

## Tutorial 2

### **Dam Breach Modelling using HEC-RAS**

GeoDarshan

### 1. Objective

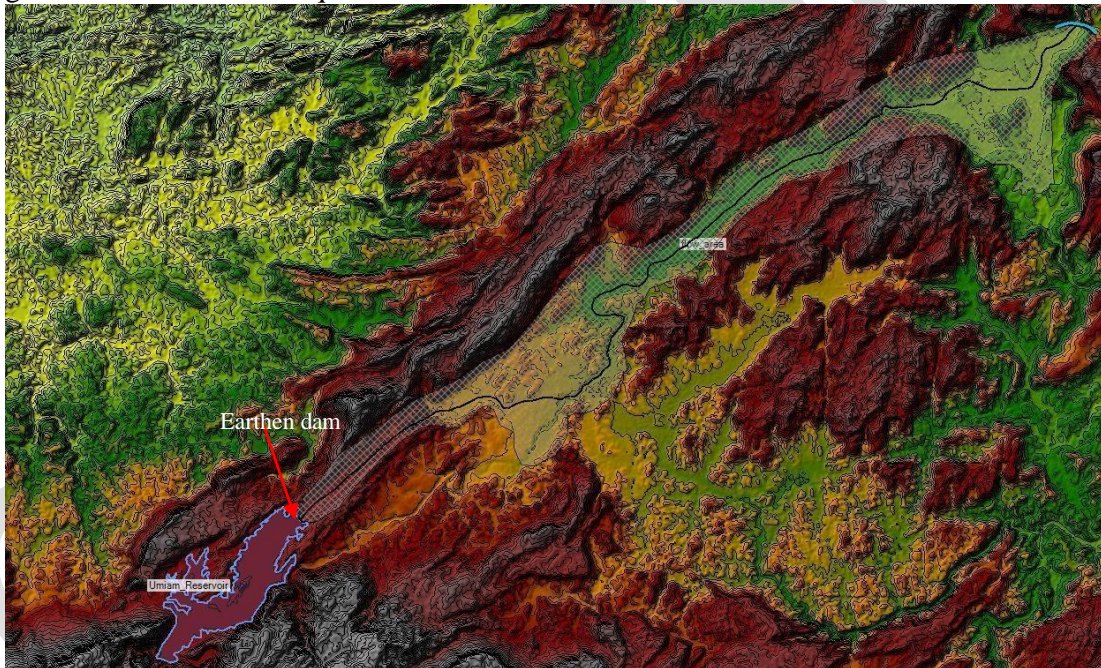
In this Session, you will exercise your knowledge on the 2D unsteady flow modelling to setup and compute a simulation for Umiam Dam breach. It consists of the following major tasks:

- Digitizing the Geometry such as Storage area, Dam axis and 2d flow area.
- Selection of Dam Breach Parameter.
- Setting initial conditions.
- Reviewing results.


**2. Available Data :** DEM, River network, Reservoir extent, Dam line, Projection detail, Inflow data, Area-capacity curve etc

