Effect on Flood Simulation Results with Changing Terrain Model

AHMAD HASEEB RABBANI

SUPARCO, PAKISTAN

Sequence of presentation

- Background
- Flood Modeling
- Role of DEM in flood modelling
- Study Area
- SRTM 30m vs WorldDEM 12m
- HEC-RAS 2D Model
  - Model overview
  - Input data requirements
- Simulation Results
- Conclusion and Recommendation


Background

- Pakistan has suffered cumulative financial loss of $34 billion since 1950 due to floods.

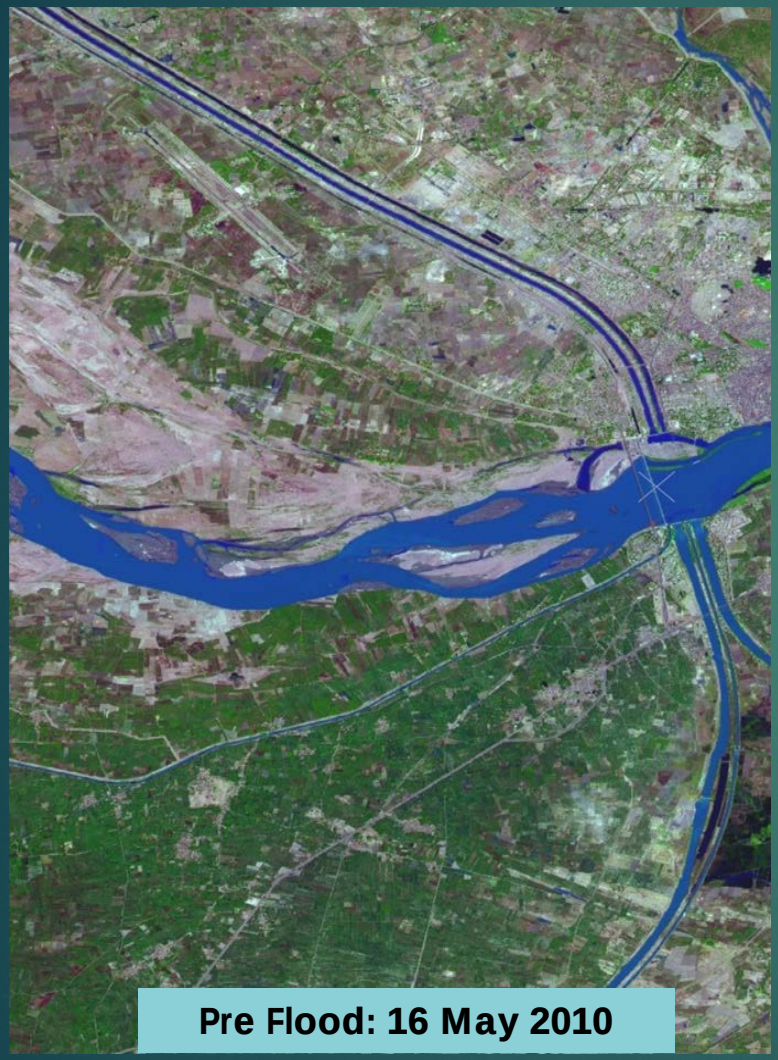
- The super flood of 2010 was most destructive having extensive loss to human lives and economy.

