Sediment

Introduction

Sediments are simulated as suspended sediments (SS) and nitrogen in algae (AE). The sum of the two **substances** is an additional output (total suspended sediments, TS). Suspended sediments are not simulated in the soil of HYPE. Suspended sediments are first introduced into the runoff of the soil by soil erosion.

The main **states** are concentration of SS and AE in all water stores of HYPE, i.e. soil, river, lakes, but also snow, aquifers (in the store and on the move there or away), irrigation water, floodplain water, and water transfer (that is delayed one time step) could hold suspended sediments and algae. In the current model though, concentration of SS and AE is only positive in river and lakes, and flows originating from them. In addition two pools of settled sediment are simulated; a pool of delayed sediment in runoff, and a pool of (temporarily) settled sediment in river. Note: No store of “settled sediment” of the soil is simulated, i.e. HYPE has an unlimited source of soil for erosion.

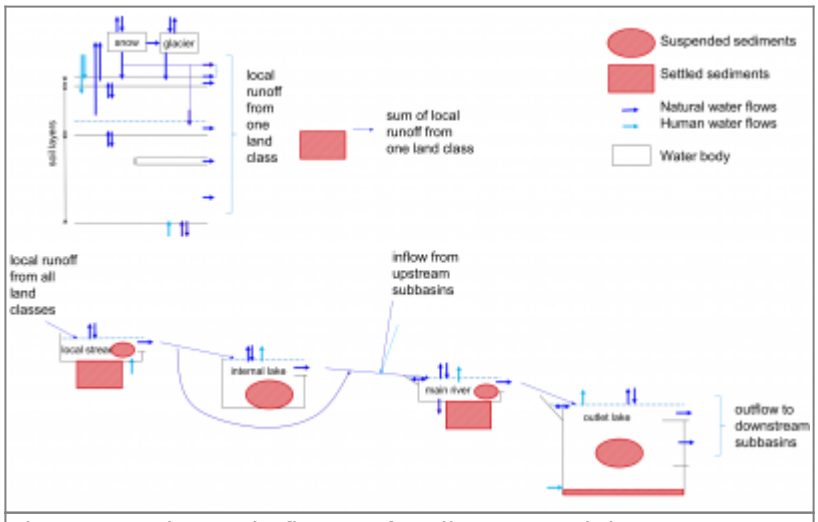


Figure 1: Schematic figure of sediment model.

Sources of sediment load

Soil erosion

The main source of sediment in HYPE is from soil erosion. Soil erosion is modelled in several steps. **First** particles are mobilized from the soil by rain or surface runoff. The result is here called “mobilized sediments”. The mobilized sediments are assumed suspended in an “eroding flow”, which is surface runoff plus macropore flow. **Secondly**, if there is surface runoff, the mobilized sediments is transported away from the field with the surface runoff and macropore flow (“eroded sediment”). A filtering can be applied to reduce the amount of eroded sediment. If there is no surface runoff, there will be no transport of eroded sediments. For SS, the eroded sediments are taken from an infinite pool. For PP, the eroded particulate phosphorus is taken from the soil pools. **Thirdly**, the eroded sediments in macropore flow and surface runoff (and in tile runoff though that is generally zero) are delayed in a temporary pool. The release of suspended sediments from this pool is determined by the

total runoff from the class, and is following the total runoff off the land.

Step 1: Mobilization of particles from soil

HYPE has two alternative models for mobilization; soil erosion model 1 and soil erosion model 2.