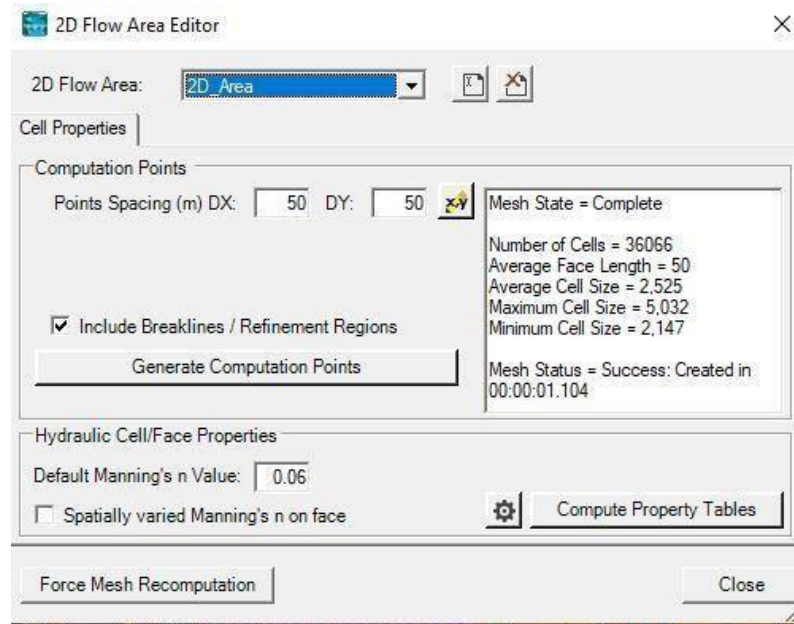
### 3. Background

You will be working with a dataset for Umiam Dam on Umiam River about 15 kilometres north of **Shillong, the capital city of Meghalaya**. See the figure below to become acquainted with the dataset.

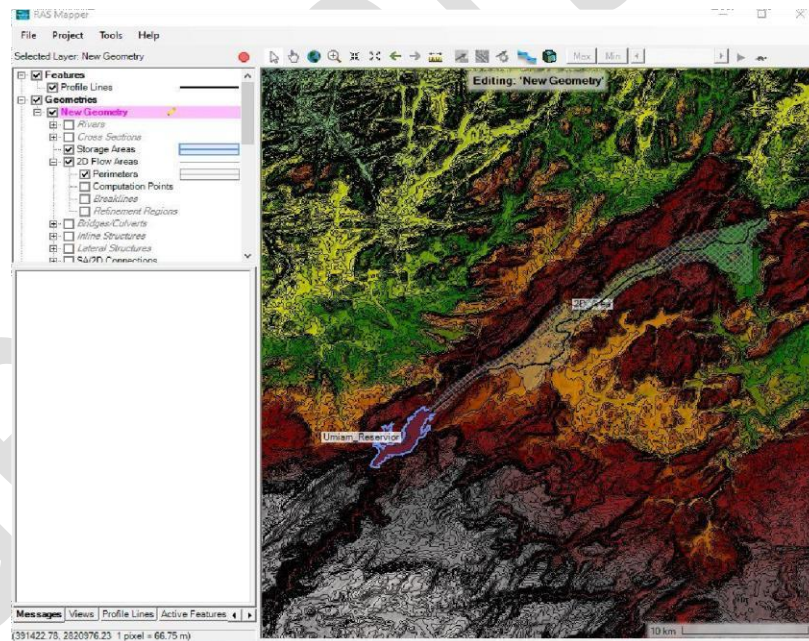


#### 4. Model Setup

1. Open a new project in HEC RAS and set the units to SI customary.
2. Open RAS-Mapper>Set Projection
3. Load DEM as explained in 2D flood modelling exercise. It may take several minutes before it finishes.
4. Right click on generated Terrain>Image Display Properties and select update Legend with view option. Also select plot contour option and define interval as 20.
5. In the RAS-Mapper right click on Geometries > Add new geometry and give it a name as “geometry”. Now edit the geometry (  ) and create the following elements:
  - a. Go to Storage Areas start digitizing storage area, give it name as Umiam\_Reservoir (We can also import the shape file of reservoir by right clicking on storage Area >Layer Property>Features> Import Features>Select Umiam\_Reservoir.shp>import).
  - b. To know the fetch of study, add the river shape file by adding it as reference layer (Right click Map layer>Reference layer>add reference layer>select river shape file).
  - c. Now, right click on 2D Flow Areas> Edit geometry > Perimeters, then start digitizing the flow area and give it name as 2D\_Area, then assign DX and DY as 50 as mentioned below and click on Generate Computation Points.

