## System preparation

### Installation software

* GAMS (<http://www.gams.com/>) (license is needed, please contact Fujimori). Version 26.0.0 or newer is needed. CPLEX is needed for the solver license.
* Git for windows
* Git application software, (e.g. Source Tree (<https://www.sourcetreeapp.com/>) or TortoiseGit (<https://tortoisegit.org/)>) (open source)
  + (choose commit as-is) when you install
* R (<http://www.r-project.org/>) (open source); this is not necessity but highly recommended to use for analysis and visualization.
* RStudio (<http://www.rstudio.com/>) (open source) is recommended to use R.
* Cygwin (enable all netcdf functions after selecting "full" from the drop-down menu)
  + Cygwin requires a Linux distribution to run commands such as bash. To run a Linux distribution, enable the Windows Subsystem for Linux (open the powershell as an administrator and run [Enable-WindowsOptionalFeature -Online -FeatureName Microsoft-Windows-Subsystem-Linux]) or use the GUI Turn Windows features on or off then reboot. Download and install a distribution of your liking from Microsoft Store (e.g Ubuntu, SUSE, Debian etc). You need to create a username and password to use the distribution. After successful setup, run the update command [sudo apt update] to update the repository cache from which packages will be installed. This is because the cache of a newly installed system is empty (does not contain available packages). Then, install "netcdf" package [sudo apt install netcdf]. The code examples are for Ubuntu on WSL. We use "sudo" because installing packages is an administrator task. "apt" is a package manager that downloads and installs packages from the Ubuntu archive.

### Computational load

10GB memory per scenario

17 threads per scenario

15GB storage per scenario

### GitHub and download the AIMPLUM model

* Make one directory for working space of the latest AIM/PLUM (e.g. AIM\_PLUMv) and clone the model from Github or get the code from Hasegawa.
* Right click in the folder and Github checkout
  + You would be asked the repository and then put the repository name <https://github.com/KUAtmos/AIMPLUM>. Using branches would be preferable and for the beginner, it would be better to make a branch from “master”. For the developer, new branch is better to be made by “develop”.
  + If you don’t have access to the repository please contact Fujimori
  + Then you have several folders under AIMPLUM such as shown below

AIM\_PLUMv

│data

│define

│doc

│

### Environmental variables

The following directory paths should be added to “Path”

* GAMS exe file location
* Cygwin exe file location (Cygwin/bin)
* R exe file location (R/bin)

Note that you need to reboot the system in order to reflect the changes of the environmental variables. It should be English instead of font of Chinese or other languages.

How can you check whether you have added the directory paths to “Path’ correctly? First, open command prompt. Then type ‘bash’ to see if Cygwin works fine. Then type ‘R’ to see if R works fine.

When you run the model and find something is wrong with plotting graphs, please try install R library. First, open R studio, click ‘tools’, then ‘install package’, type ‘ggplot2’ in the blank line and click ‘install’. After it is finished, do it similarly for ‘RColorBrewer’ and ‘reshape2’.

For running PREDICTS, which estimates biodiversity state related to land use, additional 6 R packages 'ncdf4', 'raster', 'dplyr', 'Matrix', 'lme4', 'car' is needed.(Latter 3 packages are not needed if you won't turn PREDICTS subswitch "Sub\_calc\_PREDICTScoef" on.)

## Get and put data

## 

~~Currently the global land-use data that is required to run the model can be distributed from Hasegawa and please contact directly. The required files are as shown below which should be located same directory as model named “data”.~~

~~/biomass~~

~~/cbnal0 (this directory should have AIM/CGE results in output/cbnal0 directory)~~

Analysis.gdx (this file can be obtained from AIM/CGE results in output/global/global\_17/gdx/) should be obtained from CGE outputs and copied to ./data/cgeoutput/