Soil erosion model 1 (MMF-based model): The first model is based on Morgan-Morgan-Finney erosion model (Morgan et al., 1984) and calculates particles mobilized by rainfall energy and surface runoff. The kinetic energy in rainfall is calculated as a function of rainfall (*rain*, mm/ts) and day of the year (*dayno*). If the precipitation falls as snow, or if it falls on snow-covered ground or if it is smaller than 5 mm/day no mobilization occurs in the model. Some of the raindrop's energy can be absorbed by vegetation. Crop cover is defined as the portion of land that is sheltered from raindrops; for a description of how this is calculated, see Chapter Crop cover and ground cover. The factor $common_{cropcover}$ is the sheltering effect that the main and secondary crops give together. It varies over the year due to crop growth and management. The mobilization by rain (*MobilisedRain*, g/m2/ts) is also influenced by soil erodibility (soil dependent parameter *soilerod* (g/J)).

$$Rainfall_{energy} = rain \times \left(8.95 + 8.44 \times LOG10 \left(rain \times 2 \times \left(0.257 + 0.09 \times \sin \left(2\pi \times \left(dayno - 70 \right) / 365 \right) \right) \right) \right)$$

$$MobilisedRain = Rainfall_{energy} \times \left(1. - common_{cropcover} \right) \times soilerod$$

When surface runoff occurs, soil particles are eroded and carried away as the soil surface is exposed to shear forces. The mobilization (*MobilisedSR*, g/m2/day) is calculated from the surface runoff (*sflow*, mm/day), subbasin average slope, a parameter for soil cohesion (*soilcoh* (kPa) soil type dependent), and a general parameter (*sreroexp*). This type of erosion can be mitigated by protective vegetation or vegetation residues that are in contact with the ground. The calculation of this reducing factor (*groundcover*) is described in Chapter Crop cover and ground cover. The factor $common_{groundcover}$ is the combined effect of the main and secondary crops.

$$MobilisedSR = \frac{\left(sflow \times 365 \right)^{sreroexp} \times \left(1 - common_{groundcover} \right) \times \frac{1}{0.5 \times soilcoh} \times \sin \left(\frac{slope}{100} \right)}{365}$$

All mobilized particles are not staying mobilized, because sometimes the transport capacity of the particle-bearing water (*eflow*) will not suffice for the task. If this is the case, a *transportfactor* reduces the particle amount mobilized:

$$transportfactor = MIN \left(1.0, \left(eflow / 4 \right)^{1.3} \right)$$

Finally mobilized sediment (*mobilSed*, kg/km2/day) is calculated as the sum of rain and surface runoff caused mobilization as:

$$mobilSed = 1000 \times \left(MobilisedRain + MobilisedSR \right) \times transportfactor$$

Soil erosion model 2 (HBV-SED based model): The second model is based on HBV-SED model (Lidén, 1999; Lidén et al., 2001) and calculates particles mobilized by rain (*rain*). When the ground is frozen or there is snow on the ground, the no particles are mobilized. The mobilization also depends on soil and land characteristics in the form of model parameters and data on subbasin characteristics.

$$mobilSed = 1000. \times \left(\frac{slope}{5} \right)^{erodslope} \times erodluse \times erodsoil \times \frac{EI}{erodindex} \times rain^{erodexp}$$

The parameters *erodslope*, *erodexp* and *erodindex* are general and thus same for the whole model domain. The parameters *erodluse* and *erodsoil* are land-use and soil type dependent. Subbasin input are: *slope*, the subbasins' average slope, and an erosion index, *EI*. The many parameters give the possibility to simulate erosion as dependent on slope, soil type, land use or subbasin. In addition an adjustment can be made with a monthly model parameter *erodmon* to help match seasonality of erosion.

$$modileSed = mobileSed \times erodmon \left(month \right)$$

where *month* is the current month.

Step 2: Transport of eroded sediments off the field

If at one time step there is no surface runoff, there will be no transport of suspended sediment. The mobilised sediment is returned to the soil. Still, calculation continues with step 3, and earlier delayed eroded sediment may reach the local stream. If there is surface runoff, a fraction of the mobilised sediments is assumed to go with surface runoff (*sflow*). If there is surface runoff and tile runoff and macropore flow, a fraction of the mobilized sediments is assumed to travel with the macropore flow (*mflow*). The respective fractions depend on the respective size of the two flows, but are reduced by filtering of the particles. The filtering depends on landuse, the proximity of agricultural land to water, presence of buffer strips etc. The filtering effect on suspended sediments in surface runoff (*srfilt*) is parameterized with land use parameters and subbasin input, while the filtering effect on suspended sediments of macropore flow is parameterized with a soil type parameter (*macrofilt*).

