## Purpose

This document summarized the cleaned up methodology that does not consider the hiccups and side analysis along the way for historical and future hydropower potential analysis work presented in Dhaubanjar et al. (2023a, 2023b). Post processing scripts for plotting and analysis are not fully documented. Refer to scrips in postprocess folder for all scripts.

## Code flow for future hydropower potential analysis

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| SPHY modeling | SPHY post-processing, HyPE pre-processing | HyPE future runs | Post-processing |

| **Step (system)** | **Relevant script** | **Purpose** |
| --- | --- | --- |
| 1. Rename 365d calendar to leap year calendar   *HadGEM was 360d first but later AL reran his codes to generate it in 365d calendar and run it as the rest*  *(EEJIT)* | UIB\_basic\_model/addons/re-index\_365d.r | Rename 365d GCMs to leap year and copy to my forcing dir |
| UIB\_basic\_model/addons/re-index\_360d\_to\_leap.R | Rename 360d HadGEM GCMs to leap year and copy to my forcing dir |
| UIB\_basic\_model/addons/countFiles.sh | Check that file counts in my forcing dir are correct – 31411 files for 86 years |
| 1. Run SPHY model for future models for entire timeperiods   *Ran historical separately as it got overwritten somehow*  *(EEJIT)* | UIB\_basic\_model/addons/create\_run\_MultConfig.py | Create file structure for output folder to be same a forcing dir.  Add one config file for each ssp-GCM name |
|  | Manually create/relocate config file for hist and create output folder for hist |
| UIB\_basic\_model/addons/runSPHY\_eejitparallel.sh | Check if code needs any other changes to ensure all new config files are accessible. Do not run the code. It is called by the schedule\_SPHY code instead. |
| UIB\_basic\_model/addons/schedule\_SPHY.sh | Change jobname, processors and time regd in the code. Use sbatch to submit job to eejit and run all sphy models in parallel |
| 1. Take longterm monthly averages (LTMA) for specific 30 years mid and future timeframes   *(EEJIT)* | UIB\_basic\_model/postprocess/get\_LTavgmonTS\_from\_monTS.py | Generate filename indices for selected time frame and take long term avgs. Files are read from UIB\_output\_all and saved to a new folder UIB\_outputs\_LTMavgs |
| UIB\_basic\_model/postprocess/schedule\_pyscript.sh | Use sbatch to submit job to eejit and run the processing of all future time frames |
| 1. Route future LTMA files for 5km-Runoff to get 500m-Discharges for future timeframes   *HPC access was not setup at this time. Probably could be faster on HPC*  *(UU\_PC)* | HPmodel/data/data\_prep/UIB\_outputs\_LTMavgs.m | Manually download the LTMA .map files from eejit to data folder |
| Hydrus/data\_prep/data\_prep\_scripts\_fut/ProcessSPHY\_futureRmaps.m | Convert LTMA .map files to .tiff and save it as .mat for use in matlab |
| Hydrus/data\_prep/ downscale\_Q/DownscaleQ\_wWC\_future.m | Load .mat files and perform discharge routing to get 500m monthly Q LTMA .mat files |
| 1. Evaluate design discharge for future timeframes   *(HPC)* | Hydrus/data\_prep/ data\_prep\_scripts/EvalDesignFlows\_FutQ.m | Evaluate design discharge using the 500m monthly Q .mat files |
| 1. Run HyPE for future scenarios in parallel   *(HPC)* | Hydrus/RunFutScenarios.m | Load old basin file, then load new Q files for each future scenarios to runHydrus model to get tech/fin/sust potential |
| 1. Evaluate discharge time series (TS) for future timeframes   *(UU\_PC) (HPC)* | SPHY\_UIB/UIB\_outputs\_all | Manually download the monthly runoff TS .map files from eejit to data folder |
| Hydrus/data\_prep/data\_prep\_scripts\_fut/ProcessSPHY\_futureRmaps\_TS.m | Convert 5km runoff TS .map files to .tiff |
| Hydrus/data\_prep/ downscale\_Q/DownscaleQ\_TS\_future.m | Load 5km tiff files and perform discharge routing to get 500m monthly Q TS .mat files |
| 1. Prepare plots   *(UU\_PC)* | PlotTheoreticalPotential\_Fut.m | Refer to in code documentation |
| GetTotals\_Fut.m |
| PlotSubBasinWisePotential\_Fut.m |
| PlotMultCostCurves\_Fut.m |
| PlotCostvsSizeScatter\_Fut.m |
| CompareQ\_future.m |
| ProcessFutPopEnergyData.m |
| 1. Evaluate HP performance   *(UU\_PC) (HPC)* | SimulateHPproduction.m | Compile optimal portfolios for all future scenarios and evaluate actual energy generation at optimal HP projects under historical and future climate |
| CompareHPperformance\_Fut.m | Review outputs of SimulateHPproduction and making exploratory plots |
| PlotHPperformance\_Fut.m | TS analysis  Box plots  Supply vs demand |

