Model Metadata

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CSDMS
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

Integration between WMT and wiki

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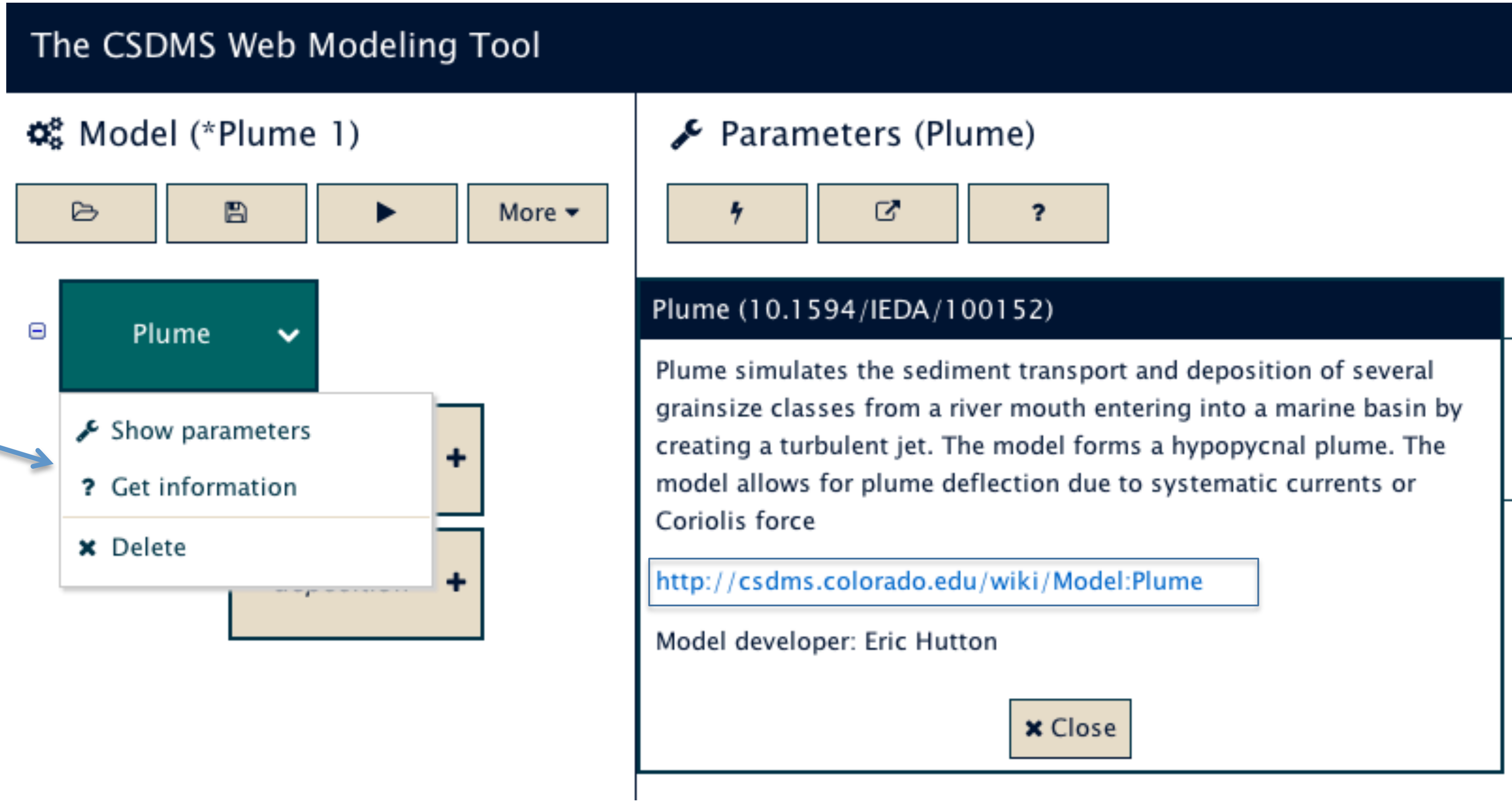


HydroTrend

Metadata

Summary | Contact | Technical specs | In/Output | Process | Testing | Other | Component info

Also known as	
Model type	Single

Incorporated models or components:	

Spatial dimensions	1D, 1.5D
Spatial extent	Continental, Regional-Scale, Landscape-Scale
Model domain	,
One-line model description	Climate driven hydrological transport model
Extended model description	HydroTrend v.3.0 is a climate-driven hydrological water balance and transport model that simulates water discharge and sediment load at a river outlet.