$$srfilt = otherfilt + alfa \times \left(1. + bufferpart \times \left(bufferfilt - 1. \right) \right) + innerfilt \times \left(1. - alfa \right)$$

$$erodedSed = \frac{\left(srfilt \times sflow + macrofilt \times mflow \right) \times mobilSed}{eflow}$$

$$eflow = sflow + mflow$$

The total amount of eroded sediment (*erodedSed*, kg/km2/day) is the sum of contributions from surface flow and macropore flow. For SS, the eroded sediments are taken from an infinite pool. For PP, the eroded particulate phosphorus is calculated from the eroded sediment (see Soil erosion) and then taken from the solid soil pools (*humusP* and *partP*). This difference exists because HYPE does not simulate any pool of “soil sediments”.

Step 3: Suspended sediment reaching the local stream

The concentration of suspended sediments of the runoff leaving the soil is calculated based on total runoff (*runoff*, mm/ts) and a pool of sediment particles (*relpool*). The pool collects the suspended sediments in the respective runoff pathways, i.e. primarily the eroded sediment from surface runoff and macropore flow calculated in the previous step. The pool constitutes a temporary delay. The release of sediment (*release* (kg/km2)) from the pool temporary is calculated with two general parameters (*pprelmax* and *pprelexp*):

$$release = MIN\left(relpool, relpool \times \left(runoff / pprelmax \right)^{pprelexp} \right)$$

The suspended sediments released are following the total runoff off the land. The release divided by the total runoff gives a suspended sediment concentration, which is used for all runoff pathways. This concentration is added to all runoff from the class, i.e. the sediments are transported by all flow paths off the land.

The sediment may be removed from the temporary pool between the land surface and the local stream if addition to the pool is made for the time step through erosion by surface runoff or through tile drainage. A 1st order decay, with parameter *eroddecay*, is used so that sediment doesn't remain detached forever.

Rural household outlets and point sources

Suspended sediments may be added to the model as diffuse rural households outlets (private sewers) or point sources. Similar to other substances in HYPE, they are added as flow with concentration of the total suspended sediments and with a fraction determining the suspended part, while nitrogen in algae make up the rest (GeoData.txt PointSourceData.txt). To add only suspended sediments set the fraction to 1. The diffuse source is divided into two parts, where the division is determined by a general parameter (*locsoil*). One part is added directly to the local river. The other part is added to the water of the bottom soil layers of each class in the subbasin. The distribution between classes is done proportional to the area of each class. Point sources are added in the main river. Point sources are described in the Chapter on Water management (point sources) and rural household diffuse source in the Chapter on Nitrogen and phosphorus in land routines (rural sources).

Links to file reference

Section	Symbol	Parameter/Data	File
Soil erosion		*soilerod, soilcoh, sreroexp, erodslope, erodluse, erodsoil, erodindex, erodexp, erodmon, bufferfilt, innerfilt, otherfilt, macrofilt, pprelmax, pprelexp, eroddecay*	par.txt
	slope	*slope_mean*	GeoData.txt
	EI	*eroindex*	
	alfa	*close_w*	
	bufferpart	*buffer*	

Section	Symbol	Parameter/Data	File
Rural household outlets and point sources		*subid, ps_vol, ps_type, ps_tsconc, ps_ssfrac, fromdate, todate*	PointSourceData.txt
		loc_ts, loc_vol, loc_ss	GeoData.txt
		locsoil	par.txt

Link to relevant processes in the code

Modules (file)	Procedures	Sections
npc_soil_processes (npc_soil_proc.f90)	particle_processes_for_runoff	Soil erosion
	calculate_hbvsed_erosion	
	calculate_erosion	
datamodule (data.f90)	load_pointsourcedata	Rural household outlets and point sources
	read_pointsourcedata	
	get_current_pointsources	
npc_surfacewater_processes (npc_sw_proc.f90)	add_point_sources_to_main_river	
	add_diffuse_source_to_local_river	
npc_soil_processes (npc_soil_proc.f90)	local_diffuse_source	

Soils

Suspended sediments are not simulated in the soil calculations of HYPE. Suspended sediments are first introduced into the runoff of the soil.

