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| **Stage** | **Module name** | **Task** |
| pre | creating\_farmer\_data | Converting grid to long data, lat, lon and value |
| pre | Creating\_pcraster | Creating required pcr input files |
| functions | Agg\_Disagg | Contains aggregated and disaggregated functions for mapping grid data to farmers and vice-versa |
| functions | space\_time\_fn | Functions to cut, mask space-time data |
| functions | stats | Function to get nse, r2 for runoff, GWL. Called at the end of simulation to print these variables. |
| functions | Cal\_para | Functions which are based on spatial data and variable files create the parameters in the code. Need settings for file name and spatial data ( space\_time\_fn) to create the same. Called in all modules when required parameters are needed. |
| settings | settings | Contains start end dates for model, all input files paths |
| data | Climate\_data | Loads the climate data from specified file name in the settting |
| data | Crop\_farmer\_data | Loads the farmer data from specified file names in the settings |
| data | spatial\_data | Loads the aspatial data based on path, space\_time\_fn |
| data | variables | Create all variables in which data is stored |
| Running the code | cal\_loop | Function to run the code on loop from a variable csv file |
| Running the code | Run\_SHM | Function to run the code without loop and variable file with variables given in settings. Need changing code a little bit. Default is new cal\_loop event for one run |
| Main function | Householdmodel | Houses the main function in which all modules are called |
| Module | WB\_yield\_space\_runoff | Soil water module producing runoff and recharge |
| Module | Runoff\_m | Functions for runoff, recharge etc. |
| Module | check\_dams | Functions for check dam capture and recharge |
| Module | crop\_selection | Functions for farmers to choose crop and their area |
| Module | Crop\_module\_agent | Main code for crop ET, AET, IWR |
| Module | crop\_yield | Crop yield is calculated based on water requirement met |
| Module | NetHousehold income | Crop income from production is calculated |
| Module | Expenditure | Expenditure is calculated |
| Module | output | Function to save output files to directory based on variables file row |

**Input data**

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| --- | --- | --- | --- |
|  | Variable name | File name | What |
| Spatial | mask\_sh | kamadhiya1.shp | Defines the extent of the model spatial boundaries. Used for setting the extent and cutting other spatial datasets |
| slope | slope\_rsp.nc | Slope of the catchment |
| clone | dem2.map | PC raster input file requirement |
| Climate | rain\_g\_3 | rain\_gauge\_idw\_com.nc | Rainfall data in netcdf format derived from spatial interpolation of the gauge data |
| meanT | meant\_stack.nc | Temperature data |
| minT | meant\_stack.nc | Temperature data |
| maxT | maxt\_stack.nc | Temperature data |
| Soil | FC\_top | FC\_top.nc | Spatial data on field capacity of top layer |
| WP\_top | WP\_top.nc | Spatial data on wilting point of top layer |
| SAT\_top | SAT\_top.nc | Spatial data on sat capacity of top layer |
| Ksat\_top | Ksat\_top.nc | Spatial data on sat hydraulic conductivity of top layer |
| FC\_bottom | FC\_bottom.nc | Spatial data on field capacity of bottom layer |
| WP\_bottom | WP\_bottom.nc | Spatial data on wilting point of bottom layer |
| SAT\_bottom | SAT\_bottom.nc | Spatial data on sat capacity of bottom layer |
| Ksat\_bottom | Ksat\_bottom | Spatial data on sat hydraulic conductivity of bottom layer |
| farmers\_data | farmers\_data | farmer\_data\_n | Data list of ~ 38000 farmers giving their grid id, lat, lon and variables (area, type, cd, livestock) |
| farmer\_irr | farmer\_irr\_data | Data list of ~ 38000 farmers giving yearly access to irrigation (0 or 1) from 1983 to 2015. |
| far\_training | training | Data list of ~ 38000 farmers giving yearly access to training (0 or 1) from 1983 to 2015. |
| farmer code\_grid | farmer\_code\_n | gives farmer id against grid id and lat and lon |
| grid\_Code | grid\_code.csv | give grid id against lat and lon |
| Check dams | check\_dams\_file | check\_dams.csv | For each grid, give the cd presence, storage and width |
| water | water | water.csv | Lcoation of grids which are close to dams and rive |
| crop | kc | kc.csv | Containing dail kc value for the year of the day and stage of crop growth period |
| cropvar | crop\_variables.csv | Crop variables include ky, cost and all |
| crop\_area\_ratio | Crop\_area\_ration2 | Crop potential yield year wise and cotton ration to NCA for farmers with cd and wocd. |
| calibration | calibration | variables.csv | Subsample of 500 lhs samples which fits the conditoons on soil parameters (339) |
|  | calibration | variables\_run1.csv | Sub-sample [140] of 339 variales which have gw and runoff nse > 0.5. |

