SEDI

Version 1.0

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A sediment transport model for large-scale basins in cold regions.

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Contents

Contents

1 Introduction

- Solutes are transported across the catchment via surface runoff and groundwater flow.
- Nitrogen (N) and phosphorus are abundant nutrient especially in agricultural areas.
- Nutrients can cause eutrophication and water quality deterioration. Pollutants can also deteriorate the water quality.
- Sediments can be considered as proxies of solutes.

1.1 Sediment transport processes

- Overland and in-stream erosion and deposition.
- Soil leaching of sediments.
- Atmospheric deposition
- In cold region:
  - Soil freeze-thaw cycles enhance rock weathering and soil leaching
  - Frozen soil-enhance runoff and erosion in surface layer

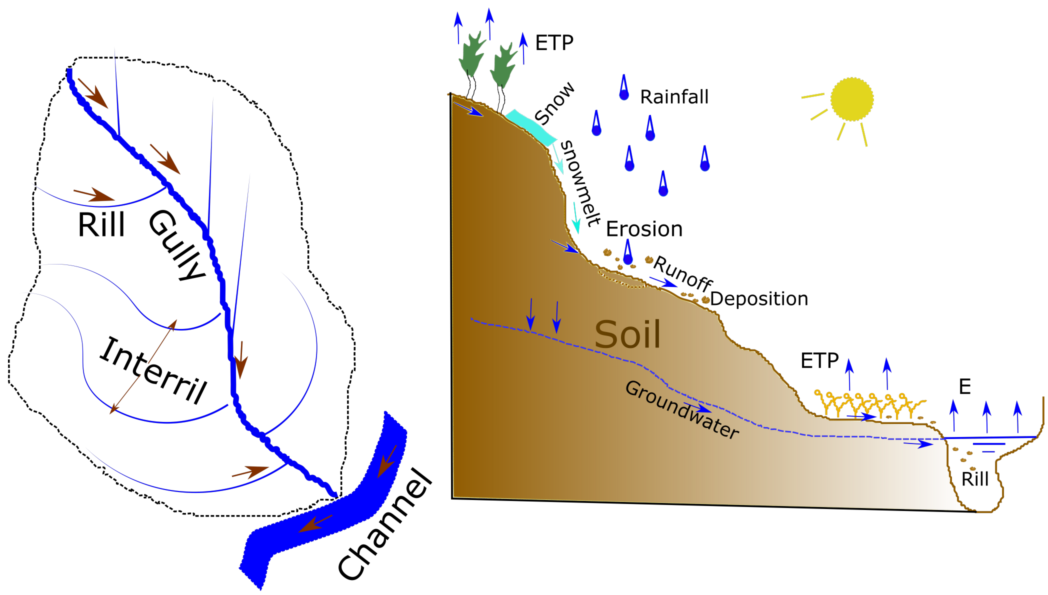
2 Controls and boundary conditions

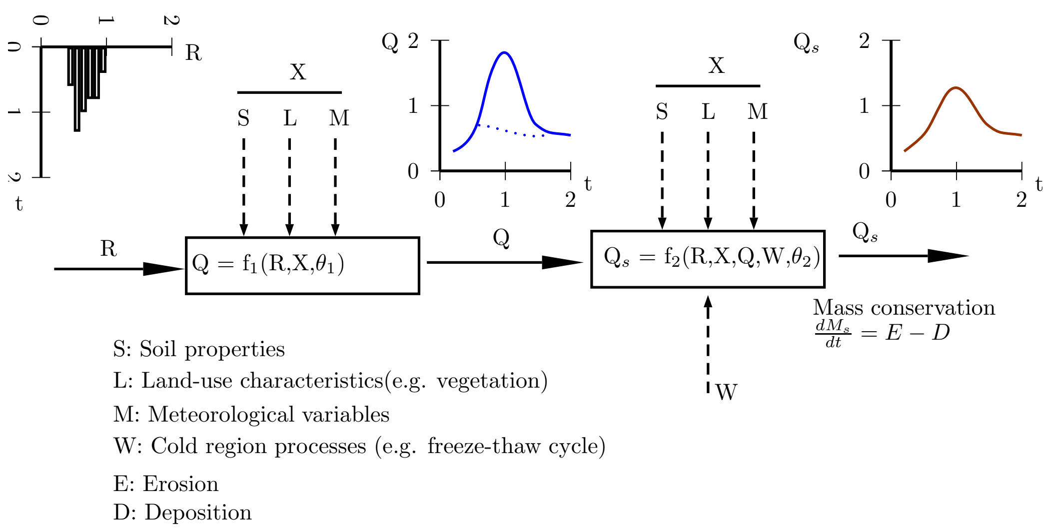
Controls in overland and groundwater transport.

