### Morphological Acceleration Workshop

**<u>Objective</u>**: This workshop will introduce you to the workflow associated with the morphological acceleration approach to improving run time and testing protocol.

Morphological acceleration can decrease your run time by accelerating morphological response and compressing the time series. But this requires several steps to synch your flow data with your acceleration parameter. This workshop guides you through those steps.

#### Convert DSS Flows to Tabular Data

If your flows are already in the manual flow data editor, you can just adjust the time step. However, this model gets the flows from DSS, so we have to copy them into the manual data editor.

- 1. Open the **Unsteady Flow** file.
- 2. Open the **Flow Hydrograph** associated with the upstream boundary condition.

A	Add RS	Add SA/2D Flow Area	Add C	Conn Add Pump Sta Add Pipe Node					
	Select Location in table then select Boundary Condition Type								
	River	Reach	RS	Boundary Condition					
St	orage/2D Flo	w Areas		Boundary Condition					
1	Bend Model	BCLine: US BC		Flow Hydrograph					
2	Bend Model	BCLine: DS BC		Rating Curve					

The **Enter Table** portion of the editor is empty, but the **Read from DSS before simulation** is selected with a DSS file and path.

3. Press the Select DSS file and Path button to launch the DSS editor.

	2D: Bend Model BCLi	ne: US BC		
Read from DSS before simulation	n		Select DSS file a	and Path
File: C:\Users\q0hecsag\Docu	uments\Projects\Classes\St Lo	ouis 2D Sed\Produ	uction (Morpholo	gical Acceleration
Path: /ARKANSAS/LD03/REL.T	OT/01SEP2010-01SEP2022/1HC	UR/OBS/		
C Enter Table Select/Enter the Data's Startin Use Simulation Time:	g Time Reference Date: 080ct2018 Tim Date: Tim	Data time i e: 0000	interval: 1Da	ay 🔽

This should open the DSS file which has two boundary conditions, **Rel.TOT** is the total flow upstream and **Tailwater** is a stage downstream which we will not use.

4. Click on **Rel.TOT** and press the **Show Plot** arrow at the bottom of the editor.

	Last Appli	ast Applied Filter: Path Count: 2 / 2										
ı F	Row #	File Name	Type TimeSeries _▼	Part A	Part B	Part C	Part D	Part E	Part F	Data Type	Data Units	x,y,z
IJ	1	Pool3_hourly_TW_Release	e RegularTimeSeries	ARKANSAS	LD03	REL.TOT	01SEP2010-01SEP2022	1HOUR	OBS	INST-VAL	CFS	
	2	Pool3_hourly_TW_Release	RegularTimeSeries	ARKANSAS	LD03	TAILWATER	01SEP2010-01SEP2022	1HOUR	OBS	INST-VAL	FT-MSL	
:												
	✓ Show F	Plot										
:	Selected Pa	ath: /ARKANSAS/LD03/RE	L.TOT/01SEP2010-01	SEP2022/1H0	OUR/OB	IS/					ОК	Cancel

#### This should plot the hydrograph in the DSS file which is a large event from 2018 (WY2019).

5. Press the Data grid button to switch to the tabular data.

Row #	File Name	Type TimeSeries	Part A	Part B	Part C	Part D	Part E	Part F Data	a Type Data Units
<ul> <li>Hide Plo</li> </ul>	ot								. 🖌
Ordinate	Time and Date	1 - ARKANSAS/LD03 REL.TOT (CFS)		s)	120000				
1	07Oct2018 2400	30506.00	<b>^</b>	۳. E	100000	/	<u>y</u> r —		Legend
2	08Oct2018 0100	30540.00		1 5	80000	. É			<u> </u>
3	08Oct2018 0200	29877.00		ΙĔ	60000				1 - ARKANSAS/LD03
4	08Oct2018 0300	29898.00		REL	40000	22			
5	08Oct2018 0400	29921.00			20000				
6	08Oct2018 0500	29954.00			-	++++++	****	++++++	
7	08Oct2018 0600	30012.00			07Oct2	2018 2400	21Oct2018 2400		
8	08Oct2018 0700	29992.00	<b></b>			Tii	me and Date		
Selected Pat	h: /ARKANSAS/ID	03/RFL TOT/01SEP2010	0-01SEP2022/1H	OUR/OF	35/				OK Cancel

These are hourly data.

