Reference

Content

1 Introduction

FLUSH is a program that allows to estimate discharge, velocity distribution and other hydraulic variables in cross-sections and river channels. It assumes uniform or non-uniform one-dimensional flow conditions. The main features are

- Manning-Strickler formula for bed shear.
- Unsteady flow calculations for sub- and supercritical flows
    - spatial discretization with Finite-Volume-Method (Roe fluxes)
    - time solution with explicit Euler scheme

- Two-grain size transport models of Meyer-Peter/Müller and Smart&Jäggi.
- Two-fraction model of Wilcock&Kenworthy

This documentation describes how to use **FLUSH** for your specific river data. Before starting you should have specified the input data on an input file (standard name is 'cin').

Important: FLUSH does not calculate on the original cross-section, but it does interpolate between cross-sections instead. The original cross-sections must be simplified to a total number of 7 (in words: seven) data points. Use the File/Simplify option to reduce your cross-section data.

The input is given in free format using predefined keywords (see http://www.fluvial.ch/m/syntax.html for more details). Keywords starting with double arrow allow to structure the input. The default name of the input file is 'inx'. The output is writen to the file 'cout'.

In a command shell the program can be started by typing

```
program_path/flush inputfile
```

or simply by typing

```
program_path/flush
```

where `program_path` denotes the directory where the executable is located.

2 Flow Reference

The following keywords are used to specify the flow data.

Input	***Unit***	***Describtion***
title 'name'	string	'name' is a string (max. 64 characters) that is stored on the result file and appears in the header of the plots
>>global		main keyword for the definition of global values
defkst r	$m^{1/3}/s$	global Strickler value (default=30)
label 'xx' r	string	name of a label (max. 4 characters) to which the Strickler-value r is related
>>section		main keyword for the definition of cross-sections.
cs 'csname' r r11 r12 r21 r22 r31 r32 . . .	km	record for the cross-section definition. 'csname' is the name of the cross-section (max. 8 characters), r is the relative distance along the river [km]. The offset (i.e. distance from the left border) is stored in the first column and the bed level is stored in the 2nd column. Important: The number of cross-section nodes must be 7!
>>branch		main keyword for the definition of a river branch.
cs 'csname' r	km	csname is the name of the cross-section as defined on the file with the cross-section data. r is the location of the section in the branch (the default value is taken from the section list).
inflow r1 r2	km, m^3/s	location r1 and discharge r2 of the in-/outflow between the preceding and the following section. For unsteady flows replace r2 by ** and add a timetable with time and inflow in the 1st and 2nd column, respectively.
waterlevel r1 r2	km, m	water level at location r1 where r2 is the value above sea level. For unsteady flows replace r2 by ** and add a timetable with time and waterlevel in the 1st and 2nd column, respectively.
critical r	km	critical outflow boundary at location r[km].
roughness r1 r2 'xx' 'xx' 'xx'	km	roughness between location r1[km] and r2[km]. The roughness labels in the following line are related to the left wall, the bed and the right wall, respectively. Note: For bed load calculations on alluvial beds the friction parameter of the bed section is estimated by the Strickler formula $k_{st} = \frac{21}{d_{ms}^{1/6}}$ with d_{ms} = mean diameter [m] of the surface layer (= d90 for the MPM and Smart/Jäggi formula).
>>init		to define initial conditions
waterlevel km1 z1 q1 km2 z2 q2 . . .		initial condition where the distance [km], the waterlevel [m] and the discharge [m^3/s] are given in the first, second and third column of a table

`>>structure`		to define flow over weirs and through gates
`location r`	km	position of structure in the branch.
`weir r1 r2 r3`		flow over weir with r1 = weir crest level [m], r2 width of weir [m] and r3 = weir (poleni-) coefficent [-] (default = 0.58 for broad crested weirs)
`gate r1 r2 r3 r4`		flow through sluice gate with r1 = bottom of gate [m], r2 width of gate [m] , r3 = opening of gate [m] and r4 = contraction coefficent [-] (default = 0.64)

Example: At km 0.650 a gate is located that is combined with a weir. The input looks like this:

```
>>structure
location 0.650
gate 343.0 12. 2.5  /
weir 346.5 12. 0.62 /
```