Keywords:	basins, Hydrological model, Transport model,

Model info

Authors [show]

Source code [show]

DOI [hide]

- HydroTrend version: 3.0.2
  Doi: 10.1594/IEDA/100135

QR-code [hide]

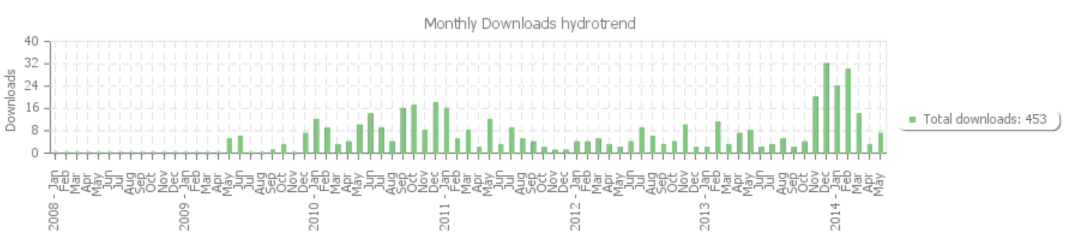
Link to this page

Other models by this author [show]

HydroTrend is made available under the GPL_v3 license. The developer(s) are not responsible for any harm that might be caused by running this program.

When applying HydroTrend, please make a reference to: Kettner, A.J., and Syvitski, J.P.M., 2008. HydroTrend version 3.0: a Climate-Driven Hydrological Transport Model that Simulates Discharge and Sediment Load leaving a River System. *Computers & Geosciences*, **34**(10), 1170-1183.

Download statistics



Introduction

HydroTrend is an ANSI-standard C numerical model that creates synthetic river discharge and sediment load time series as a function of climate trends and basin morphology and has been used to study the sediment flux to a basin for basin filling models. As a drainage basin simulator, the model provides time series of daily discharge hydraulics at a river mouth, including the sediment load properties. HydroTrend was designed to provid[illegible] input to lake or shelf circulation and sedimentation models (Steckler et al., 1996; Syvitski and Alcott, 1995b), and study the impact of land-sea fluxes given climati[illegible] ange [illegible] Moore, 1992; Syvitski an[illegible]s, 1994). HydroTrend simulates the major processes that occur in a river basin, including:

- [illegible]d areas with advances and retreats depending on the climate scenario,
- [illegible]cumulation in the winter and melt in the subsequent spring/summer,
- Rai[illegible] over the remaining portions of the basin with canopy evaporation,

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- Glacierized areas with advances and retreats depending on the climate scenario,
- Snow accumulation in the winter and melt in the subsequent spring/summer,
- Rainfall over the remaining portions of the basin with canopy evaporation,
- Groundwater recharging and discharging,
- The impact of reservoirs.