**Settings fixed parameters**

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| delt | 0.05 | A 5% depreciation rate of capital is assumed |
| capital | 25000 | initial capital of each farmer |
| inte | 0 or 1 | one if interventions need to be considered |
| cond | 1, 2, 3 | specify which condition CD recharge is operating |
| human | 0 or 1 | human behaviour rules on or off. 1 if need to be considered |
| cotton\_s | 0 or 1 | 1 if cop selection rule to be considered else 0 |
| wheat\_s | 0 or 1 | 1 if cop selection rule to be considered else 0 |
| Check dam bouwer parameters | a=4.3 #confition A parameter  A= 3 #condition A' parameter  P\_cr=-0.5 #critic pressure for bouwer[m]  R\_a=150#impendence of the clogging layer [day] | Bouwer parameters |
| drip\_cost/ha | 60000 |  |
| bw\_cost | 70000 |  |
| crop | 5 | number of crops including fallow area |
| D | 10 | Rainfall interception |

**Calibration file parameters**

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| --- | --- |
| variables |  |
| Scenario | Scenario number |
| top | Top soil depth. Fixed. |
| bottom | Bottom depth. Fixed. |
| cap\_ris\_max | Max cap rise/day |
| aq\_depth | Depth of aquifer |
| YieldGw | Specific yield of groundwater |
| aq\_conduct | Aquifer conductivity |
| deltaGw | GROUNDWATER RECHARGE DELAY TIME (delay in groundwater recharge (days)) |
| alphaGw | ASEFLOW DAYS (parameter of baseflow days: alfaGw = 2.3/X (X = nr. of baseflow days). |
| BaseThresh | ASEFLOW THRESHOLD (minimum value for baseflow to occur (mm)). |
| kx | RECESSION ROUTING COEF |
| RF | Return flow factor |
| f\_soil\_top1 | Scaling factor for FC top layer |
| f\_soil\_top2 | Scaling factor for WP top layer |
| f\_soil\_top3 | Scaling factor for SAT top layer |
| f\_soil\_top4 | Scaling factor for KSAT top layer |
| f\_soil\_bottom1 | Scaling factor for FC bottom layer |
| f\_soil\_bottom2 | Scaling factor for WP bottom layer |
| f\_soil\_bottom3 | Scaling factor for SAT bottom layer |
| f\_soil\_bottom4 | Scaling factor for KSAT bottom layer |
| RWP | Root wilting point (0 to 1) |
| GN\_Irr | % of Groundnut area irrigated |
| risk\_drip | RANAS equation variables for drip |
| impact\_drip |
| ability\_drip |
| attitude\_drip |
| norm\_drip |
| intercept\_drip |
| ability\_bw | RANAS equation variables for BW |
| attitude\_bw |
| norm\_bw |
| water\_bw |
| area\_bw |
| livestock\_bw |
| plan\_bw |
| intercept\_bw |
| intercept\_wheat | Wheat area equation parameters |
| GWL\_wheat |
| intercept\_cotton | Cotton equation parameters |
| year\_cotton\_b |
| year\_cotton\_a |
| training\_per | Contribution of training to ability for drip |
| income\_per | Percent of income contributed to investments |
| threshold\_drip | Threshold for drip adoption |
| threshold\_bw | Threshold for BW adoption |

**Setting up the model**

* All input data given in the input\_data directory. Climate data linked to gdrive.
* Change the input path wherever needed.
* Create output directory path and add the same in output file.
* Set the number of iterations based on the calibration file in the cal\_loop.py file. Currently set to run for 1 run which is the calibrated parameters.

Settings define the following parameters.

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| Parameter | Description | Format |
| startdate | Start date of uploaded precipitation dataset (gridded one, not use) | YYYY-MM-DD |
| enddate | Start date of uploaded precipitation dataset (gridded one, not use) | YYYY-MM-DD |
| Startdate\_g | Start date of uploaded precipitation dataset from rain gauge (used in the model) | YYYY-MM-DD |
| Enddate\_g | Start date of uploaded precipitation dataset (used in the model) | YYYY-MM-DD |
| startdate\_t | Start date of uploaded temp dataset | YYYY-MM-DD |
| enddate\_t | Start date of uploaded temp dataset | YYYY-MM-DD |
| sim\_start | Start date of simulation period | YYYY-MM-DD |
| sim\_end | End date of simulation period | YYYY-MM-DD |
| start\_year | Starting simulation year | YYYY |
| end\_year | End simulation year | YYYY |
| Path to file | This include path to:   * Climate data * Soil data * Slope data * Farmers data file * Grid code file * Crop parameters file |  |