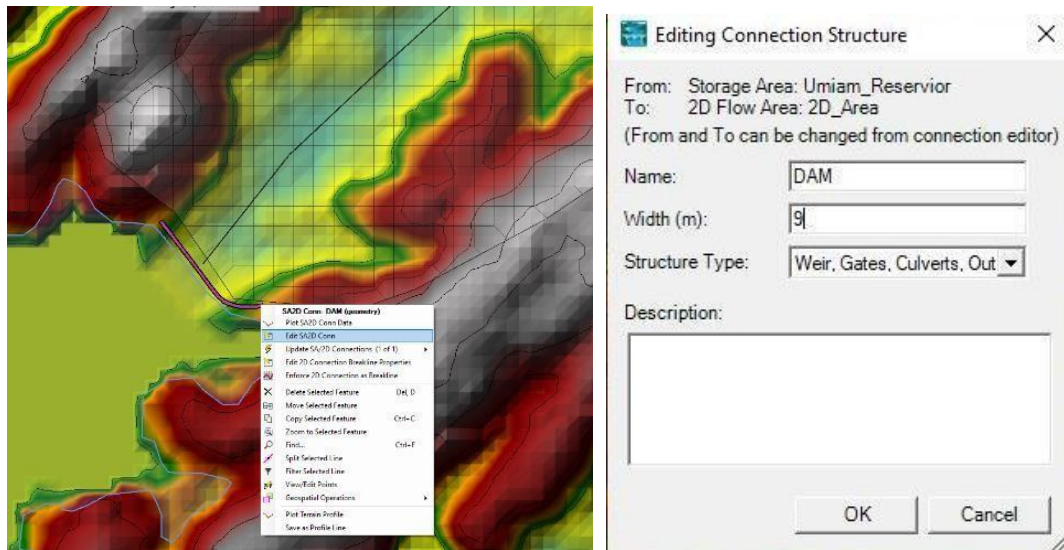


d. Final image will be visible as below:

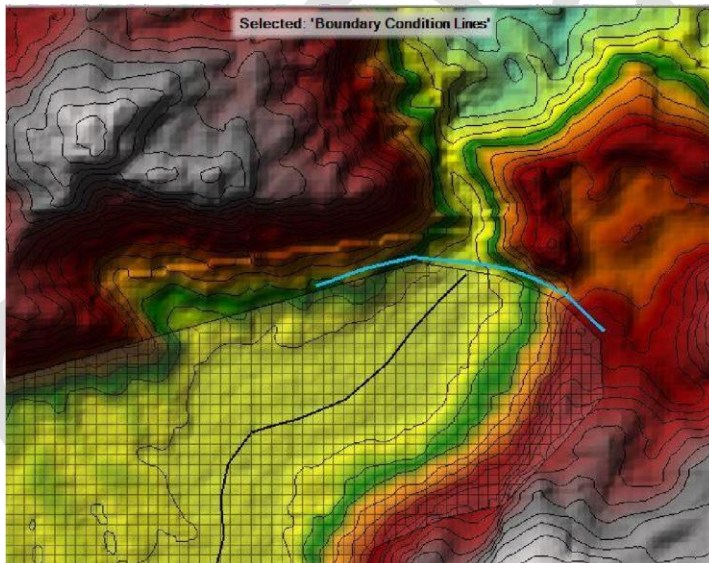


e. Create a Connection representing the dam between the storage area and 2D flow area using SA/2D Connections tool or import the axis of the dam same as storage area Now by right clicking on feature added> click on edit SA2D Conn and give it a name and weir width as mentioned below:

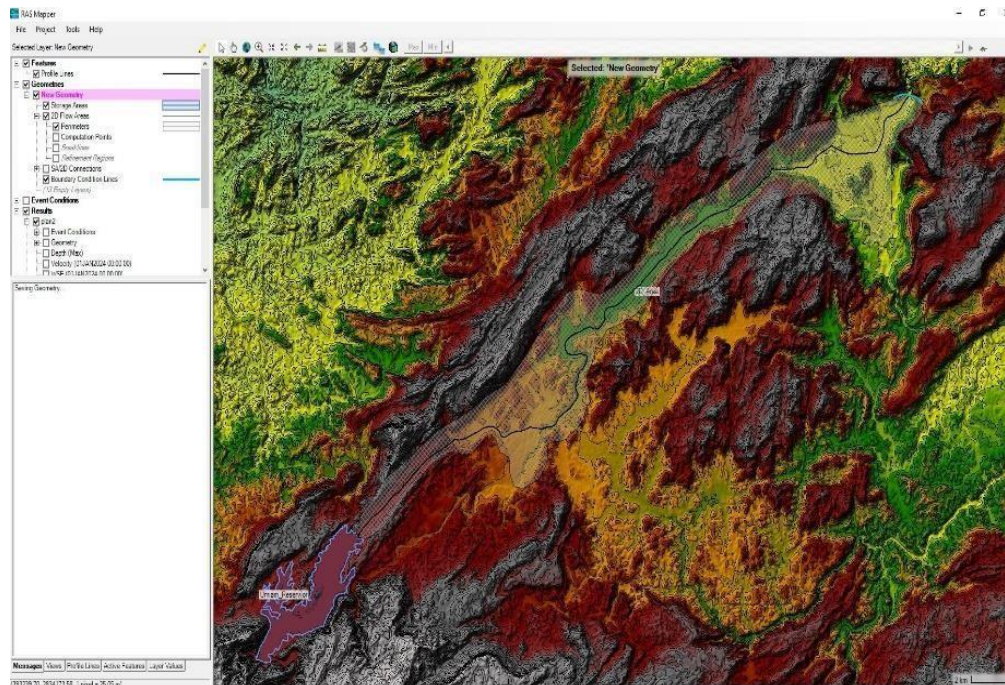





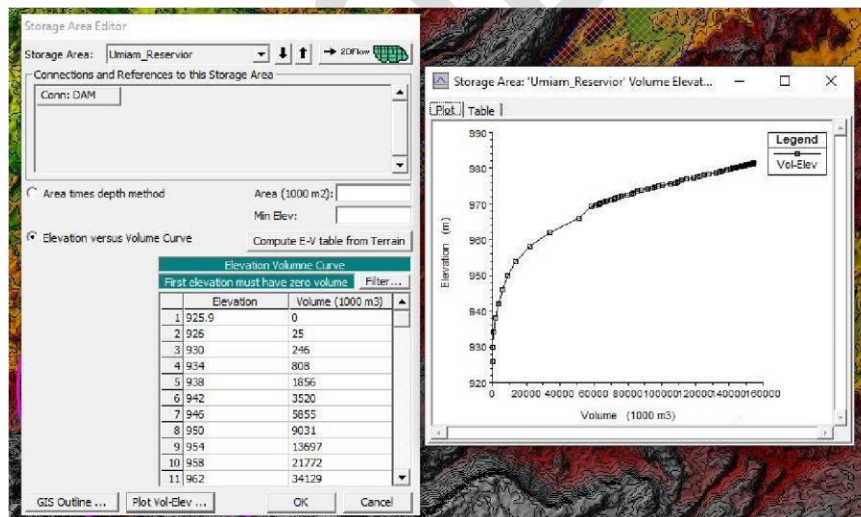
- f. Create boundary condition as shown below and give it name as DS\_BC.



- g. The final map in the RAS mapper will be shown below:



5. Now STOP EDITING (  ) and Save the geometry data and close the RAS Mapper.
6. Now go to Geometry data editor > File > Open Geometry Data then select the geometry created in RAS mapper.
7. Add data to the Elements created in the above steps.
  - a. Enter the Elevation-volume curve in the Storage Area using Edit Storage Area option. The data entry and plot are shown in the diagram as given below:



- b. If everything goes right, Conn DAM will also appear on the top in data entry dialogue box.

c. 2D Flow Area edit option will also show look as shown below.

Notice three connections as shown.

2D Flow Areas

2D Flow Area: 2D\_Area

Connections and References to this 2D Flow Area

Conn: DAM BCLine: DS\_BC

Default Manning's n Value: 0.06

Edit Land Cover to Manning's n...

Cell Volume Filter Tol (0=OFF)(m): 0.003

Cell Minimum Surface Area Fraction (0=OFF): 0.01

Face Profile Filter Tol (0=OFF)(m): 0.003

Face Area-Elev Filter Tol (0=OFF)(m): 0.003

Face Conveyance Tol Ratio (min=0.0001): 0.02

Face Laminar Depth (0=OFF)(m): 0.06

☐ Spatially Varied Manning's n on Faces

GIS Outline ... Force Mesh Recomputation

2D Flow Area Computation Points

Mesh contains: 26605 cells  
max cell(26590) = 5398.59(m2)  
min cell = 1913.91(m2)  
avg cell = 2535.02(m2)

Generate Computation Points on Regular Interval with All Breaklines...

Enforce Selected Breaklines (and Internal Connections) ...

View/Edit Computation Points ...

OK Cancel

d. Finally use Edit connection i.e. Dam to enter the dam and breach related information.