Flood 2010 at Guddu Barrage

Pre Flood: 02 June 2010

Post Flood: 12 Aug 2010

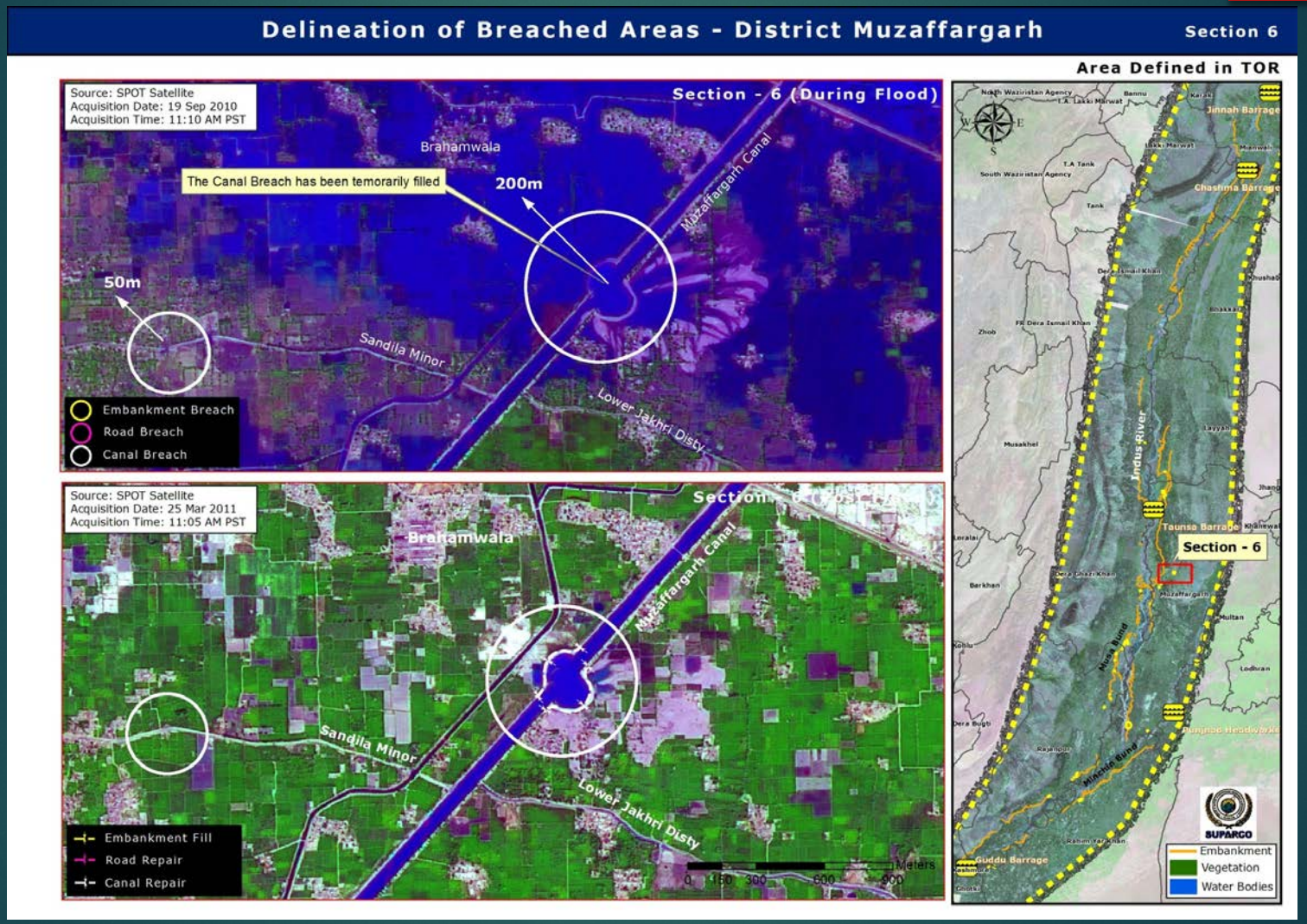
Flood 2010 at Sukkur Barrage



Pre Flood: 16 May 2010

Post Flood: 13 Aug 2010

Flood 2010 – Breaches in District Muzaffargarh



Flood Modeling

- Flood modeling is the fundamental non-structure approach used worldwide for flood hazard assessment.

- Flood Modeling is a technique used to simulate flood scenarios to determine the extent and intensity of a flood event before time. It helps the decision makers to make strategies and mitigation measures even before the happening of the flood event.