- Slope, land type, soil type (diameter, resistance, specific weight, etc)
- Rainfall, air temperature, soil water content, soil conductivity

Controls in in-stream transport:

- Channel slope and section geometry
- Bank and bottom material properties (diameter, resistance, specific weight), discharge, shear stress (function of slope and discharge) and


Rill
Gully
Interril
Channel
ETP
Snow
Rainfall
snowmelt
Erosion
Runoff
Deposition
Soil
ETP
E
Groundwater
Rill


R
t
X
S L M
Q
t
X
S L M
Q_s
t
R
$Q = f_1(R,X,\theta_1)$
Q
$Q_s = f_2(R,X,Q,W,\theta_2)$
Q_s
Mass conservation
$\frac{dM_s}{dt} = E - D$
W
S: Soil properties
L: Land-use characteristics(e.g. vegetation)
M: Meteorological variables
W: Cold region processes (e.g. freeze-thaw cycle)
E: Erosion
D: Deposition

2.1 System representation of solute transport

3 Model structure

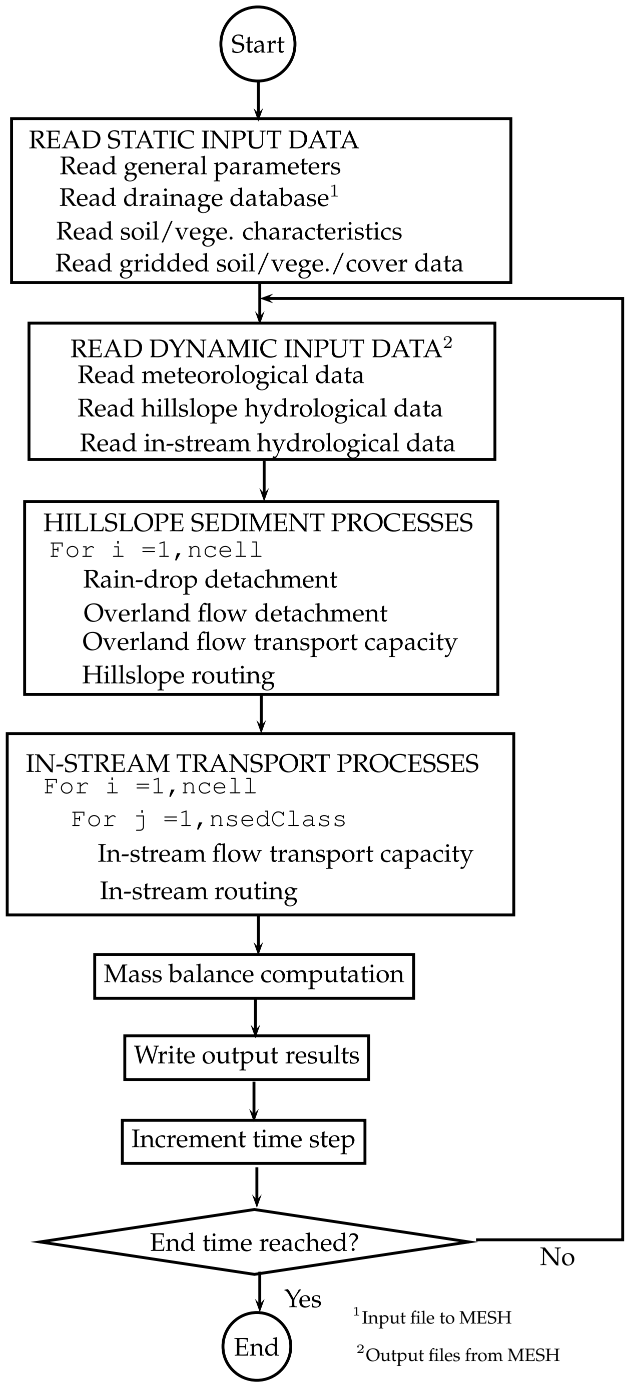
Some **MESH-SED** features:

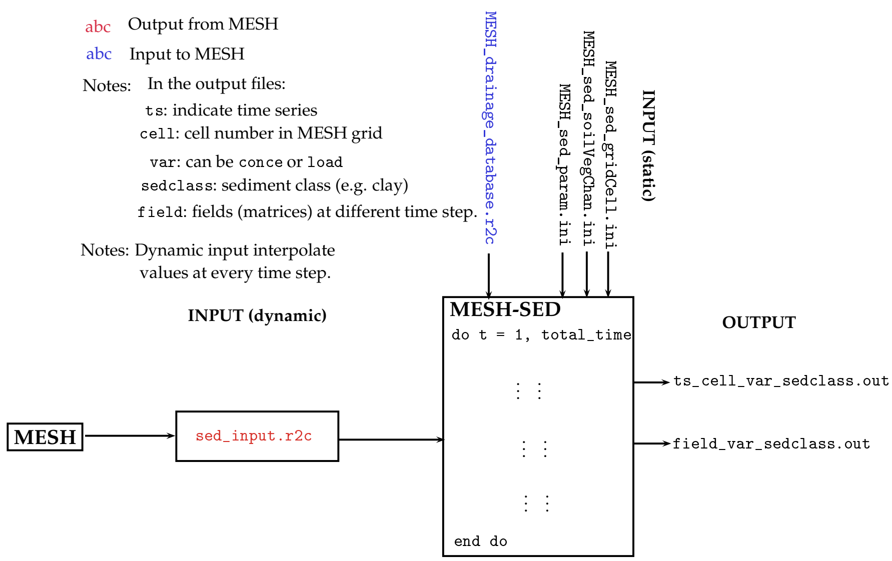
- loosely coupled with MESH [1].
- physically-based watershed sediment transport model.
- developed based on SHETRAN [2] and SHESED [3].
- semi-distributed model that work on a orthogonal grid (MESH grid).
- suitable for large-scale catchment to run on a continuous basis.
- include different sediment classes.
- future work: sedimentation in reservoirs, code parallelization.

3.1 Source code structure

Program `mesh_sed.f90`: Before main loop

```
[commandchars=\\\{\}]
    \verbb{Read the study case name}
    call mesh_sed_case
    !> Read 'MESH_sed_param.ini'
    call read_sed_param
    !> Read 'MESH_drainage_database.r2c'
    call read_MESH_drainage_database
    !> Allocate memory space of important variables
    call sed_allocate_var
    !> Get (i,j) position of RANK cells and neighbor cells.
    call sed_config_init
    !> Read 'MESH_sed_gridCell.ini'
    call read_sed_gridCell
    !> Read 'MESH_sed_soilVegChan.ini'
    call read_sed_soilVegChan
    !> Read 'MESH_sed_reservoir.ini'
    call read_sed_reservoir
```


Start
READ STATIC INPUT DATA
Read general parameters
Read drainage database[1]
Read soil/vege. characteristics
Read gridded soil/vege./cover data
READ DYNAMIC INPUT DATA[2]
Read meteorological data
Read hillslope hydrological data
Read in-stream hydrological data
HILLSLOPE SEDIMENT PROCESSES
For i =1,ncell
Rain-drop detachment
Overland flow detachment
Overland flow transport capacity
Hillslope routing
IN-STREAM TRANSPORT PROCESSES
For i =1,ncell
For j =1,nsedClass
In-stream flow transport capacity
In-stream routing
Mass balance computation
Write output results
Increment time step
End time reached?
No
Yes
End
[1]Input file to MESH
[2]Output files from MESH



4 Input data

4.1 MESH-SED input/output structure

4.2 Static input data

4.2.1 MESH drainage database data

The information regarding catchment topology, cells connectivity, and model 'skeleton' is contained in `MESH_drainage_database.r2c`. This file is an input file for MESH and it is usually produced by Green Kenue.