Connection Data Editor - geometry

File View Options Help

Connections: DAM

Description: DAM

From: Storage Area: Unim\_Reservoir Set SA/2D ...

To: 2D Flow Area: 2D\_Area Set SA/2D ...

Breach (plan data) ...

Weir Length: 353.20

Centerline Length: 353.19

Centerline GIS Coords ...

Structure Type: Weir, Gates, Culverts, Outlet RC and Outlet TS

Flap Gates: No Flap Gates

Cut profile from terrain ...

Clip Weir Profile to 2D Cells ...

Legend

Spillway

Current Terrain

Embankment Station/Elevation Table

Station	Elevation
1	0
2	353.2
3	353.2
4	353.2
5	353.2
6	353.2
7	353.2
8	353.2
9	353.2
10	353.2
11	353.2
12	353.2
13	353.2
14	353.2
15	353.2
16	353.2
17	353.2
18	353.2
19	353.2
20	353.2
21	353.2
22	353.2
23	353.2
24	353.2
25	353.2
26	353.2
27	353.2
28	353.2
29	353.2
30	353.2
31	353.2

OK Cancel

e. Go to Breach (Plan Data). Go to Parameter calculator then fill the values as mentioned below:



Breach Plot | Breach Progression | Simplified Physical | Physical Breaching (DLBreach) | Parameter Calculator

**Input Data**

Top of Dam Elevation (m): 987 Breach Bottom Elevation (m): 969  
Pool Elevation at Failure (m): 980.694 Pool Volume at Failure (1000 m3): 142170  
Failure mode: Piping

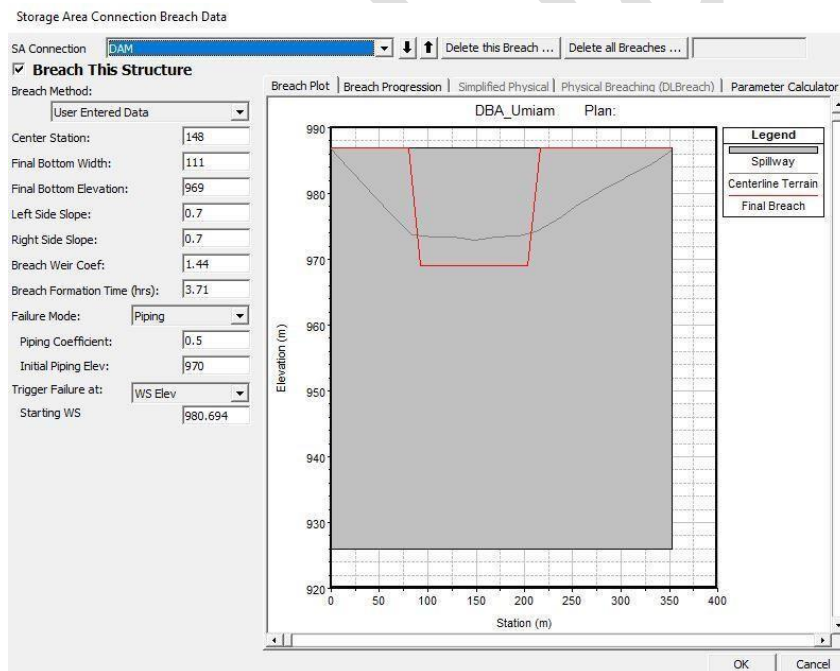
**MacDonald**  
Dam Crest Width (m): 9 Slope of US Dam Face Z1 (H:V): 2.5  
Earth Fill Type: Non-homogeneous or Rockfill Slope of DS Dam Face Z2 (H:V): 2

**Xu Zhang (and Von Thun)**  
Dam Type: Dam with corewall Dam Erodibility: Medium

Method	Breach Bottom Width (m)	Side Slopes (H:V)	Breach Development Time (hrs)	
MacDonald et al	274	0.5	1.65	Select
Froehlich (1995)	111	0.9	3.95	Select
Froehlich (2008)	111	0.7	3.71	Select
Von Thun & Gillette	75	0.5	0.48	Select
Xu & Zhang	90	0.42	8.17 *	Select

\* Note: the breach development time from the Xu Zhang equation includes more of the initial erosion period and post erosion than what is used in the HEC-RAS breach formation time.