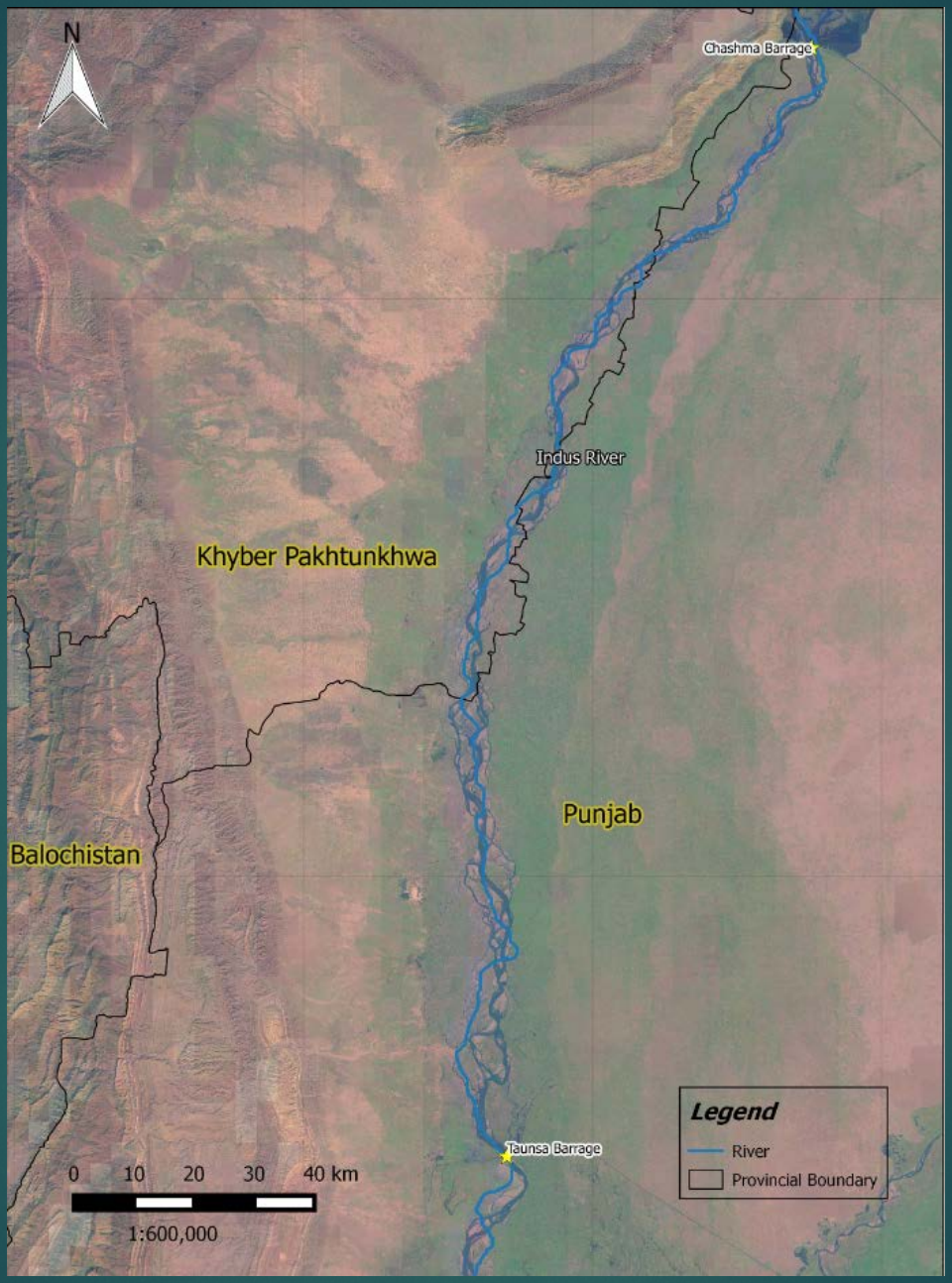
Flood Models

- **1D Model**
  - 1D model can solve flood problem in river flow direction only and does not have capability to model later flows
  - Examples: HEC-RAS 1D, MIKE11 etc
- **2D Model**
  - 2D model can solve flood problem 2 dimension i.e. along the river and lateral flows
  - Examples: HEC-RAS 2D, MIKE21, SOBEK, RRI etc
- **1D/2D Model**
  - 1D for River while 2D for overland flow
  - Examples: HEC-RAS 1D/2D, MIKE21, SOBEK etc.

Role of DEM in flood modelling

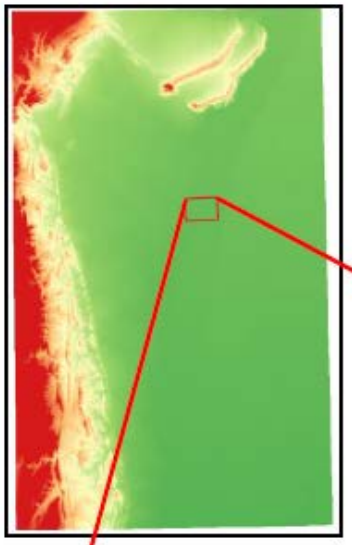
- For an accurate flood modelling results, an accurate terrain need to be prepared in the computer system.
- Digital Elevation model is one of the way to represent terrain in terms of GIS.
- An accurate digital elevation model will lead to accurate flood modelling results.