Model History

HydroTrend, an ANSI-standard C coded program has been developed over many years by a number of researchers. The program started out with the name "RIVER" and was coded in F
capabilities have been built upon and greatly expanded up to RIVER version 5.11. The model development of RIVER and HydroTrend has been under the direction of by James Syvitski.
the primairy authors:

Model Name	Version	Main developer	Date
River	1.0	M. Nicholson	April 1992
River	2.0	T. Maceachern	August 1992
River	3.0	J.M. Alcott	July 1993
River	4.0	M. Nicholson	April 1995
River	5.0	M.D. Morehead	October 1996
River	5.1	M.D. Morehead	August 1997
HydroTrend	1.0	M.D. Morehead	1998 - 1999
HydroTrend	2.0	S.D. Peckham	2000 - 2001
HydroTrend	2.3	A.J. Kettner	2002 - 2004
HydroTrend	3.0.x	A.J. Kettner	2004 - now

Current Users

User community:

Albert Kettner	kettner@colorado.edu	(since January 2002)
Irina Overeem	Irina.Overeem@colorado.edu	(since January 2003)
Kerry McCarney	kmccarney@geol.sc.edu	(since June, 2006)
Camilo Medina	camilomedi@gmail.com	(since October, 2007)
Ted Lewis	limno.ted@gmail.com	(since December, 2007)
Phaedra Upton	P.Upton@gns.cri.nz	(since February, 2009)
Silke Carmen Lutzmann	slutzman@uni-bonn.de	(since March, 2010)

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Add a publication

Overview and general

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Applications

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HydroTrend Issues

Error reports:
This would be the place to leave any comments. Please provide your name and add a date to the comment. I'll try to answer your questions as soon as possible but feel free as HydroTrend us
comments as well.

1. Request: Add multiple hypsometry input to HydroTrend --Ted, 03/10/2008.
   1. The option to have multiple hypsometry input files (to simulate e.g. changing sea-level) was taken out as HydroTrend web version isn't supporting that option (too many files wou
      However, I added the option again in HydroTrend_3.0.1. I haven't fully tested it so please let me know if you continue to find bugs --Albert 03/11/2008
2. Bug 1: "bus error" when simulating an arctic river in extremely cold climate conditions. --Ilja, 03/13/2008.
   1. Error was generated as the entire drainage basin became glaciated. I build in a new error message warning the user that the whole basin has become glaciated. HydroTrend will s
      program is not designed for such systems. This is incorporated in HydroTrend_3.0.2 --WikiSysop 09:55, 14 March 2008 (MDT)
3. Bug 2: "nan" generated if peakflood values are above the maximal possible peakflood. --Ilja, 03/13/2008.
   1. True bug; error was only generated in extreme cold environments. The 13th is not my lucky day for sure. Solved as well in version HydroTrend_3.0.2 --WikiSysop 09:55, 14 Marc
4. Request: Replace the hardwired evapotranspiration parameter to the Hydro.in file so users can adjust this parameter to region specific evapotranspirations --Kerry, 06/30/2008.
   1. Oops, forgot to close this issue but adjusted the input file such that you can specify the evapotranspiration parameters yourself. (July 2008) See HydroTrend_3.0.3 --WikiSysop 1
      (MDT)
5. Request: Get the bedload variables incorporated in the input file (so not hardwired any more. --Jon Pelletier, 01/14/2009.
   1. A new line is added to the input file (27a) where people can change the bedload rating coefficient value--WikiSysop 16:34, 14 January 2009 (MST)
6. Possible 'bug' in sediment

HydroTrend Help

Input files

There are 2 input files required to run the model: HYDRO.IN and HYDRO0.HYPS. You can use an optional input file (HYDRO.CLIMATE) to specify daily precipitation and temperature events if you do not want to use the climate generator build in to HydroTrend. Each file has it's own format which are discussed below together with an explanation of each of the input parameters.

HYDRO.IN

Explanation table for HYDRO.IN input file. Download this example HYDRO.IN file In case you want to set up a HydroTrend run for your specific river drainage basin.