- 6. Copy the flow column by selecting it (you cannot just click on the heading, you will have to select the first one and scroll down, hold Shift and select the last one) and pressing **CTRL-C**.
- 7. Press **OK** to close out of the DSS editor and Return to the Flow Editor.
- 8. Select the **Enter Table** radio button to use the manual data table.
- 9. Switch the **Data time interval**: to the time step of the data we are pasting (1 hour)
- Then paste the data by clicking the heading of the Flow column so the whole column turns blue and pressing Ctrl-V. (Note: you no longer have to change the No. Ordinance first, RAS recognizes that you are pasting >100 flows).
- 11. Press OK to save the flows and select File→Save As and name your file something like "Morphological Acceleration Flows."

ſ	Ente	er Table	Data time	e interval: 1Day	•	
	Sele	ect/Enter the Data's Starting Time Re	eterence	30 Minute	^	
	• L	Jse Simulation Time: Date:	080ct2018 Time: 0000	1 Hour		
	O F	ixed Start Time: Date:	Time:	2 Hour		
			,	3 Hour		
	No	Ordinates Interpolate Missing V	alues Del Row Tos Row	6 Hour		
	140.	Interpolate Missing v		8 Hour		
						1
			Hydrograph Data	12 Hour	~	
		Date	Hydrograph Data Simulation Time	12 Hour Flow	~	Γ
		Date	Hydrograph Data Simulation Time (hours)	12 Hour Flow (cfs)	~ <b>—</b>	
	1	Date 070ct2018 2400	Hydrograph Data Simulation Time (hours) 0:00:00	12 Hour Flow (cfs)		
	1	Date 070ct2018 2400 080ct2018 2400	Hydrograph Data Simulation Time (hours) 0:00:00 24:00:00	12 Hour Flow (cfs)		
	1 2 3	Date 07Oct2018 2400 08Oct2018 2400 09Oct2018 2400	Hydrograph Data           Simulation Time           (hours)           0:00:00           24:00:00           48:00:00	12 Hour Flow (cfs)		
	1 2 3 4	Date 07Oct2018 2400 08Oct2018 2400 09Oct2018 2400 10Oct2018 2400	Hydrograph Data           Simulation Time           (hours)           0:00:00           24:00:00           48:00:00           72:00:00	12 Hour Flow (cfs)		

#### Set The Morphological Acceleration Factor

- 12. Open your sediment file by pressing the sediment data button **V** or selecting **Edit→Sediment Data** .
- 13. Select **Options**→**2D Options** from the Sediment Data Editor.

Because we have to change our input time to use the Morphological Acceleration, it is useful to choose a Morphological Acceleration Factor that is easily divisible by the time step.

For example, if a boundary condition data increment is 15 minutes, selecting Morphological Acceleration Factors of 3, 5, or, 15 makes it easier to adjust these data to accommodate the temporal dilation.

## What are some Morphological Acceleration Factors that will make the time shift easier with a 1 hour time step? \_\_\_\_\_

This is a workshop which we want to run fast, so a morphological acceleration factor of 30 (though this is on the high side of what you would use for a project, I would start with 4, 6, 10, 15, or even 20).

2D Sediment Options			$\times$
Simulation Components:	All Com	ponents	•
Sheet and Splash Erosion:	None		•
Erodibility:		1.	
Morphological Acceleration F	actor:	15.	
Base Bed-Slope Coefficient:			_

14. Select File→Save As and call the file something like "Morphological Acceleration 24."

### Adjust your Time Series to Sync with Your Morphological Acceleration Factor

15. Return to your flow file and your upstream hydrograph.

Because HEC-RAS does not automatically update the flow series to match the morphological acceleration of the sediment model, you must change your time step.