Study Area

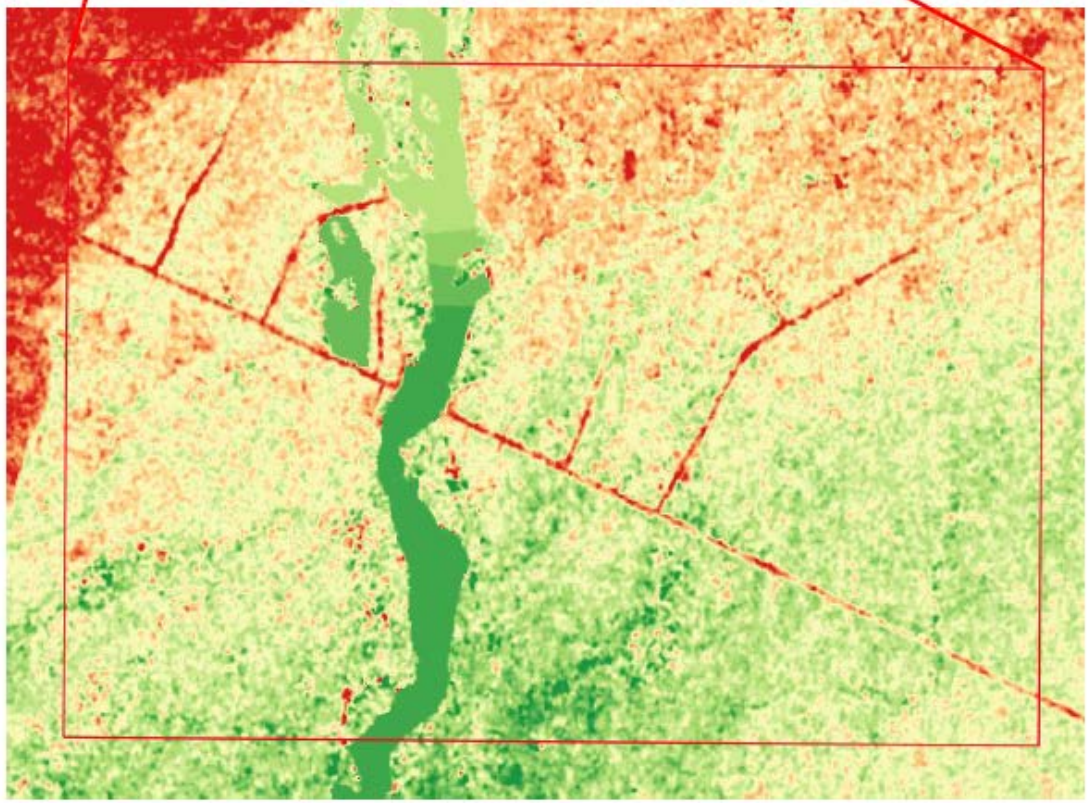

N
Chashma Barrage
Indus River
Khyber Pakhtunkhwa
Punjab
Balochistan
Taunsa Barrage
0 10 20 30 40 km
1:600,000
Legend
River
Provincial Boundary

