

Silica

The silica routines were first released in HYPE version 5.15.0. Two new substances were introduced; dissolved silica (DS) and algal silica (AS). Together they form the sum of silica (SI).

Source of silica

Weathering

Soil chemical weathering is the source of (dissolved) silica in the model. *Weathering* (mg/m²) in the model is a function of soil temperature, depth of soil layer, soil type and geology. The equation is

$$Weathering = rate \times f_{cdepth} \times f_{cemp} \times weathcorr \times soilthick$$

where *rate* is a soil type dependent weathering rate parameter (mg/m³), and *soilthick* is the thickness of each soil layer.

Silica weathering is dependent on soil organic acids, which are more prevalent in the upper humus rich soil layer. Therefore a function of soil depth was deployed, assuming an exponential decline with soil depth (*d*).

$$f_{cdepth} = 2^{-\frac{d}{weathdep}}$$

where the depth is calculated from soil surface to the middle of the soil layer. *weathdep*, a general model parameter (m), is the depth where the activity is half of that at the surface.

The weathering is also temperature dependent with the activity increasing with increasing temperatures. It is implemented in the model accordingly:

$$f_{cemp} = e^{-\frac{weathKT}{R} \times \left(\frac{1}{T} - \frac{1}{T_0} \right)} \times frozensoilcorr$$

where *weathKT* (J/mol) is the rock activation energy (general model parameter), *R* is the universal gas constant, *T* is the soil temperature of the soil layer (Kelvin) and *T₀* is a reference temperature. To account for lower water-soil contact during frozen or partly frozen soil conditions, the weathering is reduced when soil temperature is below 0 °C according to a correction factor:

$$frozensoilcorr = 1 - \frac{soiltemp}{(soiltemp - 1)}$$

where *soiltemp* is the soil temperature (this time in °C).

The factor *weathcorr* is subbasin weather correction factor that may be used to account for spatial differences in weathering that is not explained by the other factors, such as for example lithology.

Point sources

It is technically possible to add pointsources for dissolved silica and algae silica.

Links to relevant procedures in the code

Modules (file)	Procedures
npc_soil_processes (npc_soil_proc.f90)	weathering

Soil pool initial values

The initial concentration of dissolved (and algae) silica in soil is zero.

Rivers and lakes

The initial silica concentration in rivers are assumed to be zero, while the lakes' concentration are set by the user. The parameter, *iniSi*, is general.

Primary production and mineralization

The dissolved silica and the algal silica interact. Net uptake of DS and production of AS occur during spring and early summer in a similar way as for other nutrients. The process is reversed during late summer and early autumn. This net production is simulated as a function of water temperature and phosphorus concentration in the water body.

The production/mineralization depend on temperature and total phosphorus and lake area or river bottom area (*area*). The potential carbon transformation (*minprodSIpot*, kg / day) is calculated with the following equations:

$$tmpfcn1 = \left(\frac{T}{20} \right)^{\exp}$$

$$tmpfcn2 = \frac{(T_{10} - T_{20})}{5}$$

$$tmpfcn = tmpfcn1 \times tmpfcn2$$

$$TPfcn = \frac{(TPconc - plimSi)}{(TPconc - plimSi + hsatTP)}$$

$$minprodSIpot = wprodsi \times TPfcn \times tmpfcn \times area \times depth$$

where *T* is the water temperature(°C) and *T10* and *T20* are the average water temperatures of the

last 10 and 20 days, respectively. *exp* is a general model parameter (*sitmpexp*). *TPconc* is the current total phosphorus concentration in the waterbody and *plimSi* and *hsatTP* are general model parameters. The water depth (*depth*) is the current lake water depth, and for the river the depth use is calculated as described [here](#). The calculated mineralization of algal silica is limited to a maximum of 50% of the available algae pool, and the production is limited to a maximum of 50% of the available dissolved silica pool.

Sedimentation

Sedimentation in lakes is a sink for algae silica and works the same way as for organic nitrogen and particulate phosphorus. Sedimentation (*sedSI*, *kg/day*) is calculated as a function of AS concentration in lake water (*conc*) and lake area (*area*). The settling velocity parameter *sedsi* is general or can be specified for each lake.

$$sedSI = sedsi \times conc \times area$$

Links to relevant procedures in the code

Modules (file)	Procedures	Sections
npc_surfacewater_processes (npc_sw_proc.f90)	substance_processes_in_river	primary production and mineralization
	production_mineralisation	
	substance_processes_in_lake	primary production and mineralization
	lake_sedimentation	sedimentation

Links to file reference

Section	Symbol	Parameter/Data	File
Sources of silica	<i>weathcorr</i>	<i>weathcorr</i>	GeoData.txt
	<i>rate</i>	<i>weathrate</i>	par.txt
	<i>weathKT, weathdep</i>	<i>weathKT, weathdep</i>	
		<i>iniSi</i>	
	<i>soilthick</i>		GeoClass.txt
Rivers and lakes	<i>area, lakeregion</i>		GeoData.txt
	<i>wprodsi, sedsi</i>	<i>wprodsi, sedsi</i>	par.txt or LakeData.txt
	<i>plimSi, hsatTP</i>	<i>plimsi, hsatTP</i>	par.txt
	<i>exp</i>	<i>sitmpexp</i>	