In **MESH-SED** , `MESH_drainage_database.r2c` is read at the beginning of the model.

4.2.2 Sediment transport model data

The following input files are read at the beginning of the program.

- `MESH_sed_param.ini`: Contains general information require to run de model.
- `MESH_sed_soilVegChan.ini`: Contains the soil and vegetation type characteristics.

- `MESH_sed_gridCell.ini`: Soil, vegetation and cover information for every cell of the grid.

4.2.3 `MESH_sed_param.ini`

Line 1	Comment
Line 2	MESH study case directory path
Line 3	Comment
Line 4	Hillslope_time_weighting_factor in-stream_time_weighting_factor in-stream_space_weighting_factor
Line 5	Comment
Line 6	Hillslope transport capacity method: 1[Yalin, 1963][4] 2[Engelund-Hansen, 1967][5]
Line 7	Comment
Line 8	In-stream transport capacity method: 1[Engelund-Hansen, 1967][5], 2[Ackers and White, 1973][6], 3[Day, 1980][]
Line 9	Comment
Line 10	Simulation time step (sec). It must be a multiple or factor of 60s but $\leq 3600s = 1h$.
Line 11	Comment
Line 12	Comment
Line 13	Start time: year julian_day hour minutes seconds
Line 14	End time: year julian_day hour minutes seconds
Line 15	Comment
Line 16	Upper limit of volumetric suspended sediment concentration
Line 17	Comment
Line 18	Output directory
Line 19	Comment
Line 20	Number of output grid points (ngr)
Line 21	Comment
Line 22	Comment
Line 23	$\begin{array}{lll} \text{cell\_number}_1 & \text{variable}_1 & \text{particle\_class}_1 \\ \vdots & \vdots & \vdots \\ \text{cell\_number}_{ngr} & \text{variable}_{ngr} & \text{particle\_class}_{ngr} \end{array}$ where *cell_number* is equal to *rank* in `MESH_drainage_database.r2c`, *variable* can be *conce* (concentration) or *load* and $particle_c lass$ is listed in Table 1.

4.2.4 `MESH_sed_param.ini`

Line 1	Comment
Line 2	Number of output fields (gridded data)
Line 3	Comment
Line 4	Comment $\begin{array}{ll} \text{variable}_1 & \text{particle\_class}_1 \\ \vdots & \vdots \\ \text{variable}_{ngr} & \text{particle\_class}_{ngr} \end{array}$

Table 1: Sediment/soil particles classes and diameters [7]

	particle_class		ϕ range (mm)
Mud	1	clay	$0.00006 \leq \phi > 0.0039$
Silt	2	veryFineSilt	$0.0039 \leq \phi > 0.0078$
	3	fineSilt	$0.0078 \leq \phi > 0.0156$
	4	mediumSilt	$0.0156 \leq \phi > 0.0313$
	5	coarseSilt	$0.0313 \leq \phi > 0.0625$
Sand	6	veryFineSand	$0.0625 \leq \phi > 0.125$
	7	fineSand	$0.125 \leq \phi > 0.25$
	8	mediumSand	$0.25 \leq \phi > 0.5$
	9	coarseSand	$0.5 \leq \phi > 1.0$
	10	veryCoarseSand	$1.0 \leq \phi > 2.0$
Gravel	11	granule	$2.0 \leq \phi > 4.0$
	12	pebble	$4.0 \leq \phi > 64.0$
	13	cobble	$64.0 \leq \phi > 256.0$
	14	boulder	$256.0 \leq \phi > 4096.0$