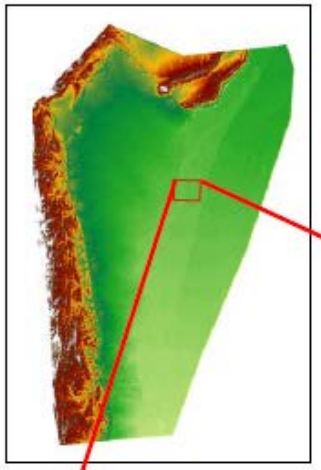
Study Area

SRTM 30m Vs WorldDEM 12m

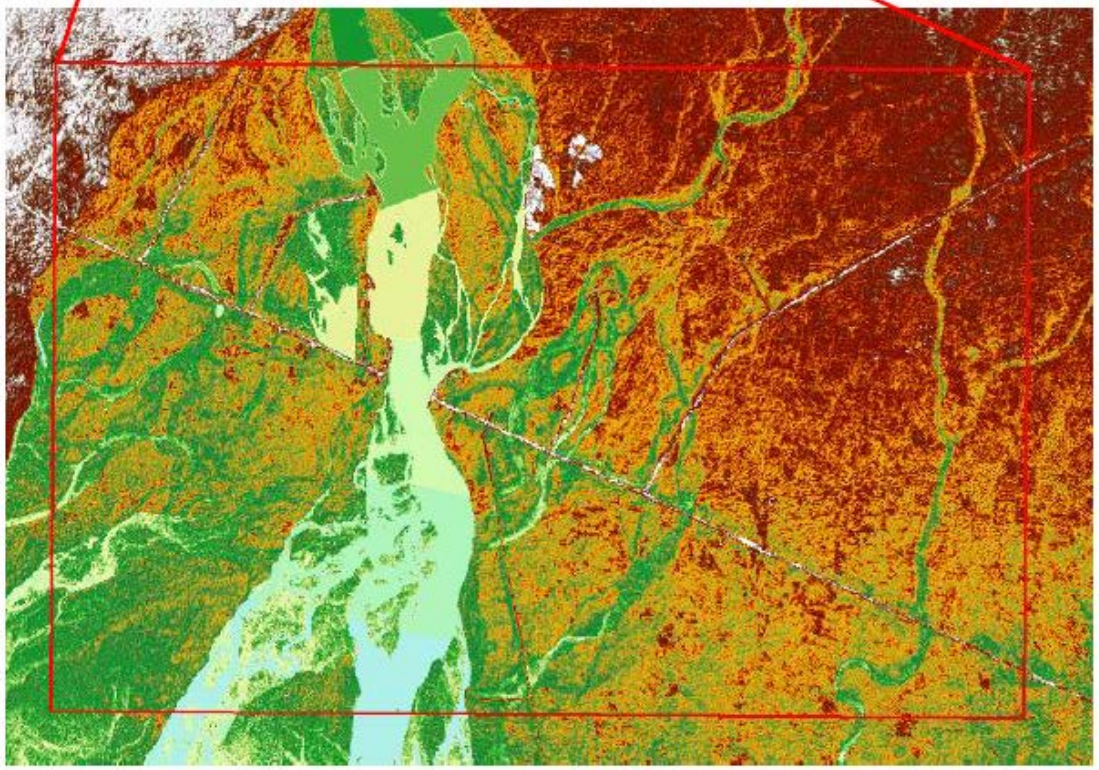


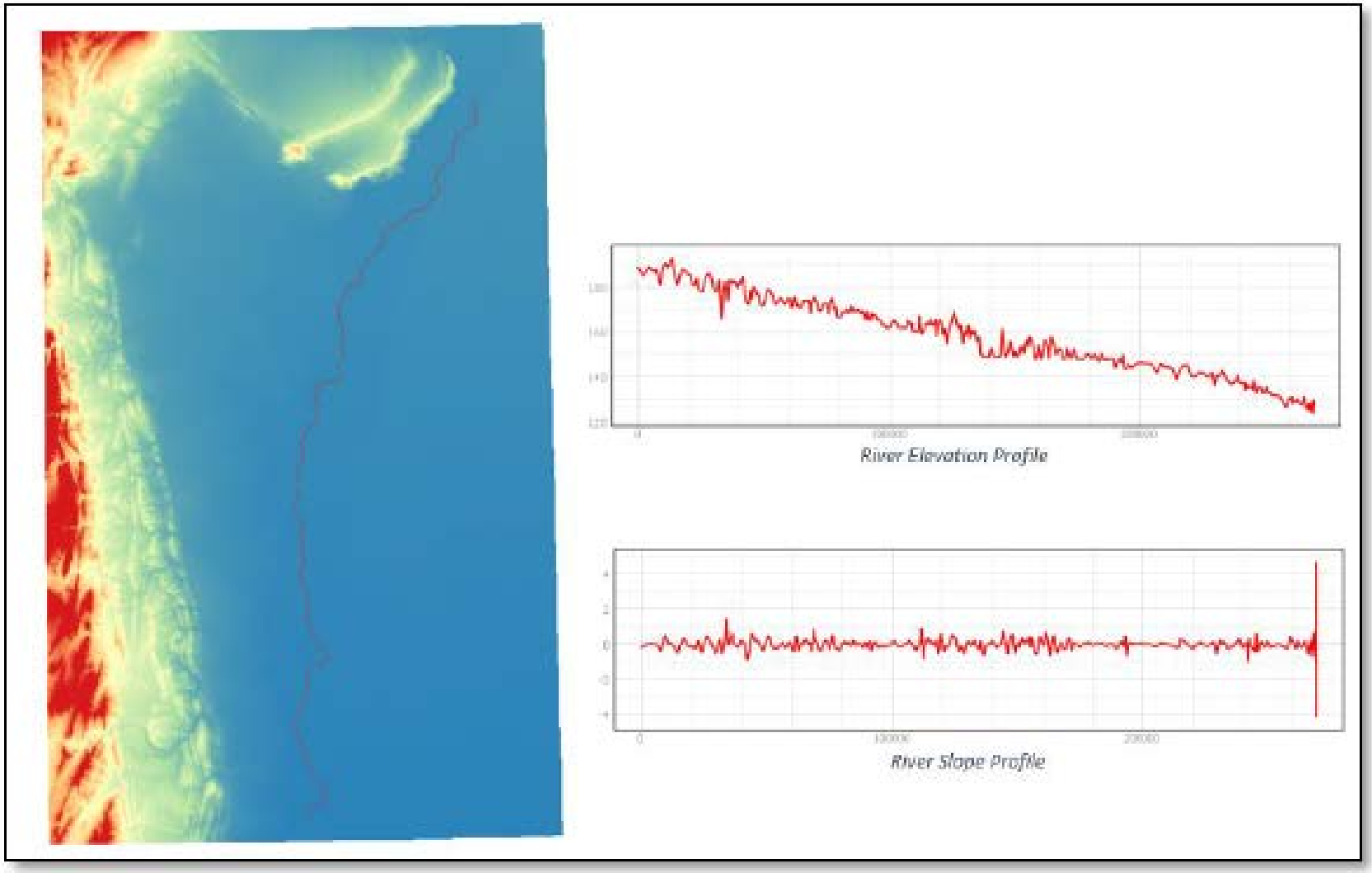
30m SRTM DEM	
XY Coordinate System	GCS_WGS_1984
Vertical Coordinate System	EGM1996 geiod height
Resolution	1 arc sec = 30m
Vertical Accuracy	16m (with 90% confidence)