Line #	Description	Explanation
1	Title	This first line of the input file, is written to a header line in many of the output files and is used to track the model runs. Up to 119 characters are read. You can set a title for each run, not per epoch!
2	ASCII on/off	This option allows you to turn the option of writing output to ASCII files on or off. If it's turned on 6 ASCII files will be created. All the output is standard written to a binary file which is readable by matlab. Notice: If you are running the model for more than 20.000 years the option will automatically set to OFF. This because the files sizes are getting to big to handle.
3	Set output directory	Defines location where the output data will be stored. (This option is not available in the web version of HydroTrend).
4	Nepochs	Defines the number of climate epochs to run. A HydroTrend epoch is a period of time over which linear (or no) climate change accurs. If you are running more than 1 epoch start copying the lines after this input, (so starting from line 5) all down to the bottom and past the block with a blance line between each epoch.
5	Syear, Nyears, timestep	Syear: Defines the start year for this epoch. The years are used in many of the ouput files. Nyears: Number of model years for this epoch. Note that for following epochs the start year must match the end year of the previous epoch, syear[ep + 1] == syear[ep] + nyears[ep]. Timestep: HydroTrend always runs on a daily time step. This variable defines the time step over which the data output are averaged. D = daily, M = monthly, S = Seasonally, Y = yearly.
6	Number of grain sizes	The number of grain sizes (max = 10) to simulate for the suspended sediment load.
7	Proportion of sediment	The proportion of sediment in each grain size. The number of values on this line should match the number specified by line 6, and should sum to one. (sum[nr. of grain] == 1).
8	Tstart, Tchange, Tstd.	Tstart: The beginning annual mean temperature (°C) for this climate epoch. Tstart should be warmer than -20°C and colder than 30°C. Tchange: The trend or change per year in the annual temperatures for this epoch (°C/annum). Must lie in the range between +1 or -1°C. Tstd.: The standard deviation about the trend line that the annual temperatures will have. Must lie in the range between -5 and 5.
9	Pstart, Pchange, Pstd.	Pstart: The beginning total annual precipitation (m) for this climate epoch. Pstart lies in the range between -5 and 5. Pchange: The trend or change in the total annual precipitation that will occur during this epoch (m/annum). Pchange lies in the range between -0.5 and 0.5. Pstd.: The standard deviation about the trend line that the annual precipitation will have. Pstd lies in the range between -2 and 2.
10	P mass balance coef., Distribution exp., Distribution range.	P mass balance coef.: Rain mass balance coefficient. Typically for modern climate simulations, Pstart will be from observations. A point measurement will typically not represent the entire basin and will need to be scaled up or down to provide the correct amount of basin wide precipitation. This variable is used to scale the total annual precipitation (Pstart). P mass balance coefficient lies between 0 to 10. Distribution exp.: A skewed gaussian distribution is used to create the precipitation which creates realistic tails for the precipitation events. This exponent is the skew factor and lies between 1 and 2. Distribution range: This variable defines the width function for the skewed gaussian distribution of the simulated precipitation and lies between 0 and 10.
11	Baseflow	Defines the constant annual base flow (m^3/s) which occurs in the basin. This is analogous to a deep groundwater pool. Baseflow should be bigger than 0 and smaller than the total precipitation discharge.
12-23	Monthly climate variables	The monthly climate variables are used to create the daily temperature and precipitation time series. If you are looking for data, The National Climate Data Centre (NCDC) has climate records of over a 10000 weather stations around the world, see GLOBALSOD. *If you uploaded a climate file as described on the hydrotrend webpage, just fill out fake numbers. Hydrotrend will read the lines 13-24 but won't use the values (so don't leave them blank)*! • Column 1: Month name: this is not used in HydroTrend, but is useful for the user. • Column 2: Tnominal: The average monthly mean temperature (°C) before correction for the climate frends. (Lies between -50 and 50°C). • Column 3: Tnomstd: The monthly temperature standard deviation (Lies between 0 and 10). • Column 4: Pnominal: The total monthly rainfall (mm) before correction for the climate trends (Lies between 0 and 1000). • Column 5: Pnomstd: The monthly rainfall standard deviation (Lies between 0 and 1000).
24	Lapse rate	This lapse rate (°C/km) is used to calculate the daily temperatures in each of the altitude bins, which are in turn used to determine where it snows or rains and where the freezing line is. Lapse rate is defined between 1 and 10.
25	ELAstart, ELAchange	ELAstart: The starting glacier equilibrium line altitude (m). Should be bigger than 0. ELAchange: The ELA change per year (m/a). The ELA at the beginning of one epoch must match the ELA at the end of the precious epoch. elastart[ep + 1] == elastart[ep] + nyears[ep]*elachange[ep].
26	Dry precipitation evaporation fraction	The percentage of the dry precipitation (nival&ice) which will be evaporated. Lies between 0.0 and 0.9.
27	Delta plain gradient	The average slope of the river bed delta (gradient) is used in calculations of bedload transport and lies between 0.000001 and 0.01.
28	River length	The length of the river basin (km), used for flow routing, lies between 10 and 10000.
29	Volume, altitude ... drainage area ... eservoirs	Volume (km^3), altitude (m) or drainage area (d) above a reservoir in drainage basin. If the reservoir capacity is more than $0.5km^3$, Trap Efficiency (TEbasin) will be calculated based by: (TEbasin = 1.0 - (0.05 / $exp(Rvol/RQbar)^{0.5}$, where Rvol = Reservoir volume and RQbar = the mean inflow discharge)[1]. If the reservoir capacity is less than $0.5km^3$, (TEbasin = (1.0 - (1.0 / (1 + 0.0021 *D * ((Rvol * 1e9) / Rarea)))) where Rvol = Reservoir vo ... n^2) = drainage area above the Reservoir) and D, set to 0.1, represents the reservoir characteristics [2].
30	...ty coef ... exponent (m)	(k): The river mouth velocity coefficient (m): The river mouth velocity exponent, See explanation line 32. [3].