Sediment in rivers and lakes

If the siltation model option is set, the sedimentation of lakes is added to a sediment pool. The sedimentation of rivers is always added to a sediment pool.

Primary production and mineralization

Primary production in lakes and rivers is affecting sediment simulation by being a source of algae organic nitrogen (AE). Mineralisation, as a sink of AE, is the reverse process. Nitrogen in algae is assumed to grow and decline with the same function as production and mineralisation of organic nitrogen (ON). The production and mineralisation processes are modelled together and only one is active at the time. If nitrogen is simulated by HYPE it uses the actual estimated production/mineralization for AE, otherwise the potential production/mineralisation (*minprodNpot*) is used for AE. The actual production is limited by the availability of inorganic nutrients. If sediments are simulated without simultaneously simulating nitrogen, the mineralisation of algae is limited to available amount, but the production is unlimited.

The potential production/mineralisation is depending on temperature (T_w, *T10*, *T20*), long-term total phosphorus concentration (*TP*), surface area of water body (*area*) and a parameter (*wprodn*).

$$minprodNpot = wprodn \times TPfcn \times tmpfcn \times area$$

$$TPfcn = \frac{TP\text{-}limsedPP}{\left(TP\text{-}limsedPP\right) + hsatTP}$$

$$tmpfcn = tmpfcn1 \times tmpfcn2$$

$$tmpfcn1 = \frac{T_w}{20.}$$

$$tmpfcn2 = \frac{\left(T10\text{-}T20\right)}{5.}$$

Temperatures T10 and T20 are calculated as the average water temperature (T_w) of 10 and 20 days. They determine if production or mineralization dominates at the current time. The water temperature is calculated through weighting the air temperature (T) and yesterday's water temperature (see basic assumptions of rivers and lakes).

The phosphorus function (*TPfcn*) is dependent on a general half saturation parameter *hsatTP*, and a limitation parameter *limsedPP*. If phosphorus is simulated by HYPE the long-term average concentration (*TP*) is calculated from that, otherwise a lakeregion parameter is used (*tpmean*).

Sedimentation of lakes

Sedimentation in lakes is a sink for SS and AE and works the same way as for nutrients. Sedimentation (*sed*, kg/day) is calculated as a function of concentration in lake water (*conc*) and lake area (*area*). The settling velocity parameter (*sedss, sedae, m/timestep*) is general. The concentration used in the equation may be limited (*lim*) by general parameter (*limsedSS*) for SS, but not for AE (*lim*=0). No sedimentation occurs unless the concentration is above this limit.

$$sed = par_{sed} \times \left(conc\text{-}lim\right) \times area$$

The sedimentation is additionally limited by the amount of substance in the lake. If the lake is shallow or the sedimentation rate (sinking velocity) high, all substances in the lake may settle on the bottom.

Sedimentation/Resuspension in rivers

In the river we simulate both sedimentation and resuspension. No particles are removed from the simulation by sedimentation. For the original model, and a variant, they are redistributed over time and can come back through resuspension based on flow. For the other alternative model it is possible to resupend more particles than is previously settled. This double process of sedimentation and resuspension is used for suspended sediments (SS). Particles in the sediments is collected in a pool (*sedimentpool*, kg).