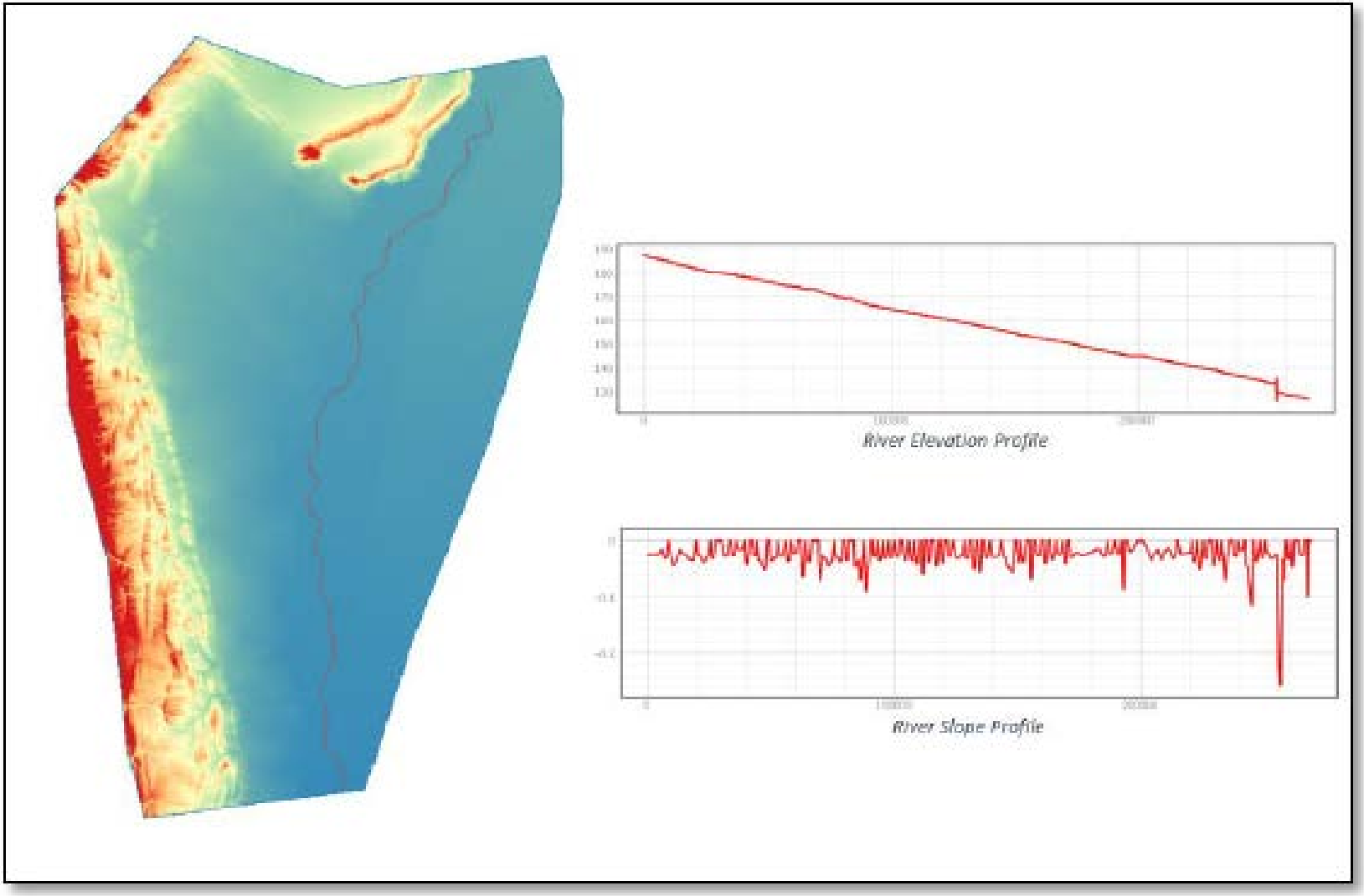


12m WorldDEM DSM	
XY Coordinate System	GCS_WGS_1984
Vertical Coordinate System	EGM2008 geiod height
Resolution	12m
Vertical Accuracy	2m (relative) / 4m (absolute)