Example

```
! MESH study case directory path
'/media/Data3/MESH/Graham_River_WFDEI_Luis/07FA005_Graham_Riv/'
! Hillslope time weigh. factor        in-stream time weigh. factor        in-stream space weigh. factor
0.65        0.50        0.50
! Flag for overland sediment transport capacity
2       ! Choose transport capacity method: 1[Yalin, 1963] 2[Engelund-Hansen, 1967]
! Flag for instream sediment transport capacity
3       ! Choose transport capacity method: 1[Engelund-Hansen, 1967], 2[Ackers and White, 1973], 3[Day, 1980]
! Simulation time step sec
3600
! Simulation Run Times
---#---#---#---#---#
2002 365  23   0   0                                 ! Start year, jday, hour, minutes, seconds                5I4
2003 360   1   0   0                                 ! Stop year, jday, hour, minutes, seconds                 5I4
! Upper limit of volumetric suspended sediment concentration
0.9
! TS output Directory
'/media/Data3/MESH/MESH_SED/test/output_ts/'
! Number of output grid points
5
! Grid numbersranks        variable_name        sed_class_name
123456789012345678901234567890123456789012345678901234567890
1          load           clay
2          conce          veryCoarseSand
4          conce          cobble
10         conce          boulder
15         load           clay
! Field output Directory
'/media/Data3/MESH/MESH_SED/test/output_field/'
! Number of output fields gridded
0
! variable_name        sed_class_name
123456789012345678901234567890123456789012345678901234567890
load           clay
conce          fineSand
```

4.2.5 MESH_sed_soilVegChan.ini

Line 1 Comment

Line 2 Number of soil types (ns)

Line 3 For each soil type i

$$
\begin{array}{l}
\mathrm{frac}_1^1 \quad \dots \quad \mathrm{frac}_j^1 \quad \dots \quad \mathrm{frac}_{14}^1 \\
\rho_s^1 \quad \lambda^1 \quad k_R^1 \quad k_F^1 \quad k_b^1 \\
\vdots \quad \vdots \quad \vdots \\
\mathrm{frac}_1^i \quad \dots \quad \mathrm{frac}_j^i \quad \dots \quad \mathrm{frac}_{14}^i \\
\rho_s^i \quad \lambda^i \quad k_R^i \quad k_F^i \quad k_b^i \\
\vdots \quad \vdots \quad \vdots \\
\mathrm{frac}_1^{ns} \quad \dots \quad \mathrm{frac}_j^{ns} \quad \dots \quad \mathrm{frac}_{14}^{ns} \\
\rho_s^{ns} \quad \lambda^{ns} \quad k_R^{ns} \quad k_F^{ns} \quad k_b^{ns}
\end{array}
$$

Line 4 Comment

Line 5 Number of vegetation classes (nv)

Line 6 For each vegetation type j

$$
\begin{array}{ccccc}
\mathrm{vege}_1 & \dots & \mathrm{vege}_j & \dots & \mathrm{vege}_{nv} \\
X_1 & \dots & X_j & \dots & X_{nv} \\
d_1 & \dots & d_j & \dots & d_{nv} \\
\mathrm{DRIP}_1 & \dots & \mathrm{DRIP}_j & \dots & \mathrm{DRIP}_{nv}
\end{array}
$$

Line 7 Comment

Line 8 $\beta \quad \delta_{max} \quad \alpha$

frac = Fraction occupied for each particle class.

ρ_s = Soil density (kg m^{-3}).

λ = Soil surface porosity ($0. \leq \lambda \leq 1.$).

k_R = Soil detachability (J^{-1}).

k_F = Overland flow detachment (mg m^{-2} s^{-1}).

k_b = Channel bank flow detachment (mg m^{-2} s^{-1}).

vege = Vegetation class.

X = Fall height (m).

d = Leaf drip diameter (mm).

DRIP = % drainage as leaf drip.

β = Threshold sediment concentration in channels for infiltration and overbank sediment flow.