Saturated hydraulic conductivity

Saturated hydraulic conductivity rates shown in the table below are in relation to texture and are only a general guide. Differences in bulk density may alter the rates shown below.
Table 2: General values for Saturated hydraulic conductivity

SOIL TEXTURAL CLASSES & RELATED SATURATED HYDRAULIC CONDUCTIVITY CLASSES					**HydroTrend values**
Texture	*Textural Class*	*General*	*Ksat Class*	*Ksat Rate (um/sec.)*	*Ksat Rate (mm/day)*
Coarse sand			V. rapid	> 141.14	> 1219.45
Sand	**Coarse**	**Sandy**	**Rapid**	**141.14-42.34**	**1219.45-364.95**
Loam sand					
Sandy loam Fi.san.loam	Mod. coarse		Mod. Rapid	42.34-14.11	364.95-121.91
v. fi. sa. loam loam silt loam silt	Medium	**Loamy**	Moderate	14.11-4.23	121.91-36.55
clay loam sa. cl. loam si. cl. loam	Mod. fine		Mod. slow	4.23-1.41	36.55-12.18
sandy clay silty clay clay	Fine and very fine	Clayey	Slow	1.41-0.42	12.18-3.63
Cd horizon Natric horizon, fragipan, ortstein			V. slow or impermeable	0.42-0.00	3.63-0.00

HYDRO0.HYPS

The HYDRO0.HYPS file is an ASCII file that provides the model with a hypsometry curve, describing the area - relief relation of the studied river basin. HydroTrend determines the freezing and the snow line based on this information. Under conditions of changing sea level the basin hypsometry curve might be altered as well. In that case you want to run multiple epochs that each have a different hypsometry file. Therefore a number is added in the file name. For example if the simulation contains 2 epochs you need 2 hypsometry files named HYDRO0.HYPS and HYDRO1.HYPS.

This is the format of the file in case you want to create a HYDRO0.HYPS from scratch:

```
--------------------------------------------------
Hypsometry input file for HYDROTREND
First line: number of hypsometric bins
Other lines: altitude (m) and area in (km^2) data
--------------------------------------------------
3
1       208.9168081
51      375.2451287
101     536.0996727
```

were the first 5 lines are the header followed by the *number* of hypsometric bins (in this case 3), followed by *3 lines* containing altitude and the cumulative area at that elevation, starting close to sea level (between 0 - 50m). The elevation increases should go in steps not larger than 50m, and each elevation step should be increasing with the same elevation. Also, the cumulative area always has to increase!