For the **original model** the sediment pool will increase as particles from the water volume (*waterpool, kg*) settle at low water flows, and vice versa. At high water flow the sedimentation is lower and the resuspension higher, and more particles returns to the water. The net effect of these combined processes are given by the variable *sedresp*. It is governed by the current flow (*flow*) in relation to the bankful flow (*qbank*) and a general parameter *sedexp*. The net effect is determined by

the sign of the variable (-1 <*sedrespfactor* <1), and the variable size give the fraction of the pool that is transfered per day. The process will give either net sedimentation (*settl, kg/day*) or resuspension (*resusp, kg/day*).

$$sedrespfactor = \max\left(-1., \min\left(1., \frac{qbank - flow}{qbank}^{sedexp} - \frac{flow}{qbank}^{sedexp} \right) \right)$$

$$settl = \begin{cases} sedrespfactor \times waterpool & sedresp > 0 \\ 0 & sedresp < 0 \end{cases}$$

$$resusp = \begin{cases} -sedrespfactor \times sedimentpool & sedresp < 0 \\ 0 & sedresp > 0 \end{cases}$$

where *flow* is the current river flow (*m3/s*) and *qbank* is the flow when river is filled to the brim. The latter flow is calculated as the second largest simulated flow in the last year. It is adjusted with a correction factor of 0.7 before use in the *sedresp* equation. The first alternative model is the same as the original model but the correction factor can be calibrated. It is given by the general model parameter *qbank*.

The **second alternative model** is based on a simplified Bagnold equation (Neitsch et al., 2011). Suspended sediment concentration is compared to a calculated maximum amount of sediment that can be transported in the river to determine if sedimentation or resuspension occurs. The maximum transport depends on the peak velocity across the river (v_{peak}). This is estimated from flow in the river (*Q*) using the hydraulic geometry relationship (river velocity) which gives the average river velocity and a peak adjustment factor (*vpeak*).

$$v_{peak} = vpeak \times k \times Q^{m}$$

where *vpeak*,*k* and *m* are general parameters. The maximum amount of sediment that can be transported in the reach ($cmax_{SS}$, mg/L) is calculated using the peak velocity and two general model parameters (*spcon* and *spexp*).

$$cmax_{SS} = spcon \times v_{peak}^{spexp} \times 1000000.$$

If the simulated HYPE suspended sediment concentration (conc_SS) is larger than the maximum transport concentration, then sediment is deposited in the temporary pool. Resuspension occur in the opposite case. The net transport (*sedresp=settl+resusp*):

$$sedresp = \begin{cases} \left(conc_{SS} - cmax_{SS} \right) \times riverbox & conc_{SS} > cmax_{SS} \\ \left(conc_{SS} - cmax_{SS} \right) \times riverbox \times suspch & conc_{SS} < cmax_{SS} \end{cases}$$

where *riverbox* is volume of water in attenuation box of the river and *conc_SS* its concentration of suspended sediments. The effect of channel erodibility and channel vegetation cover is captured by a

river channel erodability/vegetation cover modification factor, *suspch*.

As default the amount of sediment that can be resuspended is limited by the amount of sediment that has been deposited before (i.e. the temporary pool (*sedimentpool*)). This can be changed by using a parameter *addsusp* which allows users to apply a limit to the amount of sediment that can be resuspended in HYPE in excess of the amount of sediment in the temporary pool. If *addsusp*=0, then the amount of sediment that can be resuspended is limited to the amount of sediment in the temporary pool. If *addsusp*=1, then there is no limit on the amount of sediment that can be resuspended (the full amount from equation above will be resuspended). For values in between the additional resuspension increases linearly:

$$resuspension = sedimentpool + \left(-sedresp - sedimentpool \right) \times addsusp$$

Siltation

It is optional to simulate the lake sediment in HYPE. If the siltation model option is not used the settled sediment (Sedimentation of lakes above) is lost from the system. If the siltation option is used then the settling sediment add to a sediment pool. This is true for all substances that sediment in lakes, but only the substances SS and AE are used further. The settled substances may be compressed over time and their density thus affected. They may fill up the lake and affect its water depth and outflow. They may be removed or flushed at regular or irregular intervals.