δ_{max} = Maximun thickness (m) of top (active) bed sediment layer in channel. δ_{max} = 1 or 2 $D_9$9 for gravel-bed channels and δ_{max} = 10 mm for sand-bed channels.

α = Ratio of critical shear stresses for deposition and initiation of motion ($\alpha < 1$). Likely range 0.25-0.75.

Example

```
! Soil type characterization
5                                                                                                     ! Number of soil types
0.      .05     .10     .30     .30     .25     0.      0.      0.      0.      0.      0.      0.      0.          ! Fra
2650.      0.2     25.     2.      2.                                                                       ! Density kg/m3, Surface porosi
0.      .05     .20     .25     .30     .20     0.      0.      0.      0.      0.      0.      0.      0.
2650.      0.2     25.     2.      2.
0.      0.      .10     .35     .25     .30     0.      0.      0.      0.      0.      0.      0.      0.
2650.      0.2     25.     2.      2.
0.05       0.05       0.05       0.20       0.30       0.15       0.10       0.10       0.      0.      0.      0.      0.      0.
2650       0.2      25.      2.      2.
0.05       0.05       0.05       0.20       0.30       0.15       0.10       0.10       0.      0.      0.      0.      0.      0.
```

```
2650.        0.2        25.        2.        2.
! Canopy vegetation parameters
8                                                                                          ! # of vegetation type
maize    bsprout subeet  potato    tforest     soybean     spruce      sycamore    ! Vegetation type
0.5      1.1     0.5     1.1        6.         0.87        18.         20.         ! Fall height m
4.5      6.3     4.6     5.9        6.         5.          7.          3.          ! Drip diameter mm
35       23      18      2          3          4           10          5           ! % drainage as leaf drip
! In-stream sediment transport parameters
5.0              0.01       0.4                                                                                                                                ! Th
```

4.2.6 MESH_sed_gridCell.ini

Line 1 Comment

Line 2 Initial depth of loose soil

$$\begin{matrix} \delta_{11} & \delta_{12} & \cdots & \delta_{1n} \\ \delta_{21} & \delta_{22} & \cdots & \delta_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \delta_{m1} & \delta_{m2} & \cdots & \delta_{mn} \end{matrix}$$

Line 3 Comment

Line 4 Ground cover

$$\begin{matrix} G_{11} & G_{12} & \cdots & G_{1n} \\ G_{21} & G_{22} & \cdots & G_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ G_{m1} & G_{m2} & \cdots & G_{mn} \end{matrix}$$

Line 5 Comment

Line 6 Hillslope soil type

$$\begin{matrix} hst_{11} & hst_{12} & \cdots & hst_{1n} \\ hst_{21} & hst_{22} & \cdots & hst_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ hst_{m1} & hst_{m2} & \cdots & hst_{mn} \end{matrix}$$

Line 7 Comment

Line 8 Steady-state sediment flux boundary conditions

$$\begin{matrix} bc_{11} & bc_{12} & \cdots & bc_{1n} \\ st_{21} & bc_{22} & \cdots & bc_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ bc_{m1} & bc_{m2} & \cdots & bc_{mn} \end{matrix}$$

Line 9 Comment

m = Number of rows (latitudes coordinates) of the MESH grid.

n = Number of columns (longitudes coordinates) of the MESH grid.

δ = Initial depth of hillslope loose soil (m) at each cell.

G = Proportion $[0 \leq G \leq 1]$ of impervious area in the cell.

hst = Index ($hst = 1...ns$) of the predominant hillslope soil type at each cell.

Steady-state sediment flux boundary conditions at each cell .

Note: **MESH-SED** can be modified to introduce dynamically time-dependant G and bc fields.

