SUPLEMENTARY MATERIALS

SIMULATION FILES DESCRIPTION

All the data is hosted on the One Drive repository from Colorado School of Mines. Requests can be performed to my advisors John McCray (jmcray@mines.edu) and Pablo Garcia (pablogarcia@mines.edu).

Formats used for the study

.gpkg	Geopackage
.tiff/.tiff	Raster files
.csv	Comma separated values (TABLES)
.tar.gz	Tar compressed files (LINUX alternative to .zip files)
.parquet.gz	Arrow Parquet format.
.dat	PRMS-related input data
< >	Labels inside "< >" represent repetitive labels. For instance, "<watershed>" can represent the same structure for the five watersheds: crops<watershed>.gpkg: - cropsCamana.gpkg - cropsYauca.gpkg - cropsOcona.gpkg - cropsQuilca.gpkg - cropsTambo.gpkg

Notes:

GitHub repository for the modified PyGSFLOW: https://github.com/jonathanqv/pygsflow

1. **GIS**
    a. **2_GIS/1_Base**

File	Description
dem.tif	DEM for the 5 watersheds in EPSG:4326
dem_32718.tif	DEM for the 5 watersheds in EPSG:32718
dem_32719.tif	DEM for the 5 watersheds in EPSG:32719
aqp.gpkg	1 Layer: - Arequipa region boundary (EPSG:4326)
basins.gpkg	Original datasets retrieved from ANA for the five watersheds (EPSG:4326) 3 layers: - Basin boundaries - Lake boundaries - Rivers
bound.gpkg	Bounding box for the five watersheds, for clipping purposes (EPSG:4326)
infrastructure.gpkg	Hydraulic infrastructure for the five watersheds (EPSG:4326) 5 layers: - ChannelsTunnels: Channels/diversions on the five watersheds, most of them associated with main reservoirs. - ChannelsTunnels_used: Channels/diversions for the five watersheds considered in the simulation. - FlowCoordinatesReservoirs: Diversions and reservoirs points for watershed delineation purposes. - Reservoirs: Reservoirs on the five watersheds + Angostura reservoir. - Ponints_infra: Points associated with channels/diversions
landuse.gpkg	Landuses for the regions present in the five watershed, each layer has a different format which was created by the regional governments 5 layers: - Apurimac - Arequipa - Ayacucho - Moquegua - Puno Source: https://geoservidor.minam.gob.pe/zee-aprobadas/zee-aprobadas/

    b. **2_GIS/2_Processed**

EPSG:4326, 32718 or 32719 depending on the watershed.

File	Description
geology.gpkg	Geology datasets for the extension of the five watersheds. Dataset merged from individual geological files retrieved from GEOCATMIN
landuses.gpkg	Reclassified landuse dataset for the extension of the five watersheds (Base file: GIS/1_Base)
landuses_keys.csv	Landuses keys used on “landuses.gpkg” (idx and landuses columns)
sand.tif	Calculated sand percentages
silt.tif	Calculated silt percentages

clay.tif	Calculated clay percentages

i. 2_GIS/2_Processed/<watershed>

File	Description
aspect<watershed>.tif	Aspect
bound<watershed>.gpkg	Bounding box
<watershed>Infrastructure.gpkg	Hydraulic infrastructure (related to 1_Base)
clay.tiff	Clay percentages
crops<watershed>.gpkg	Agricultural areas
dem<watershed>.tif	Clipped DEM for the bounding box
dem<watershed>_clip.tif	Clipped DEM to the watershed bounds
geology.gpkg	Clipped geology
hillshade30.tif	Hillshade
imperv<watershed>.gpkg	Impervious areas
landuse<watershed>.gpkg	Clipped landuse
sand.tiff	Sand perncetages
segmentCut.gpkg	Drawn lines for watershed delineation purposes
silt.tif	Silt percentages
slope<watershed>.tif	Slopes
soilType.tif	Resampled soil types

2. 3_DataInstitutions

Most of it is raw data.

File	Description
ANA	Water licenses requested to ANA
AUTODEMA	Reservoir related data retrieved from AUTODEMA for the Camana and Quilca watershed. Shapefiles, preprocesses and postprocessed reservoir volumes and levels for the reservoirs in the aforementioned watersheds. Included in the folder reading, plotting, and processing scripts
EGASA	Reservoir data for the Quilca watershed requested to EGASA
Pasto Grande	Reservoir datasets and processing scripts for Pasto Grande reservoir data.
SENAMHI	Meteorological and Streamflow data from ANA and SENAMHI

3. 4_MetDataProcessed

Meteorological data processed.

