**User guide for SMART-SED**

In the following we define the SMART-SED root directory the one that contains thee README.md file and which has the folders:

* DeterministicProgram
* Geostatistics
* Inputs
* Outputs
* run

For Windows users, we suggest to install Docker (<https://www.docker.com/products/docker-desktop>). We provide a Dockerfile in the folder run/Docker where one can build the Docker environment for the SMART-SED program.

For UNIX users it is sufficient to install the dependencies listed in the README.md file.

**Fist use: Compile**

Compiling is necessary at the first (folder: *smartsed-main/DeterministicProgram*).

Run the Docker Machine

Run file in the folder run/Docker -> runWindows.bat

Cancel the .o file before recompiling.

Execute the sequence of commands:

*ls* -> *cd Determ(tab)* -> *ls* -> *make -j4* (ls=list, cd=change directory, -j4 is the processor cores number)

Wait until it finishes.

Delete all .o files before compiling a new main file.

**Input data**

It is possible either to insert the input files in single folders or to put all of them in a unique folder. The input file paths must be inserted into the text file *SMARTSED\_input\_ev* (folder *run*). The file path always starts from the “Inputs” folder.

The complete list of the input parameters follows.

**DEM**

A picture containing text

Description automatically generated

First input is the orography (DEM), the second one is the basin mask. For both the DEM and basin mask, the .asc file is sufficient.

DEM in *.asc* format. It can be exported from ArcMap, using the function *Raster to ascii*.

It can be exported from R as well using the function

*writeRaster(y,'maschera.asc').*

In order to assign 0 values to NoData values in R, use the function

*newraster <- reclassify(oldraster, cbind(NA, 0))*

In order to define the extent of all other layers, one needs to know the coordinates of the square that contains the DEM. This can be obtained from R:

Input raster in R. Use function extent(raster).

Script to obtain this information contained in the file *‘valletta.R’*

**Meteo data**

Two different formats for meteorological data: Comune di Lecco (pluviometer, hydrometer, thermometer) and ARPA Lombardia. Select the desired format commenting the excluded one (#).

**Temperature**

Immagine che contiene testo

Descrizione generata automaticamente

Insert one temperature file, standard atmosphere law is applied.

The height is expressed in m asl.

**Rainfall rates**

Immagine che contiene testo

Descrizione generata automaticamente

Choose the data format. If data are downloaded from the ARPA website, the format is tab delimited .txt file with the following columns: ‘Id sensore’; ‘Data ora’; ‘Valore cumulato’. The temporal resolution could be different in each file. The correct resolution should be set up in the main file: *SMARTSED\_input\_ev.txt* in the section precipitation. The coordinates and quota of each pluviometer should be indicated in the folder containing the rainfall data. In order to interpolate data from multiple pluviometers, include data files for each of them in the same format.

In case of “Comune di Lecco” format, setup the time in format dd/mm/yy hh:mm:ss.

Midnight is 00:00:00. First value is midnight.

Delete “NoData” values.

In case the precipitation is uniform, the format should be setup as Comune di Lecco and the flag *precipitation = true* should be selected.

**Soil composition**

Immagine che contiene testo

Descrizione generata automaticamente

If “restart soil moisture” is set to “false”, soil composition is computed by geostatistical downscaling of the layers of sand, silt, and clay which can be downloaded from soilgrids.org (<https://www.isric.org/explore/soilgrids>) for the extent of the desired basin. It is not necessary to provide a silt raster, because it is computed starting from the others (their sum is 1).

When precise data (e.g. field data) is available, “restart soil moisture” should be set to “true” and soil texture data should be provided as rasters of sand, silt, and clay in fractions, the sum of which adds up to 1. Values outside the range should be setup to *NoData (-9999)*. Avoid zeros.

In order to indicate that precise data should be used and not a geostatistical downscaling, the file location should be specified in the submission.sub file.

**Options**

**Restart from initial conditions**

Starts the simulation with an initial condition from the output of a previous simulation. For this, the respective initial condition files should be copied from the *Outputs/{name of the output folder}/-1/* folder to the folder *Outputs/initial\_cond.* The respective path should be indicated in the *SMARTSED\_input file.*

*restart\_soil\_moist* *= true* always in case no precise soil texture data is available (e.g. field data) and downscaling of soilgrids data will be performed.

The rainfall and temperature files should be modified to start from the desired simulation day.

**Fill sinks**

*FillSinks = {true, false}* if true smoothens sinks in order to avoid erroneous accumulations of water in concentrated areas. This option is more suitable for a basin-scaled modeling.

**Run file**

When you have field data of soil texture, set up *restart\_soilMoisture = true*.

**Submission\_ev file**

*nsim = 1* corresponds to a kriging with 1 Gaussian simulation of white noise.

*nsim = 0* corresponds to a kriging of the soil grids data without a Gaussian simulation.

*nsim* = 20 is 20 white noise simulation to produce perturbed maps in order to be able to generate a monte carlo simulation.

If field data is available, and no downscaling of Soil Grids data is required, setup *nsim = -1*.

*res* = scaling factor with respect to 5m (if it is setup to if res=4 the elevation model resolution will be 20 meters).

**Corine land cover**

Change file name (or path of necessary) and the corners of the DEM (mask) in the file called convertShapefileToRasterASCII. The coordinates are reported in the following order: xmin ymin, xmax ymax.

An .asc can be provided as well containing the correct values.

Infiltration

IsInitialLoss = true/false

**To run**

Run the Docker Machine

Run file in the folder Docker -> runWindows.bat

Execute the sequence of commands:

*ls -> cd run -> ./submission\_ev\_local.sub*

**Output**

Path:

*Outputs -> {name of folder specified in the submission file} -> Outputs -> Postprocessing.m*

In order to save the solution in a different folder, go to file *run -> submission\_ev.sub* and change *JOBID = {name of the new folder}.* Otherwise, the solution will be overwritten over the previous solution.

It is better to create the output folder manually first, but it creates it anyway.

The output files are the following:

H – water surface elevation [m]

hG – gravitational component of water within the soil (water table?)

hsd – sediment accumulation value relevant to the respective timestep, normalized to the cell dimension [m]

hsn – snow depth [m]

p – rainfall field

q – the part of rainfall which forms into runoff

w – map of sediment source areas

f – rate of infiltration

ET - evapotranspiration

**Errors**

Gauges are not good – you need to set *save\_temporal\_sequence = false* or provide valid coordinates in order to export temporal sequences of water depth/sediment.