4.2.7 `MESH_sed_gridCell.ini`

Line 10 Predominant vegetation type

$$\begin{matrix} vt_{11} & vt_{12} & \cdots & vt_{1n} \\ vt_{21} & bc_{22} & \cdots & vt_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ vt_{m1} & vt_{m2} & \cdots & vt_{mn} \end{matrix}$$

Line 11 Comment

Line 12 Canopy cover

$$\begin{matrix} C_{11} & C_{12} & \cdots & C_{1n} \\ C_{21} & C_{22} & \cdots & C_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ C_{m1} & C_{m2} & \cdots & C_{mn} \end{matrix}$$

Line 13 Comment

Line 14 Channel soil type

$$\begin{matrix} cst_{11} & cst_{12} & \cdots & cst_{1n} \\ cst_{21} & cst_{22} & \cdots & cst_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ cst_{m1} & cst_{m2} & \cdots & cst_{mn} \end{matrix}$$

Line 15 Comment

vt = Predominant vegetation class at each cell (see *vege*)

C = Proportion $[0 \leq G \leq 1]$ of the cell area covered by vegetation (canopy) at each cell.

cst = Index ($hst = 1...ns$) of the predominant channel bed soil type at each cell.

Note: **MESH-SED** can be modified to introduce dynamically time-dependent vt and C fields

4.2.8 `MESH_sed_gridCell.ini`

Line 10 Channel bank soil type

$$\begin{matrix} cbst_{11} & cbst_{12} & \cdots & cbst_{1n} \\ cbst_{21} & cbst_{22} & \cdots & cbst_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ cbst_{m1} & cbst_{m2} & \cdots & cbst_{mn} \end{matrix}$$

Line 11 Comment

Line 12 Initial thickness of channel bed material

$$\begin{matrix} \delta c_{11} & \delta c_{12} & \cdots & \delta c_{1n} \\ \delta c_{21} & \delta c_{22} & \cdots & \delta c_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \delta c_{m1} & \delta c_{m2} & \cdots & \delta c_{mn} \end{matrix}$$

- $cbst$ = Index ($hst = 1...ns$) of the predominant channel-bank soil type at each cell.
- δc = Initial thickness of channel bed material (m). Usually $0.5m \leq \delta c \leq 5m$ for small to medium size streams, $\delta c \geq 5m$ for large rivers.

Example

```
! Initial depth of loose soil m
1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03
1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03
1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03
1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03       1.0E-03
! Ground cover: %[0. -> 1.] of cell area covered by snowe.g. glaciers, rock or impervious
0.1 0. 0.2 0.6 0.3 0.5 0.9 0.8 0.1 0.2 0.8 0.9 0.1
0.1 0. 0.2 0.6 0.3 0.5 0.9 0.8 0.1 0.2 0.8 0.9 0.1
```

```
0.1 0. 0.2 0.6 0.3 0.5 0.9 0.8 0.1 0.2 0.8 0.9 0.1
0.1 0. 0.2 0.6 0.3 0.5 0.9 0.8 0.1 0.2 0.8 0.9 0.1
! Soil type
1       2       3       4       5       1       2       3       4       5       1       2       3
1       2       3       4       5       1       2       3       4       5       1       2       3
1       2       3       4       5       1       2       3       4       5       1       2       3
1       2       3       4       5       1       2       3       4       5       1       2       3
! Sediment flux boundary conditions
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
! Predominant vegetation type in each cell
maize   bsprout subeet  potato   tforest    soybean    spruce     sycamore     maize   spruce  tforest subeet  potato
maize   bsprout subeet  potato   tforest    soybean    spruce     sycamore     maize   spruce  tforest subeet  potato
maize   bsprout subeet  potato   tforest    soybean    spruce     sycamore     maize   spruce  tforest subeet  potato
maize   bsprout subeet  potato   tforest    soybean    spruce     sycamore     maize   spruce  tforest subeet  potato
! Canopy cover: %[0. -> 1.] of cell area covered by canopy see the canopy types above
0.9     1.0     0.8     0.4     0.7     0.5     0.1     0.2     0.9     0.8     0.2     0.1     0.9
0.9     1.0     0.8     0.4     0.7     0.5     0.1     0.2     0.9     0.8     0.2     0.1     0.9
0.9     1.0     0.8     0.4     0.7     0.5     0.1     0.2     0.9     0.8     0.2     0.1     0.9
0.9     1.0     0.8     0.4     0.7     0.5     0.1     0.2     0.9     0.8     0.2     0.1     0.9
! Channel-bed soil type
1       2       3       1       2       3       1       2       3       1       2       3       1
1       2       3       1       2       3       1       2       3       1       2       3       1
1       2       3       1       2       3       1       2       3       1       2       3       1
1       2       3       1       2       3       1       2       3       1       2       3       1
! Type of soil on banks of channel = Soil type
1       2       3       4       5       1       2       3       4       5       1       2       3
1       2       3       4       5       1       2       3       4       5       1       2       3
1       2       3       4       5       1       2       3       4       5       1       2       3
1       2       3       4       5       1       2       3       4       5       1       2       3
! Initial thickness of channel bed material m [0.5 - 5m, >5big rivers]
0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50
0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50
0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50
0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50     0.50
```