~~Land\_map\_rcp.gdx~~

Graphical user interface, text, application, email

Description automatically generated

## Basic flow

There are two stages to run the model and first is base year simulation and the other is future scenario (as shown in Figure 1). These are run by \prog\LanduseModel\_MCP,gms. These processes run parallelly for regions (more than 17 threads usage are recommended). Once you run base simulation, you may be able skip that procedure. Then, merging the results is run by \prog\combine.gms. Basically, model run is carried out by every regions and merging those regional results are the main purpose of this process. Then. There are two independent procedures namely; making netCDF files and png map files. For the netCDF file creations, gdx2csv.bat and csv2nc.bat are run. For PNG file creation, making gdx files and running r are the basic procedures. The main outputs are also illustrated in Figure 1.



Figure 1 Overview of the program structure

## How to run the model

Copy./shell/settings\_cout.sh and rename as you want. Assuming that those files are named as ./shell/settings\_cout2.sh, execute in Cygwin or linux OS under ./shell/ directory as below.

bash ./shell/execution\_cout.sh settings\_cout2

./shell/execution\_cout.sh describes all processes and ./shell/settings\_cout.sh is the file which you can configure settings what processes are carried out for each batch.

## Preparation of batch files

shell files for each scenario have to be created before execution in /shell/settings/${SCENARIO}.sh. This file includes three parameter configuration as below and see an example of SSP2\_BaU\_NoCC.

SCE=

CLP=

IAV=

You might be able to create files if you would like to make multiple scenarios with a systematic rule. For example, if you would like to run SCE=SSP2, IAV=NOCC but to make CLP variations, use /shell/SettingFileGen.bat and /shell/src/SettingFIleGen.sh.

## Parameters (./shell/settings\_cout.sh )

There are multiple parameters that configure the condition of main execution batch file. Full list of parameters are shown in Table 1.

# Main results

There are three kinds of outputs and they are located as below.

* + - * 1. Land use derived output in gdx files: ..\output\gdx\analysis\%Scenario%.gdx

Area; area of individual land classification (million ha)

GHGL: CO2 emissions associated with land use changes (MtCO2/year) (LUC is total and others are individual land classification associated emissions)

PYIELDL\_OUT: average yield of land category L region R in year Y

* + - * 1. Land use map output in netCDF files: ..\output\nc\\*.nc
        2. Land use output in png files: ..\output\png\%Scenario%\_%year%\*.png

If you would like to get direct output, see below

* + - * 1. Direct model outputs in gdx files (by regions) : ..\output\gdx\%Scenario%\cbnal\%region%.gdx