The separation of elevation and cumulative area could be several spaces or just a tab. Notice that the starting elevation as well as the basin area at that point should be always positive. So for sea level change studies that affect the drainage basin, make sure that the sea level is your base level (so always start the hypsometric bins with 0 - 50 m of elevation and than the highest point of the basin will change.

You can download the following HYDRO0.HYPS example file and alter it for your river drainage basin. Hypsometric curves can be created with any GIS software. However, RiverTools is very straight forward to use for this.

HYDRO.CLIMATE

The HYDRO.CLIMATE file is an optional ASCII file that can be used to simulate fluvial water discharge and sediment load for a specific climate event. The file needs to contain climate data (temperature and precipitation) for at least 1 year (the shortest simulation time for HydroTrend). Climate statistics from the HYDRO.IN file will be used when there is no HYDRO.CLIMATE file in the input directory.

This is the format of the file in case you want to create a HYDRO.CLIMATE from scratch:

```
--------------------------------------------------------------
Climate input file for Hydrotrend. DO NOT REMOVE THOSE LINES
First line: the number of rows of input values and dt [hours]
Rest lines: Total precipitation (mm) and average temperature in degrees C.
Values are per timestep.
--------------------------------------------------------------
       24
       -23.92
       -23.92
       -23.92
       ...
```

You can download an example HYDRO.CLIMATE file an modify it for your river drainage basin. CSDMS might have some good climate source suggestions in case you are searching for climate data for your river basin.

Output files

ASCII output

General ASCII output files
A summary table of information is output to HYDRO.LOG. Mean annual and total annual values of many model parameters (discharge, load, basin temperature, precipitation, etc.) are written to a set of annual trend files (HYDRO.TRN1, HYDRO.TRN2, and HYDRO.TRN3). These annual trend files are useful for verifying climate ranges and trends and to check total discharge and sediment load. HYDRO.STAT is representing the used water and sediment equations and their statistics per epoch.

Optional ASCII output files
It's possible, to write all the output data to ASCII files. This option can be turned 'ON' or 'OFF' in the HYDRO.IN file. Notice that ASCII files are larger than binary output.
When the ASCII option is turned 'ON' the following files will be created:

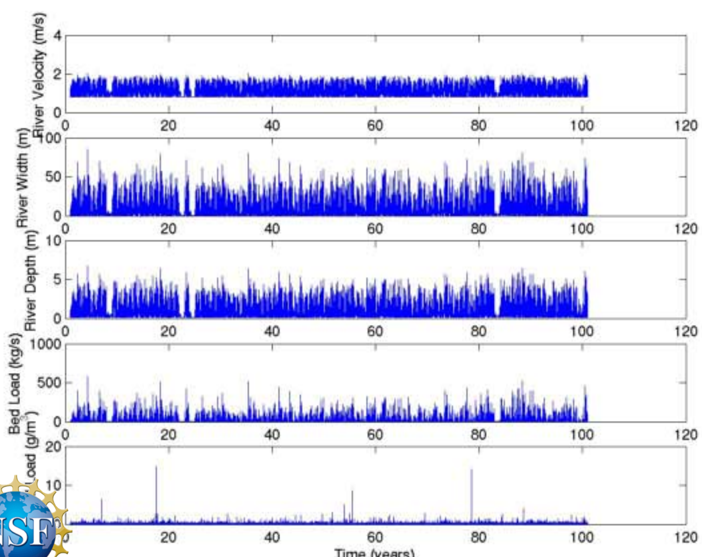
- HYDROASCII.CS; containing columns of sediment per time of each sediment size. Columns are seporated by a space
- HYDROASCII.Q; contains one column, discharge
- HYDROASCII.QB
- HYDROASCII.QS
- HYDROASCII.VWD; contains three columns separated by a space: Velocity, width and dept at the river mouth.