`>>compute`		to define parameters for unsteady flow computation
`start r`	h	start time of the simulation (default=0)
`end r`	h	time where simulation will end (default=100h)
`cfl r`	-	limiting CFL number to estimate size of time step (default=0.6)
`cs_distance r`	m	distance between cross-sections (default=10m)
`hdry r`	m	minimum depth of flow where flow equations are being solved (default=0.05m)

`>>output`		for the specification of the output format.
`frequence i`	-	refresh rate of display output (default=100).
`hydrograph r 'x' > 'n'`		writes hydrograph table at location r [km] of item 'x' to file 'n'. Valid item names are: 'q' = discharge, 'h' = flow depth, 'z' = water level, 'zb' = mean bed level Example: `hydrograph 4.5 'q' > 'q_hydro.out'`
`profile r 'x' > 'n'`		writes longitudinal section at time r [h] of item 'x' to file 'n'. Valid item names are: 'q' = discharge, 'h' = flow depth, 'z' = water level, 'zb' = mean bed level. Example: `profile 90.0 'z' > 'z_prof.out'`
`smooth`	-	reduces wiggles in water levels and bed levels (applies to display output and data export)

3 Bed Evolution Reference

The following keywords are used to specify mobile bed calculations.

Input	*Unit*	*Describtion*
`>>bed_evolution`		
`>>global`		
`thcrit r`	-	critical shields factor for MPM and Smart/Jäggi formula (default=0.05)
`repose r`	-	tangens of angle of repose of bank material (default=1.0)
`density r`	kg/m^3	density of the bed material (default=2650 kg/m^3)
`porosity r`	-	porosity of the bed material (default=0.30)
`rock_thcrit r`	-	critical shields factor for transport over bedrock
`rock_factor r`	-	multiplication factor to account for transport over bedrock (default=1.8)
`tolerance r`	m^2	area tolerance for update of cross-section geometry (default=0.1m^2)
`upwind r`	-	upwind factor applied to sediment flux calculation. Possible range between 0.5 (=arithmetic mean) to 1.0 (=full upwind). The default method is a 2nd order upwind scheme.
`stratum r`	m	size of the stratum used for stratified bed level calculations (default=0.1m).
`>>sediment`		
`formula 'name'`	-	sediment transport formula to be used. Valid names are: • `mpm` = Meyer-Peter/Müller formula. • `smart&jaeggi` = Smart/Jäggi formula • `wilcock&kenworthy` = 2-fraction model
`d30 r`	m	diameter of particle such that 30% of sample is finer
`dm r`	m	mean diameter of particles
`d90 r`	m	diameter of particle such that 90% of sample is finer

		Note: For branches with variable particle sizes the values can be given as e.g.
		`d90 **`
		`0. 0.25`
		`1. 0.20`
		`2. 0.15`
		where the distance [km] and the grain size [m] are given in the 1st and 2nd column.

`substrate`
`f1 d1`
`f2 d2`
`f3 d3`
`. .`
`. .`
		grain size distribution of bulk material where the distribution (sediment finer) and the grain size [m] are given in the 1st and 2nd column. Note: The last value in the 1st column must be 1.0!
		
		Note: The definition of the substrate is used for fractional transport calculations.

`>>boundary`		

Input	**Unit**	**Describtion**

`inflow_rate r`	g/l	sediment concentration at the inflow boundary. For negative values of the inflow rate a local equilibrium is assumed (=default). If the concentration depends on the discharge a „discharge versus sediment concentration“ table can be specified. For this reason the value r must be replaced by ** followed by a table with discharge and concentration in the 1st and 2nd column, respectively.
		
		`inflow_rate **`
		`0.   0.`
		`50.  0.`
		`60.  0.1`
		`100. 0.2`
		`500. 0.8`

`inflow r1 r2`	km, kg/s	lateral sediment inflow r2 at location r1. For unsteady inflows replace r2 by ** and add a timetable with time and inflow in the 1st and 2nd column, respectively.
`outflow_dzb r`	m/h	velocity of bedlevel changes at the outflow boundary (default=0).
`rock_depth r`	m	defines a rock level below the initial bed level. For variable values replace `r` by `**` and add a table with the distance [km] and the rock_depth [m] in the 1st and 2nd column.
`deposition r`	m	defines an initial deposition above the given bed level. For variable values replace r by `**` and add a table with the distance [km] and the deposition [m] in the 1st and 2nd column.