Table 1 List of parameters in paraconf.bat

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Default | Options |  | Rough time |
| YEAR | Years to be run | 2010 2020 …2100 | Any specific every 10 years | Specifies what years are run. Normally this can be unchanged. | - |
| global | Whether run global or individual regions | on | On/off | This specifies whether global or specific regions are run. Global on automatically runs all regions. | - |
| CountryC | Region | JPN | 17regions | Specifies regions if global is not run. If global run, this parameter will not be taken | - |
| scn | scenario | SSP2\_BaU\_NoCC | any | Specifies scenarios by space separated format. | - |
| CPUthreads | CPU core threads | 60 | Any numbers | Specifies number of CPU cores that can be used in this process. If this is more than scenario number \* 3, then CPLEX option changes to use three threads for each process |  |
|  |  |  |  |  |  |
| pausemode | Debug option | off | On/off | If you want to debug, this should be turned on to keep the command window open and pause every steps | - |
|  |  |  |  |  |  |
| DataPrep | data preparation process | on | On/off | Normally it can be off but if you would like to change the base dataset, it needs to be turn on | 2.5 hours |
| Basesim | Base simulation | On | On/off | Creating base map | 1 hour |
| Futuresim | Future years simulation | On | On/off | Simulating future scenarios | 5 hours per scenario |
| Sub\_Futuresim\_ NormalRun | Normal future simulation | On | On/off | Future land use allocation scenario simulations under optimization. This switch belongs to “Futuresim” and normally can be kept turn on | 5 hours per scenario |
| Sub\_Futuresim\_ DisagrrFRS | Disaggregation of forest and other natural land | On | On/off | Disaggregate unused area into forest and other natural land. This switch belongs to “Futuresim” and normally can be kept turn on. | Few minutes per scenario |
| Sub\_Futuresim\_ biocurve | Biomass potential supply curve calculation | On | On/off | Biomass potential curve calculation. This switch belongs to “Futuresim” and normally can be kept turn on | Few minutes per scenario |
| ScenMerge | Merge results | On | On/off | Merging scenario results | A few minutes per scenario (Without biomass supply curve calculation) |
| Sub\_ScenMerge\_BiocurveSort | Calculate biomass supply curve | Off | On/off | Sort biomass potential grids to compute biomass supply curve. This switch belongs to “ScenMerge” and normally can be kept turn off. | 3 hour per scenario |
| MergeResCSV4NC | Process results for making NetCDF files | On | On/off | This process generates ascii files for making netcdf files. | 15 minutes per scenario |
| Sub\_MergeResCSV4NC\_basecsv | Basic csv files | on | On/off | This process computes basic data for the following on calculation. This should be kept turn on normally but needs to be run if you revised the results | 30 minutes |
| Sub\_MergeResCSV4NC\_lumip | For LUMIP | On | On/off | For LUMIP data format generation. This switch belongs to “MergeResCSV4NC” and “netcdfgen”, and normally can be kept turn on. | A few minutes per scenario |
| Sub\_MergeResCSV4NC\_BTC3option | For BTC study | On | On/off | For Luclare et al. 2020 Bending the curve study data format generation. This switch belongs to “MergeResCSV4NC” and “netcdfgen”, and normally can be kept turn on. | A few minutes per scenario |
| Sub\_MergeResCSV4NC\_ssprcp | For AIM SSP-RCP data | On | On/off | For Fujimori et al. 2018 data format generation. This switch belongs to “MergeResCSV4NC” and “netcdfgen”, and normally can be kept turn on. | A few minutes per scenario |
| Sub\_MergeResCSV4NC\_bioyielcal | For bioenergy yield | On | On/off | For bioenergy potential yield calculation. This switch belongs to “MergeResCSV4NC” and “netcdfgen”, and normally can be kept turn on. | A few minutes per scenario |
| netcdfgen | Make NetCDF files | On | On/off | Making netcdf files. | 15 minutes per scenario |
| sub\_netcdfgen\_projectname | Name of projects | BTC | any | Name of project for BTC format. This switch belongs to “netcdfgen” and normally can be kept turn on. | - |
| PREDICTS | For biodiversity impact | On | On/off | For calculating biodiversity impact (BII). Need land use result as a nc file, with options for BTC format. | 10 minutes per scenario |
| Sub\_Calc\_PREDICTScoef | Estimate coefficients. | Off | On/off | For estimating coefficients for BII by yourself. (Ex. if you want to change the explain variables of regression). The default is off. |  |
| Sub\_Calc\_Scale | BII scale | Regional | Regional/Grid/Both | Whether you estimate BII on a regional or grid scale. If Grid, in addition to csv format result, nc format result will be output. |  |
| gdx4png | Process results for making PNG map files | On | On/off | Data processing for png maps. If “global“ switch is on, then only world map is made. If you would like to make specific regional map, turn off “global” switch and specifies the regional codes in “CoutryC” | Several seconds per year per scenario |
| sub\_ gdx4png\_dif | Difference from base year | on | On/off | This switch specifies whether the difference from base year is visualized or not | Several seconds per year per scenario |
| YesrListFig | List of years for visualization | 2010 2050 2100 | Year (space separated) | This specifies the years that are targeted to make map. This belongs to “PNGmake” and “plot” | - |
| plot | Plot PNG files | on | On/off | Execute R code to generate png maps |  |
|  |  |  |  |  |  |