The density of sediments may be constant in time and space. It is the given by *ldseddens*, a general parameter, or determined by the subbasin's soil particle fractions (d_{ini}). The sediment density may also increase with time through compactation (d_{comp}). This is modelled to depend on the sediment age.

$$d_{ini} = c_{sand} \times p_{sand} + c_{silt} \times p_{silt} + c_{clay} \times p_{clay}$$

where soil fraction (p_{sand}, p_{silt}, p_{clay}) are given per subbasin and coefficients (c_{sand}, c_{silt}, c_{clay}) depend on reservoir operation mode.

$$d_{comp} = d_{ini} + 0.434 \times K_{ini} \times \left(\frac{T}{T-1} \times \ln\left(T\right) - 1 \right)$$

$$K_{ini} = k_{sand} \times p_{sand} + k_{silt} \times p_{silt} + k_{clay} \times p_{clay}$$

where coefficients k (k_{sand}, k_{silt}, k_{clay}) depend on reservoir operation mode, and *T* is the sediment age in years. For ages less than one year the initial density (d_{ini}) is used.

There are four reservoir operation modes (resop_mode) implemented in HYPE (Strand and Pemberton, 1982);

1. sediment always submerged or nearly submerged,
2. normally moderate to considerable reservoir drawdown,
3. reservoir normally empty,

4. riverbed sediments.

Table of coefficients for sediment density for the different reservoir operation modes (resop_mode).

Coefficient	resop_mode 1	resop_mode 2	resop_mode 3	resop_mode 4
c_{sand}	1550	1550	1550	1550
c_{silt}	1120	1140	1150	1170
c_{clay}	416	561	641	961
k_{sand}	0	0	0	0
k_{silt}	91	29	0	0
k_{clay}	256	135	0	0

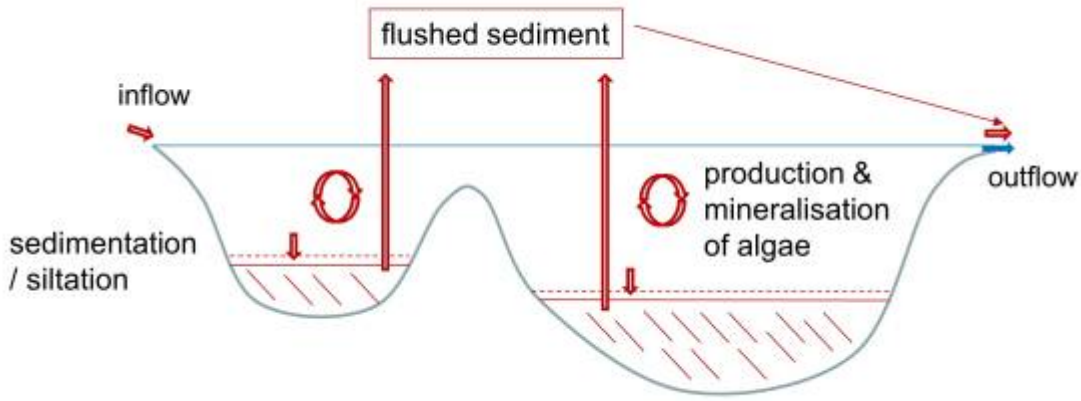


Figure 2: Schematic figure of flows and processes affecting sediment in a multibasin lake.

Flushing

Flushing is used to remove sediment that has accumulated in a reservoir over time. It is a sediment management method that can be regulated in different ways. The decision to start flushing have different option (flush modes), which are depending on capacity, sediment age, or day of year. In each case a starting day is found and a rate of flushing calculated. Additionally an ending day may be set or the flushing is ended when another threshold is met.

Flushing can be simulated for outlet lakes where the reservoir operation mode is not set to river sediments (resop_mode == 4). Flushing is not simulated for internal lakes. Sediment density is assumed to be constant while sediment flushing is operating.

The flushing can be applied in different ways for multibasin lakes (apply modes). Flushing can be applied to the whole lake or only to the last lakebasin of a multibasin lake. The fate of the flushed sediment can be handled differently (destination modes). The flushed sediment is either added to the lake outflow of the same time step, or removed from simulation.

