscale_0.4.10 ggsignif_0.6.4 grid_4.3.1 colorspace_2.1-0 nlme_3.1-162
[61] htmlTable_2.4.2 Formula_1.2-5 cli_3.6.1 textshaping_0.3.6 fansi_1.0.4 viridisLite_0.4.2
[67] gtable_0.3.4 rstatix_0.7.2 digest_0.6.33 classInt_0.4-11 ucminf_1.2.1 farver_2.1.1
[73] htmlwidgets_1.6.2 htmltools_0.5.6 lifecycle_1.0.4 MASS_7.3-60

### Controlled Randomness

- No Pseudo random generator is used in the analysis described here.

## Memory, Runtime, Storage Requirements

### Summary

Approximate time needed to reproduce the analyses on a standard 2024 server machine: - 2 hours

Approximate storage space needed: - < 2GB

### Details

Portions of the code were last run on a 32-core Intel server with 256 GB of RAM, 100 GB of network storage.

## Description of programs/code

- Script biod_pa_wp__main.R is the main script
- Script biod_pa_wp_global_libraries.R loads the libraries for R
- Script biod_pa_wp_global_libraries.do installs a library for Stata
- Scripts starting with biod_pa_wp_load load the data
- Scripts starting with biod_pa_wp_fig construct the figures

## List of tables and programs

The provided code reproduces: - All tables and figures in the paper

| Figure/Table # | Program / dataset | Output file | Note |
|---|---|---|---|
| Figure 1 | fig01_tbl01… .R | fig_01_terrestrial… .png | |
| Figure 3 | fig03a_unprotected .R | fig_03a_unprotected .png | |
| | | fig_03b_unprotected .png | |
| | | fig_03c_unprotected .png | |
| Figure 4 | fig04_top4_priorities .R | fig_04_panel_brazil .png | |
| Figure 6 | fig_06a_unprotected .R | fig_06a_unprotected .png | |
| | | fig_06b_unprotected .png | |
| | | fig_06c_unprotected .png | |
| Figure 7 | fig07_top4_priorities .R | fig_07_panel_cameroon .png | |
| Figure 8 | fig08_full_protection .R | fig_08_panel_full_protection .png | |
| Figure 10 | fig10_top4_priorities .R | fig_10_panel_south_africa .png | |
| Figure 11 | fig11_top4_priorities .R | fig_11_panel_costa_rica .png | |
| Figure 12 | fig12_ecuador .R | fig_12_panel_ecuador .png | |
| Figure 13 | fig13_papua_new_guinea .R | fig_13_panel_papua_new_guinea.png | |
| Figure 14 | fig14_Ecuador .R | fig_14_Ecuador_Species .png | |
| Figure 15 | fig15_PNG_Percents .do | fig_15_Papua_New_Guinea .png | |
| Figure 16 | fig16_top4_priorities .R | fig_16_panel_philippines .png | |

| Figure/Table # | Program / dataset | Output file | Note |
|---|---|---|---|
| Figure 17 | fig17_Philippines .do | fig_17_Philippines_Marine .png | |
| Figure 18 | fig18_top4_priorities .R | fig_18_panel_madagascar .png | |
| Figure 19 | fig19_Madagascar .do | fig_19_Madagascar_Marine .png | |
| Figure 20 | fig20_india_protected .R | fig_20a_protected_areas_north.png | |
| | | fig_20b_protected_areas_east.png | |
| | | fig_20c_protected_areas_south.png | |
| Figure 21 | fig21_India_Percents .do | fig_21_India_Species .png | |
| Figure 22 | fig22_china_protected .R | fig_22_protected_areas .png | |
| Figure 23 | fig23_China_Percents .do | fig_23_China_Species .png | |
| Table 1 | fig01_tbl01_country .R | .csv | |
| Table 2 | tbl02_SouthAfrica .R | tbl02_group1 .csv | |
| | | tbl02_group2 .csv | |
| | | tbl02_group3 .csv | |
| Table 3 | tbl03_SouthAfrica .R | tbl_03_south_africa .csv | |
| Table 4 | tbl04_CostaRica .R | tbl04_column1 .csv | |
| | | tbl04_column2 .csv | |
| | | tbl04_column3 .csv | |
| Table 5 | tbl05_CostaRica_new .R | tbl_05_costa_rica_priority .csv | |
| Table 6 | tbl06_India_new_prior .R | tbl_06_india_priority_areas .csv | |
| Table 7 | tbl07_China_new_prior .R | tbl_07_china_priority_areas .csv | |

## References

Dasgupta, S., Blankespoor, B., & Wheeler, D. (2024a). Revisiting Global Biodiversity: A Spatial Analysis of Species Occurrence Data from the Global Biodiversity Information Facility (No. 10821). The World Bank.

Dasgupta, S., Blankespoor, B., & Wheeler, D. (2024b). Estimating Extinction Threats with Species Occurrence Data from the Global Biodiversity Information Facility (No. 10822). The World Bank.

## Acknowledgements