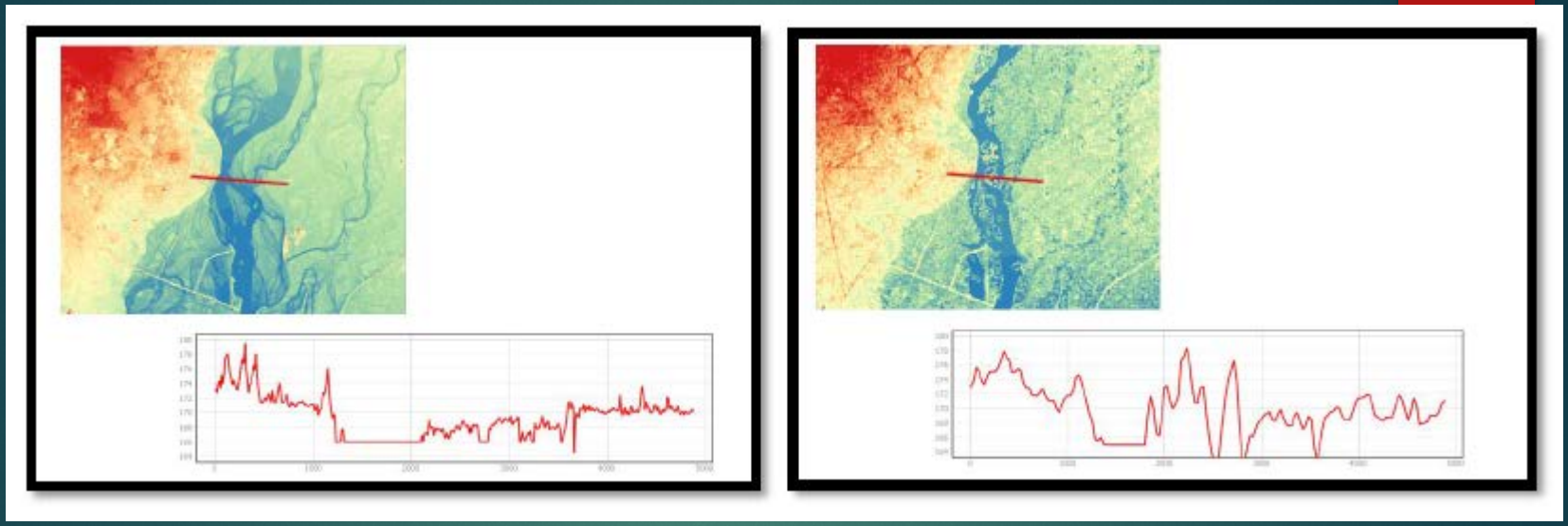




SRTM River and Slope Profile

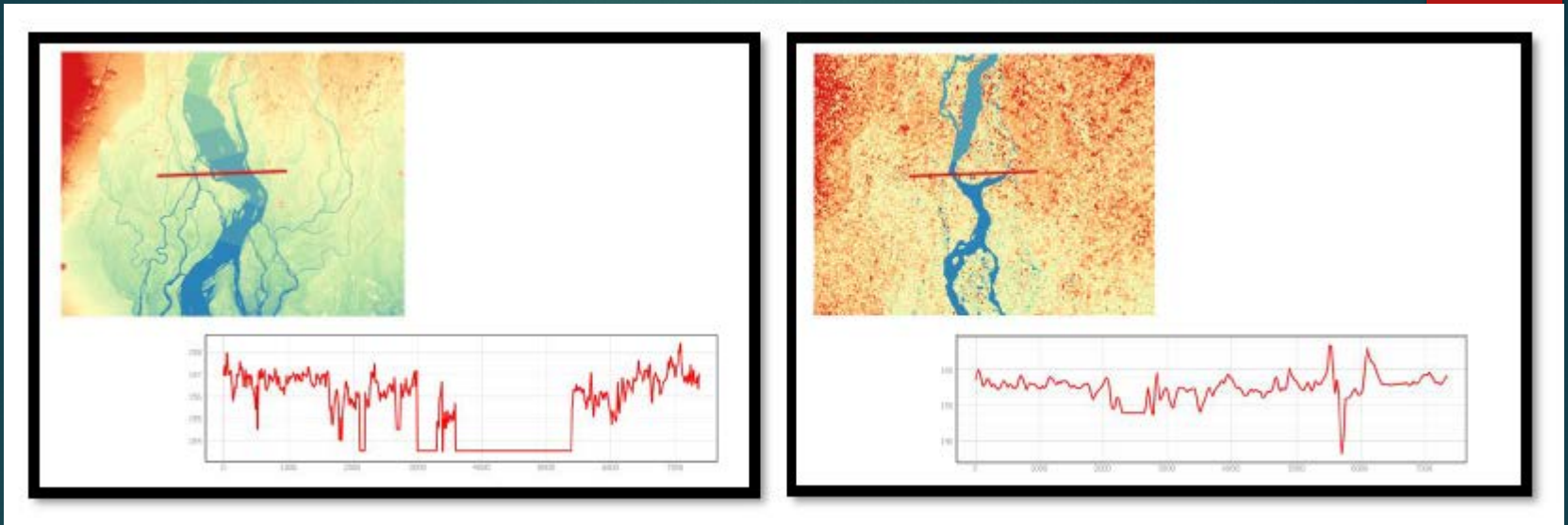


WorldDEM River and Slope Profile



X-Section Profile#1 of WorldDEM and SRTM

X-Section Profile#1’s comparison of WorldDEM and SRTM



X-Section Profile#2 of WorldDEM and SRTM

X-Section Profile#2’s comparison of WorldDEM and SRTM

HEC-RAS 2D model

Overview

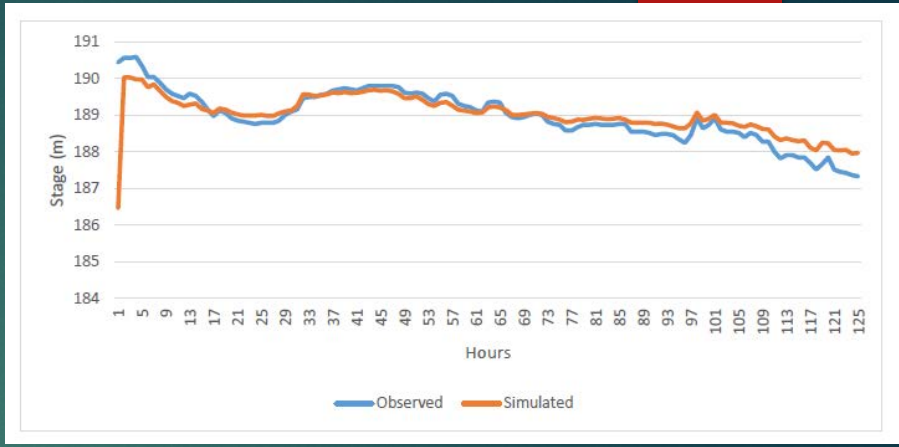
- Developed by US Army Corps of Engineers
- Can Perform 1D,2D and combined 1D/2D modeling
- Used for 2-dimensional flows i.e. river flows and lateral flows
- Solves momentum or diffusion wave equation
- Works for both structural and non-structured rivers and reaches.
- Detailed Flood Mapping and Flood Animation
- Parallel processing algorithm
- Both 32 and 64-bit computational engines