If you speed up the bed change, you must dilate time to match, reducing the time of each flow proportionately.

# Fill out the following chart with the appropriate accelerated time step for your hourly data for different Morphological Acceleration Factors:

Morphological	Updated
Acceleration	Time Step
Factor	
2	
5	
6	
10	6 Minute
15	
20	
30	

https://www.hec.usace.army.mil/confluence/rasdocs/h2sd/ras2dsed/latest/sediment-data/2doptions#id-.2DOptionsv6.3-MorphologicAccelerationFactor

- 16. Open the Unsteady Flow file again and open the flow hydrograph associated with the upstream boundary condition.
- 17. Change the time step to compress your flow time series to match the morphological acceleration. (See Figure on next page).
- 18. Then scroll down to the final row of the flow table and/or press Plot Data and choose the data table to determine the new final date and time associated with the end of your compressed time series. You will need that to define your plan.

Flow Hydrograph			
	2D: Bend Model BCLine: US BC		
C Read from DSS before simulation		Select DSS	file and Path
File: C:\Users\q0hecsag\Documents\Pro		d\Production\Mor	phological Acceleration\2D C
Path: //ARKANSAS/LD03/REL.TOT/01SEP	2010-01SEP2022/1HOUR/OBS/		
<ul> <li>Enter Table</li> <li>Select/Enter the Data's Starting Time Ref</li> <li>Use Simulation Time: Date:</li> <li>Fixed Start Time: Date:</li> </ul>	erence 08Oct2018 Time: 0000	a time interval:	4 Minute
No. Ordinates Interpolate Missing Va	lues Del Row Ins Rov	v	12 Minute 15 Minute
	Hydrograph Data		20 Minute
120000 100000 80000 60000 40000 20000			Legend Flow Hydrogra
07Oct2018 2400	08Oct2018 2400		
552 09Oct2018 1244 553 09Oct2018 1248	36:44:00 36:48:00	62814 62870	
Time Step Adjustment Options ("Critical" Monitor this hydrograph for adjustme Max Change in Flow (without changi	boundary conditions) Ints to computational time step Ing time step):		
Min Flow: Multiplier:	EG Slope for distributing flo	w along BC Line:	0.001     Image: TW Check       OK     Cancel

- 19. Open the Unsteady Flow Analysis widow either by selecting Run→Unsteady Flow Analysis or by pressing the unsteady simulation button.
- 20. Select **File→Save As** and give the simulation a new name and Short ID like "Morpological Accleration."
- 21. Change the Ending date and time to match the end of your compressed flow time series.
- 22. Press the Compute Button.

Lunsteady Flow Analysis		$\times$
File Options Help		
Plan: Morphological Acceleration	Short ID: Morphological Acceleration	
Geometry File: Fo	our Structures	•
Unsteady Flow File: M	orphological Acceleration Flows	•
Sediment File: Ma	orphological Acceleration 24	•
Programs to Run	lan Description	
✓ Geometry Preprocessor         ✓ Unsteady Flow Simulation         ✓ Sediment         ✓ Post Processor	17Nov2018 30Oct2018	
Floodplain Mapping	~	4
Simulation Time Window Starting Date: 08Oct	t2018 Starting Time: 0000	
Ending Date: 090ct	t2018 Ending Time: 1200	
Computation Settings Computation Interval: 30 Set	cond 💌 Hydrograph Output Interval: 6 Hour	-
Project DSS Filename: VIC:\Us	ers/q0hecsag/Documents/Projects/Classes/_St Louis	-
	Compute	

#### **Review Results**

- 23. Open RASMapper by pressing the Mapper button  $\square$  or selecting **GISTools**  $\rightarrow$  **RASMapper**.
- 24. Add the bed change variable to the new result.
- 25. Under the Result Node, Right click on the new result and choose Create a New Results Map Layer...
- 26. Then select **Bed Change** under the **Sediment Bed** variables and press the **Add Map** button.