4.3 Dynamic input data

4.3.1 `sed_input.r2c`

All the dynamic input data required by **MESH-SED** is saved into `sed_input.r2c` file. This file is produced by MESH (see r1295 version and newer) in `rte_module.f90` (see starting at line 923) and contains gridded information in r2c format at 1h time step. Variables are written into the file in the following order:

1. Average flow (discharge) (m^3 s^{-1}). Note: Averaged over the time-step.
2. Channel depth (m).
3. Channel width (m).
4. Channel length (m).
5. Channel slope (m m^{-1}). slope = sqrt(SLOPE_CHNL)
6. Stream velocity (m s^{-1}). Take stream speed to be average flow (m^3 s-1) divided by channel x-sec area (m^2) (from rte_sub.f).
7. Precipitation (mm h^{-1}). Note: Accumulated over the time-step.
8. Evapotranspiration (mm h^{-1}). Note: Of evapotranspiration accumulated over the time-step.

9. Overland water depth (mm). Note: Accumulated over the time-step.

10. Surface slope (m m^{-1}). SLOPE_INT isn't used in CLASS, so average slope from tiles in cell?

11. Cell width (m).

5 Output data

5.1 Output data

MESH-SED estimates sediment concentration and loads at every cell of the computational grid and for every sediment class at every time step. **MESH-SED** also estimates changes of the land surface due to accumulation or erosion of sediments. The format of the output information is specified in `MESH_sed_param.ini`. The typical output files are:

`ts_cell_var_sedclass.out`
(e.g. `ts_10_load_veryFineSand.out`)

$$\begin{array}{cc} time_1 & var_1 \\ time_2 & var_2 \\ \vdots & \vdots \\ time_n & var_n \end{array}$$

- `ts`: indicate time series.
- `cell`: cell number in MESH grid (`rank`).
- `var`: it can be `conce` or `load`.
- `sedclass`: sediment class (see Table 1)
- `field`: field (matrices) at different time steps.

`field_var_sedclass.out`
(e.g. `field_conce_coarseSilt.out`)

$$\begin{array}{cccc} time\_1 & & & \\ var_{11} & var_{12} & \cdots & var_{1n} \\ var_{21} & var_{22} & \cdots & var_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ var_{m1} & var_{m2} & \cdots & var_{mn} \\ \vdots & \vdots & & \vdots \\ \vdots & \vdots & & \vdots \\ time\_n & & & \\ var_{11} & var_{12} & \cdots & var_{1n} \\ var_{21} & var_{22} & \cdots & var_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ var_{m1} & var_{m2} & \cdots & var_{mn} \end{array}$$

6 Download, compile and execute

6.1 Download

MESH-SED can be download from https://github.com/lmoralesma/MESH-SEDGithub Repository or from command line as: `git clone https://github.com/lmoralesma/M`

6.2 Compile

Compile **MESH-SED** by typing `make`; produce `sa_mesh_sed`. Use `make clean` for removing `*.o` and `*.mod` files.

6.3 execute

To run **MESH-SED** , `./sa_mesh_sed projname` (e.g. `./sa_mesh_sed test`).

7 References

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