Binary output

There are 2 binary output files, named HYDRO.DIS and HYDRO.CONVDIS. Both files contain the same data, which is a minimum of 6 columns all seporated by space. From one to 6 or more: it contains velocity, width, depth, Qb, Cs[i](number of columns is equal to the number of grainsizes specified in the input file) and Total Cs. All values are defined as floats. Matlab can handle the format. The binary file are platform dependant. A swapped version of the output file is created for other platforms: HYDRO.CONVDIS file (this is the swabbed version of HYDRO.DIS).

Matlab tools to visualize
The binary file is created in such a way that it is easy to analyse with matlab. 3 matlab macro files are created to analyse the file. Follow the steps to use the matlab macro files.

- Download the files.
- Unzip the files.
- Place the files in your matlab mfiles directory.
- Set properties of the macro files to to 755.
- Set the pathname of your mfiles directory if this is not yet done. (Goto menu: file, Set Path.; Add Folder <the pathname of the mfiles directory>; Save)
- You are ready to use the macro's. Go to Command Window.
- Example: <PlotRiver HYDRO.DIS> is actualy plotting the data (see figure below).



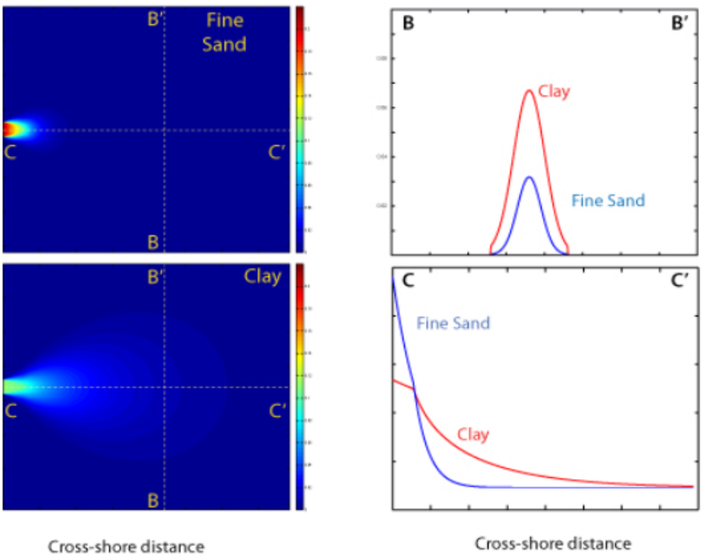
COMMUNITY SURFACE DYNAMICS MODELING SYSTEM

PLUME [1] [2][3]

Plume simulates hypopycnal plumes generated by a river draining its suspended sediment load into a receiving basin. Satellite images of any river-delta emphasize the importance of river plumes. A plume's behavior is dependent on the density contrast between the river water and the standing water (Albertson, 1950; Bates, 1953). Ocean water has a high density, and the plumes often flow buoyantly on the surface (hypopycnal). Another complementary model that deals with more rare hyperpycnal flows is Sakura. The river's sediment concentration adds density to the freshwater, but usually the effluent remains below the density of seawater. The shape that a hypopycnal plume will have, depends on a variety of factors:

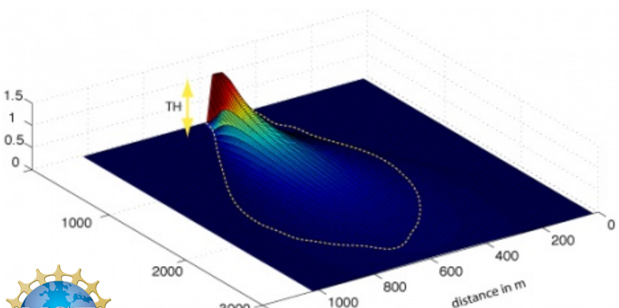
1. Angle between the river course and the coastline
2. Strength and direction of the coastal current
3. Wind direction influencing local upwelling or downwelling
4. Mixing tidal or storm energy near the river mouth
5. Latitude and thus the strength of the Coriolis effect.