To visually compare the results, you must make sure the plot range is consistent between the results maps. For both the existing and new plans, right click on Bed Change result and choose Layer Properties.

Bed (	hange (08OCT2)	18 00-00-00		South State
Map Layers			Layer Properties	

28. In the Surface section of this editor, press the Edit button.

Surface		
Plot Surface	Update Legend with View	Histogram
3.80	Stretched	Edit
-3.80	Opacity:	100%

29. Choose consistent and *symmetrical* (max and min have the same magnitude but opposite signs) max and mins for both results and press the **Create Ramp Values** button to apply them.

Г	Surface Symbol									
	Max: 4 Use Dataset Min/Max									
	Min: -4 No. Values: 3 Create Ramp Values						np Values			
1	Keep user Values with color ramp change									
		Value	Color	Red (0-255)	Green (0-255)	Blue (0-255)	Alpha (0-255)			
	1	-4.00		255	0	0	255			
	2	0.00		255	255	255	255			
	3	4.00		0	0	255	255			

30. Visually inspect your results.

## Does the Morphological Acceleration seem like an appropriate approximation of the unaccelerated simulation?

You can also compute a difference map to evaluate the error introduced by morphological acceleration.

31. Right Click on one of the results nodes in the Mapper tree and select **Create a New Calculated** Layer.



- 32. Add the bed change for both plans by adding variables with the  $\pm$  button.
- 33. Select Bed Change under Map Type.
- 34. Name the variable.
- 35. Press the Add Variable Button.

RASter Calculator			×
Script User Defined	Raster Layers	Ter	rrains ittleBayou Metro Bend Multibea X
Plan Definition: Morphological Accelerati	Map Type Courant (Velocity/Length	Animation Behavior Dynamic	Profile
	Variable Depth Hydraulic Bed Change Hydraulic Bed Elevation Subface Bed Change		d Variable Close

- 36. After you have defined the bed change for both plans as variables, edit the script with the **andalso** command in the opening line and a simple difference in the else statement (see example on next page).
- 37. When you plot the results in the bed change color ramp turn off hill shade.

### Does the Morphological Acceleration seem like an appropriate approximation of the unaccelerated simulation?

RASter Calculator	×						
Script User Defined Layers          Layers       Raster Layers         +       MorphAccBedCh = Morphological Acceleration   Bed NonAccelerated = 2D Options   Bed Change     Dyna         Image: State Sta	Terrains ?						
Calculation Check Code View Full Code							
<pre>' #VARIABLES: ' 'NonAccelerated' is the cell value from 'NonAccelerated = 2D Options   Bed Change   -1 ' 'MorphAccBedCh' is the cell value from 'MorphAccBedCh = Morphological Acceleration   Be ' 'Output' is the desired output value. '***** Write/Modify the code below! ****** '</pre>							
<	>						
Raster Output         Folder:       Its\Projects\Classes\St Louis 2D Sed\Production\Morphological Acceleration\2D Options         Name:       MorphAccDiff	s Workshop \Calculated Layers						
	Create Layer Close						

If you have time, make another sediment file and try to explore the effect of overloading the boundary condition. Open the sediment file, choose the **Capacity Ratio** boundary condition, and select a boundary condition >1 (e.g. 1.5 introduces 50% more sediment than the equilibrium load.

Boundary Condit	tions 20	) Bed Gradation	s				
			Select Lo	cation for Sediment	t Bounda	ry Condition	
Add Sediment Boundary Location(s) Delete Current Row Defi					e Sediment Split at Junction		
			Se	diment Boundary C	ondition	Types	
Rating Curve Sedimen		Sediment L	Load Series Equilibrium		ad	Capacity Ratio	Clear Water (no s
Flow Wtd Se	d Split	Potential W	td Sed Split	GC Threshold S	plit	Sed Split by GC	1
					Capaci	ity Ratio 🛛 🎽	
2DArea:	BCL	ine	US BC	Capacity Ratio	Multipl	y Equilibrium Load by:	
						ОК	Cancel