Flush mode 1 - Capacity

tart to remove accumulated sediments from reservoir after available reservoir storage capacity drops

below a specified threshold (*sm_start*, a fraction). The storage capacity is calculated based on the whole lake volume and sediment. Flushing stops when available reservoir storage capacity (fraction) exceeds the second threshold which is calculated as the start level plus the capcacity that is to be restored (*sm_caprest*). The flushing rate (capacity/day) is calculated as the capacity to restore spread over the number of days specified with variable *sm_duraday*. Note that the actual duration of flushing for each event may vary depending on how much upstream sediment enters the reservoir while flushing is occurring delaying the restoration of the capacity.

Flush mode 2 - Day of year

Start to remove accumulated sediments from reservoir at a specified day of the year (*sm_start*). The flushing may be every year or specified to occur at another frequence, e.g. every other year (*sm_yfreq*). Flushing stops after a duration given by *sm_duraday*. Flushing rate (capacity/day) is calculated as storage capacity to flush, specified with variable *sm_caprest* (fraction of capacity), over the duration of the flushing. Note that the amount of reservoir storage capacity that is restored for each event may vary depending on how much upstream sediment enters the reservoir while flushing is occurring. Note that all of the sediment may be flushed from the reservoir before the planned end date if the amount of sediment in the reservoir is not greater than or equal to the flushing rate times the number of days of flushing, basically there isn't enough sediment in the reservoir, so the reservoir runs out of sediment before the end of the flushing period.

Flush mode 3 - Capacity of last lakebasin

This flush mode works the same as flush mode 1 (capacity), but the available reservoir storage capacity is calculated based on the volume and sediment of the last lakebasin of a multibasin lake.

Apply mode 0 - Whole lake

The flushing is applied to the whole lake. Capacity is restored for all lakebasins of a multibasin lake when sediment is removed from all lakebasins. This is the default behavour.

Apply mode 1 - Last lakebasin

For multibasin lakes, the flushing is applied to the last lakebasin only. For other lakes the behaviour is the same as for apply mode 0.

Destination mode 0 - Remove

The flushed sediment is removed from the simulation and no longer available.

Destination mode 1 - Outflow

The flushed sediment is added to the lake outflow. Thus for a multibasin lake with apply mode 0,

sediment flushed from all lakebasins are added to the outflow of the multibasin lake. Flow between lakebasins are not involved.