## Code flow for historical hydropower potential analysis

| **Step** | **Relevant script** | **Purpose** |
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| 1. Prepare DEM and Q based datasets | PrepRawDatasets\_Rasters | %% Compile all raster datasets into matlab arrays |
| CreateUIboundaries | %% Create catchment boundaries for UI at 5km and 500m and merge them. Generate 500m accuflux and ldds in same extent as 5km. |
| ProcessSPHYoutputs | %% Compile SPHY and PCRASTER based .map files for Q/R and .tiff files for acc, ldd and dem into one .mat file |
| DownscaleQ\_wWC | %% Route runoff to get Q or Qwc. Use preloaded 5km and 500m R to get Q |
| CompareR\_Q.m | %% Create plots comparing R and Q at diff outlets for observed and simulated |
| Compare\_Q\_Qwc.m | %% Create plots comparing Q at diff outlets for observed and simulated (Q vs Qwc) |
| 1. Evaluate theoretical potential | PrepareTheoryPotData | %% compile arcgis processed dem, acc, fdir, outlet. Create and rename basins |
| EvalTheoreticalPot | %% % Evaluate theoretical potential using cell or channel method for either of the 3 resolutions 15s (UI or all Indus), 500m and 5km |
| CompileTheoreticalPot | %% compare theory pot at 3 resolutions: 5km, 15sUI and 500m data |
| ForPaperFig\_TheoryPot.m | %% prep figs |
| plotTheoreticalPotential | %% prep figs |
| 1. Prepare other multi-sectorial datasets | PrepRawDatasets\_Shapefiles | %% Compile shapefiles into matlab arrays. Project, clip and rasterize them to the UI extents. |
| EvalDesignFlows | %% Evaluates design flow and related load factor. |
| Distancemap\_maker\_roads.m | Refer to in code documentation |
| Distancemap\_maker\_settlements.m |
| Distancemap\_maker\_transmission.m |
| EvalAgriLandLossCost.m |
| EvalLandAcquisitionCost.m |
| EvalTreeLossCost.m |
| EvalGLOFpath.m |
| EvalMainstreamvsTributaries.m |
| GetExistingDams |
| CompileAllBasinData.m | %% Compile all data layers into one big .map fil e |
| 1. Run HyPE for historical scenarios to evaluate technical, financial and sustainable potential | RunMainScenarios.m | %% Run main energy focus and geo hazard risk representation scenarios |
| RunSAScenarios.m | %% Run sensitivity analysis scenarios |
| 1. Post process and plot output | PlotTheoreticalPotential.m |  |
| GetTotals.m | % Get subbasin wise sums and save them |
| Fig\_PlotSA\_Q\_bars.m | Refer to in code documentation |
| Fig\_MainScenarios.m |
| Fig\_PlotSubBasinTotals |
| PlotWoutersMarimekkoBar\_SubBasinPotentials |
| PlotSubBasinWisePotential.m |
| PlotSpatialMaps |
| PlotMultiParaScatterPlots | % Get more details on plant characteristics and all |