File	Description

climate_change	25 climate change datasets from the NASA-GDEX repository for the SSPs 126, 245, 370, 585, and the historic datasets in NETCDF and csv formats
flows_Infrastructure	Volumes and outflows for all simulated reservoirs
flows_SENAMHI	Processed streamgages from SENAMHI and ANA
weather_Acholado	Weather dataset: PISCO data in csv format
weather_Acholado_wI	Weather dataset: PISCO data merged with hydraulic infrastructure data in csv format
weather_Acholado_wIS	Weather dataset: PISCO data merged with hydraulic infrastructure and SENAMHI data
weather_Infrastructure	Hydraulic infrastructure weather data
weather_PISCO	SENAMHI weather stations gap filled with PISCO dataset
weather_SENAMHI	Processed weather stations data from SENAMHI
Notebooks	Processing python scripts (Jupyter notebooks) for all the meteorological and streamgage data

4. **5_WatershedDelineation**

File	**Description**
Outputs	Landuses, streams, subbasins, and watershed delineations for each watershed, which includes HRUs.
Notebooks	Processing notebooks for watershed delineation

5. **6_Pisco**

File	**Description**
coords<variable>.parquet.gz	Coordinates for each pisco raster cell
data<variable>.parquet.gz	Timeseries for each coordinate in "coords<variable>.parquet.gz"

6. **7_ClimateChange**

File	**Description**
<ClimateChangeModel>	13 climate change models selected for the simulations with bias correction. Inside each climate change model there are folder for historic datasets and SSPs: - Historical - SSP126 - SSP245 - SSP370 - SSP585 Inside each folder (for Historic and SSPs): - coordinates<variable>.csv:

	.csv files of coordinates of the raster cells for precipitation (pr), maximum temperature (tasmax), minimum temperature (tasmin) in EPSG:4326 - <variable>.csv Timeseries values for each coordinates<variable>.csv - <variable>.nc NETCDF “original” merged files for the climate change datasets - <variable>_bc.parquet.gz Bias corrected datasets in parquet files. - <variable> Original files pre merging. Merging these files you get <variable>.nc - figs Bias correction timeseries and statistics for each raster cell coordinate.

7. **8_cc**
    a. **8_cc/<watershed>**

File	Description
<ssp><ClimateChangeModel><Variable>.parquet.gz	<Variable> can be: (1) “data” corresponds to the compressed input data file for PRMS or (2) precip, tmax, tmin, which correspond to the climate change variables
<ssp><ClimateChangeModel><Variable>_bc.cbh	Climate by HRU (CBH) files for the watershed. These are the distributed weather variables for each HRU in the simulation. You could copy and paste it directly to your simulation folder.

8. **9_prms**

File	Description
prms_5.2.1_linux	Source code folder with documentation for PRMS Linux executables. - src Original source code - srcC Modified source code for proper lake budget - bin Compiled PRMS executables: (1) “prms” original executable; (2) “prms_m” executable with modification and the one applied to this research, source code for this executable can be found on “srcC”
<watershed>	Contains the simulations for each watershed. Each folder has the following folder: - data o <watershed>.gpkg: HRU geometries with attributes for the simulation o .dat files: for model related data. o .cbh files: original climate by HRU files - preproc o Preprocessing python scripts and notebooks - scripts o Model scripts for building the model, running the simulations and plotting. You can find the base parameter file here as “params-semidist.json” - Sim o Simulation folders ▪ Base represents the base watershed structure ▪ base_<name> represents the “name” of the simulation/subbasin/streamgage/reservoir.

9. 10_cc_outputs

File	Description
<watershed>	<watershed><name>, where name represents each calibrated subbasin/streamgage/reservoir. Inside each folder you can find the simulation outputs by the file name “<ssp>_<ClimateChangeModel>_<stat>.csv”. Each one of these files contains statistic outputs for each calibrated analysis.

10. 11_Extra_cc_analysis

File	Description
Cc_test	- Complementary scripts - Climate change trend analysis - Analysis of the importances of precipitation and temperature
ClimateChangeEffects	- Scripts and output files for the last part of the analysis where climate change effects are evaluated.