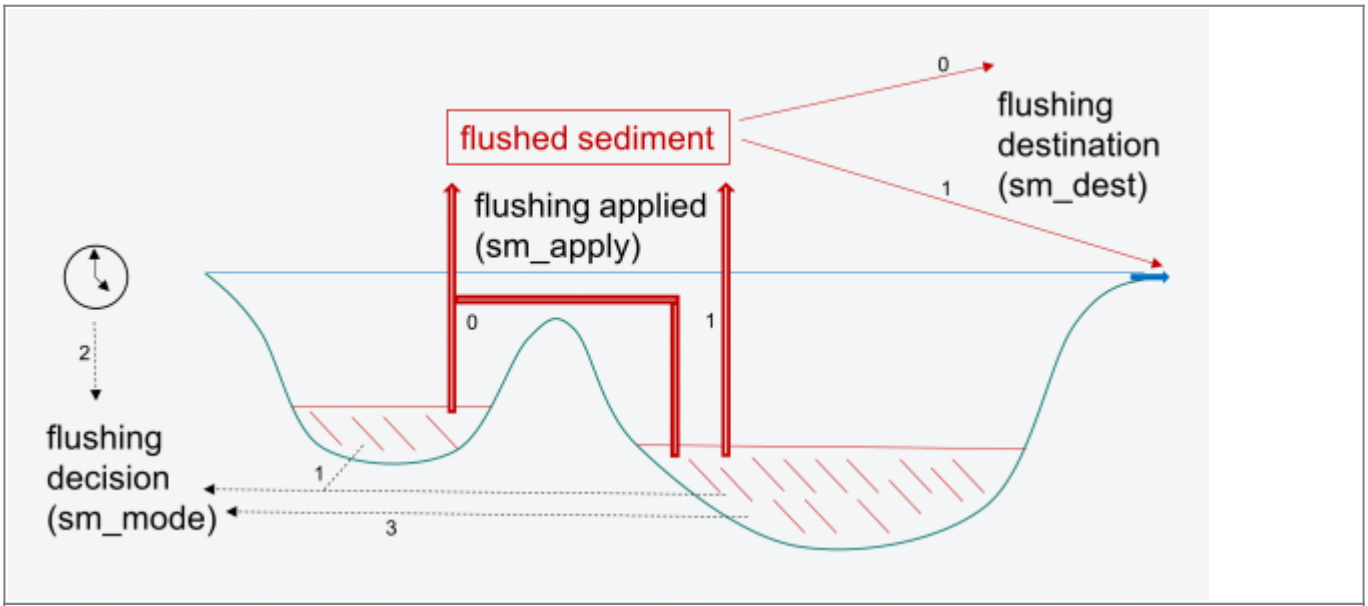


Figure 3: Schematic figure of flushing of a multibasin lake showing the different management options.

Links to file reference

Section	Symbol	Parameter/Data	File
Primary production and mineralization	*area*, *lakeregion*		GeoData.txt
		wprodn	par.txt or LakeData.txt
		hsatTP, *limsedPP*, *tpmean*	par.txt
Sedimentation in lakes	par_{sed}	*sedss*, *sedae*	par.txt or LakeData.txt
	lim	*limsedSS*	par.txt
Sedimentation and resuspension in rivers		*sedexp*, *qbank*, *vpeak*, *addsusp*	par.txt
	k,*m*	*hygeomk*, *hygeomm*	
	spcon, *spexp*	*suspconss*, *suspexpss*	
	suspch	*suspch*, *suspchannel*	par.txt or GeoData.txt
Siltation		*ldseddens*	par.txt
	p_{sand}, p_{silt}, p_{clay}	*sand*, *silt*, *clay*	GeoData.txt
	resop_mode	*sm_resop*	LakeData.txt DamData.txt
		sm_mode, *sm_dest*	
	sm_start, *sm_duraday*, *sm_caprest*, *sm_yfreq*	*sm_start*, *sm_duraday*, *sm_caprest*, *sm_yfreq*	

Link to relevant processes in the code

Modules (file)	Procedures	Sections
npc_surfacewater_processes (npc_sw_proc.f90)	substance_processes_in_river	Sediment in rivers and lakes
	substance_processes_in_lake	
	production_mineralisation	Primary production and mineralization
	calculate_lake_tpmean	
	calculate_river_tpmean	
	lake_sedimentation	Sedimentation in lakes
	river_sedimentation_resuspension	Sedimentation/Resuspension in rivers

Diagnostic output variables - sediment load

The load of sediment leaving a subbasin is calculated for suspended sediments (`cSSl`) and total sediments (`cTSl`).

Net load of main river and outlet lake can be calculated for suspended sediments (SS) and total sediments (TS). The output variables ID are `nlSS` and `nlTS`. Net load of main river and outlet lake is calculated from the inflow and outflow of substance to the main river and outlet lake in a subbasin as one system. The inflow is composed of upstream coming inflow and local inflow to the main river. The outflow is the outflow of the subbasin through the main and secondary branch. The net load is the load of outflow minus the load of inflow. A bit of caution, do not misstake this output as the net load from a catchment, i.e. the load in the main river leaving the catchment.

Included in the net load is the effect of production/mineralisation of algae in the lake (for TS), point sources. Reduction of the net load is the effect of sedimentation, but also abstraction of water for irrigation or other purposes. In the case of zero outflow, or if the incoming load is larger than the load leaving the system, the net load becomes negative. Negative load could thus be caused by e.g. sedimentation, but also temporary holding up the sediment in the system. For subbasins holding a part of a lake, i.e. a lake basins, it is also possible that the water flow between the lake basins is (temporary) opposite of what is defined as downstream in GeoData. In this case the outflow of the subbasin in an inflow, and is withdrawn from the net load. Thus the net load of main river and outlet lake become negative.

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