- f. Select the Froehlich (2008) then breach parameters will be visible as below. Also give the Center station as 148 and select Breach This Structure.



- g. Save geometry data and close it.



- h. Create the Unsteady Flow Data file. Select Edit Unsteady Flow Data from the main menu.
  - i Use Normal Depth for the DS\_BC (0.001) ii Add more boundary conditions Add SA/2D Flow Area -> Umiam\_Reservoir iii Use Lateral Flow Hydrograph as the boundary condition for reservoir. iv. Use 980.694 as the initial condition for reservoir.

The screenshot shows the 'Unsteady Flow Data' application window with the 'Lateral Inflow Hydrograph' dialog box open. The dialog box has a title bar 'Lateral Inflow Hydrograph' and a subtitle 'SA: Umiam\_Reservoir'. It contains several sections:

- Read from DSS before simulation:** Includes fields for 'File:' and 'Path:' and a 'Select DSS file and Path' button.
- Enter Table:** Includes a 'Data time interval:' dropdown set to '1 Hour' and radio buttons for 'Use Simulation Time' (selected) and 'Fixed Start Time'. It also has fields for 'Date:' and 'Time:'.
- Hydrograph Data:** A table with columns 'Date', 'Simulation Time (hours)', and 'Lateral Inflow (m3/s)'. It contains 17 rows of data starting from 31Dec0999 24:00 to 01Jan1000 16:00.
- Time Step Adjustment Options:** Includes a checkbox 'Monitor this hydrograph for adjustments to computational time step' and a field 'Max Change in Flow (without changing time step):'.
- Min Flow:** Includes a 'Multiplier:' field.
- Buttons:** 'Plot Data', 'OK', and 'Cancel'.

The 'Hydrograph Data' table is as follows:

	Date	Simulation Time (hours)	Lateral Inflow (m3/s)
1	31Dec0999 24:00	0:00:00	33
2	01Jan1000 0:00	1:00:00	36
3	01Jan1000 0:20	2:00:00	45
4	01Jan1000 0:30	3:00:00	66
5	01Jan1000 0:40	4:00:00	105
6	01Jan1000 0:50	5:00:00	174
7	01Jan1000 0:60	6:00:00	273
8	01Jan1000 0:70	7:00:00	414
9	01Jan1000 0:80	8:00:00	648
10	01Jan1000 0:90	9:00:00	987
11	01Jan1000 1:00	10:00:00	1359
12	01Jan1000 1:10	11:00:00	1647
13	01Jan1000 1:20	12:00:00	1761
14	01Jan1000 1:30	13:00:00	1680
15	01Jan1000 1:40	14:00:00	1506
16	01Jan1000 1:50	15:00:00	1389
17	01Jan1000 1:60	16:00:00	1416

iv Save the file (usf\_data).

8. Finally run the plan using Run from main menu and using option Unsteady Flow Analysis.
9. Give computation interval as 10s and Hydrograph output interval, Mapping output interval, Detailed output interval as 10 min each. Select Geometry Preprocessor, Unsteady Flow simulation and Post Processor and save the file (usf\_plan) and provide a short id (trail1). Now click on compute

Unsteady Flow Analysis

File Options Help

Plan: usf\_plan Short ID: trail1

Geometry File: geometry

Unsteady Flow File: usf\_data

Programs to Run

- ☒ Geometry Preprocessor
- ☒ Unsteady Flow Simulation
- ☐ Sediment
- ☒ Post Processor
- ☐ Floodplain Mapping

Plan Description

Simulation Time Window

Starting Date: 01JAN2024 Starting Time: 0000

Ending Date: 02JAN2024 Ending Time: 1300

Computation Settings

Computation Interval: 10 Second

Mapping Output Interval: 10 Minute

Hydrograph Output Interval: 10 Minute

Detailed Output Interval: 10 Minute

Project DSS Filename: d:\shivendra\WORKSHOP 2. DAM BREAK ANALYSIS\WORKS

1 Storage Area Connection with breach data. 1 set to breach.

Compute

10. Open the RAS Mapper and look at the results in Result option in the table of Content.