The plume equations follow those of Albertson (1950) developed for a jet flowing into a steady receiving basin. Plumes of similar shape but differing concentrations result for each grain size in the model. Fine sand will generally settle rapidly, whereas clay can travel much larger distances. Naturally, this affects the geometry of the deposited sediments on the basin floor.



River dimensions, i.e. the channel width, depth and velocity at the river mouth are input conditions. In addition, river sediment concentration and settling velocities for specific grain size classes are input parameters as well. Plume is a steady-state model, meaning that it simulates constant input conditions, representative of a 'unit' event.

River dimensions for plume range over orders of magnitude, small streams of only a few meters wide have been run, as well as large continental scale rivers (for example the Ganges-Brahmaputra). Consequently, the spatial resolution of the grid is highly variable depending on the modeling objective. If plume is used in stand-alone mode, it runs events of a single day. If you are interested in exploring deposits of changing plumes over time you will need to use the PLUME model within the framework of the stratigraphic model Sedflux.



References

Sedflux

SEDFLUX is a basin-fill model, writt
tens of thousands of years. It simul
regional geology, and it can provide
estimates are not adequate by them

Model introduction

Sedflux combines individual process
continental margin. The model allow
The new version, Sedflux 2.0 introd
stratigraphy in either 2D or 3D. Add
along a riverbed, (2) cross-shore tra
include (1) river channel avulsion, (
The spatial resolution of the archite
mode, the horizontal resolution usu
event-based time stepping as a way

Model parameters

Input Files and Directories

Parameter	Descripti
Input directory	path to input files
Site prefix	site prefix for Input files
Case prefix	case prefix for Inpu files

Uses ports

This will be something that the CSD

Provides ports

This will be something that the CSD

Main equations

$$t\left(x,y\right) = \frac{u_0 + u_c\left(x\right) + 7u\left(x,y\right)}{9} \qquad (10)$$

$$u_c\left(x\right) = u_0\sqrt{\frac{b_0}{\sqrt{\pi}C_1 x}} \qquad (11)$$

$$u\left(x,y\right) = u_0\sqrt{\frac{b_0}{\sqrt{\pi}C_1 x}}exp[-\left(\frac{y}{\sqrt{2}C_1 x}\right)^2] \qquad (12)$$

- Diffusion of seafloor sediments

1) Amount of bottom sediments that can be reworked by resuspension and diffusion

$$q_s = k\left(t,z,D\right)\bigtriangledown z = k\left(\frac{\partial z}{\partial x}\hat{i} + \frac{\partial z}{\partial y}\hat{j}\right) \qquad (13)$$

2) Amount and direction of transport of the ith grain size

$$q_{si} = \beta_i q_s \qquad (14)$$

- Sediment failure

1) Stability of a possible failure plane

$$F_{total} = \frac{\sum_{i=0}^{N}[b_i\left(c_i + \left(\frac{W_i}{b_i} - u_i\right)tan\phi_i\right)\frac{sec\alpha_i}{1+\frac{tan\alpha_i tan\phi_i}{F_{total}}}]}{\sum_{i=0}^{N}W_i sin\alpha_i} \qquad (15)$$

2) excess pore pressure using Gibson's graphical approximation (1958)

$$u_i = \frac{\gamma' z_i}{a_i} \qquad (16)$$

$$a \equiv 6.4\left(1 - \frac{T}{16}\right)^{(17)} + 1 \qquad (17)$$

$$T \equiv \frac{m^2 t}{c_v} \qquad (18)$$

- River mouth turbidity currents

$$\frac{\partial u}{\partial \ldots} = g_0 sin\alpha C - \frac{E + C_d}{\ldots}u^2 - g_0\left(\frac{e^C - 1}{\ldots}\right)cos\alpha C tan\gamma \qquad (19)$$