Input data requirements

- Digital Elevation Model (DEM)
- 2D Flow Area
- Landuse/Landcover/Soil Manning
- Boundary Condition lines
- Flood Event Flow Hydrograph
- Flood Event Stage Hydrograph

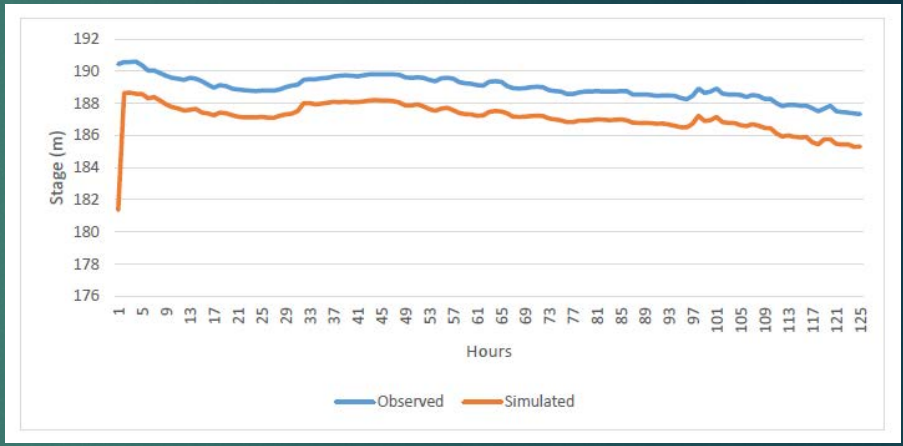
Simulation Results

Taunsa Barrage flow hydrograph for WorldDEM



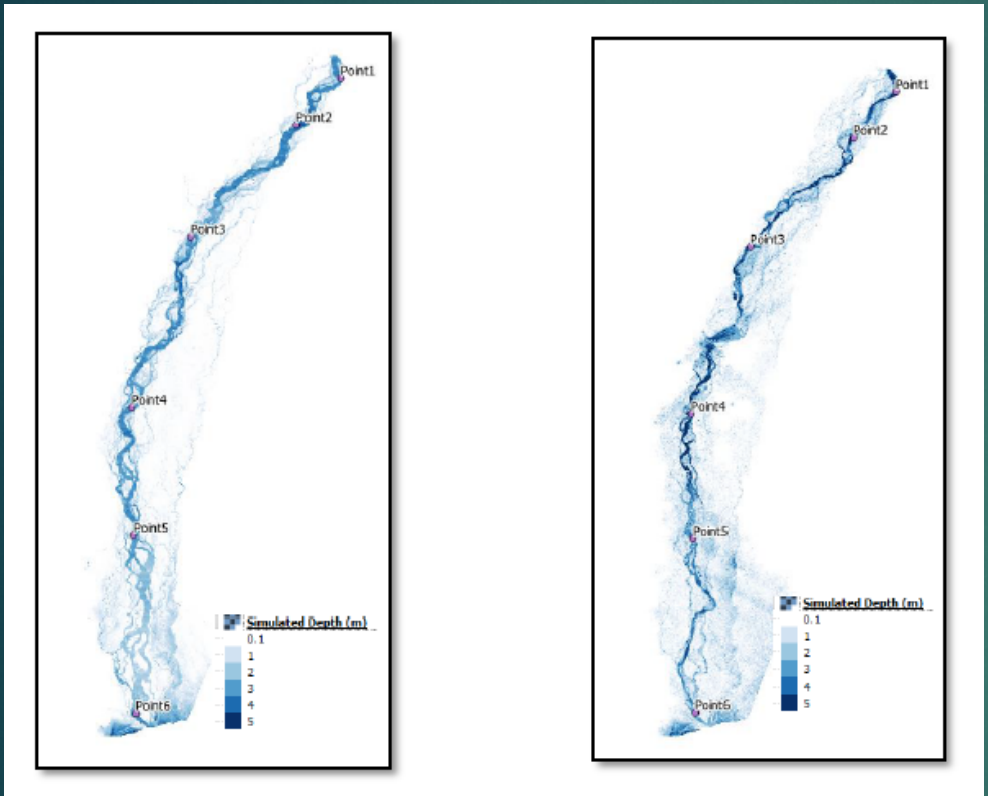
Chashma Barrage stage hydrograph for WorldDEM

Taunsa Barrage flow hydrograph for SRTM



Taunsa Barrage stage hydrograph for SRTM

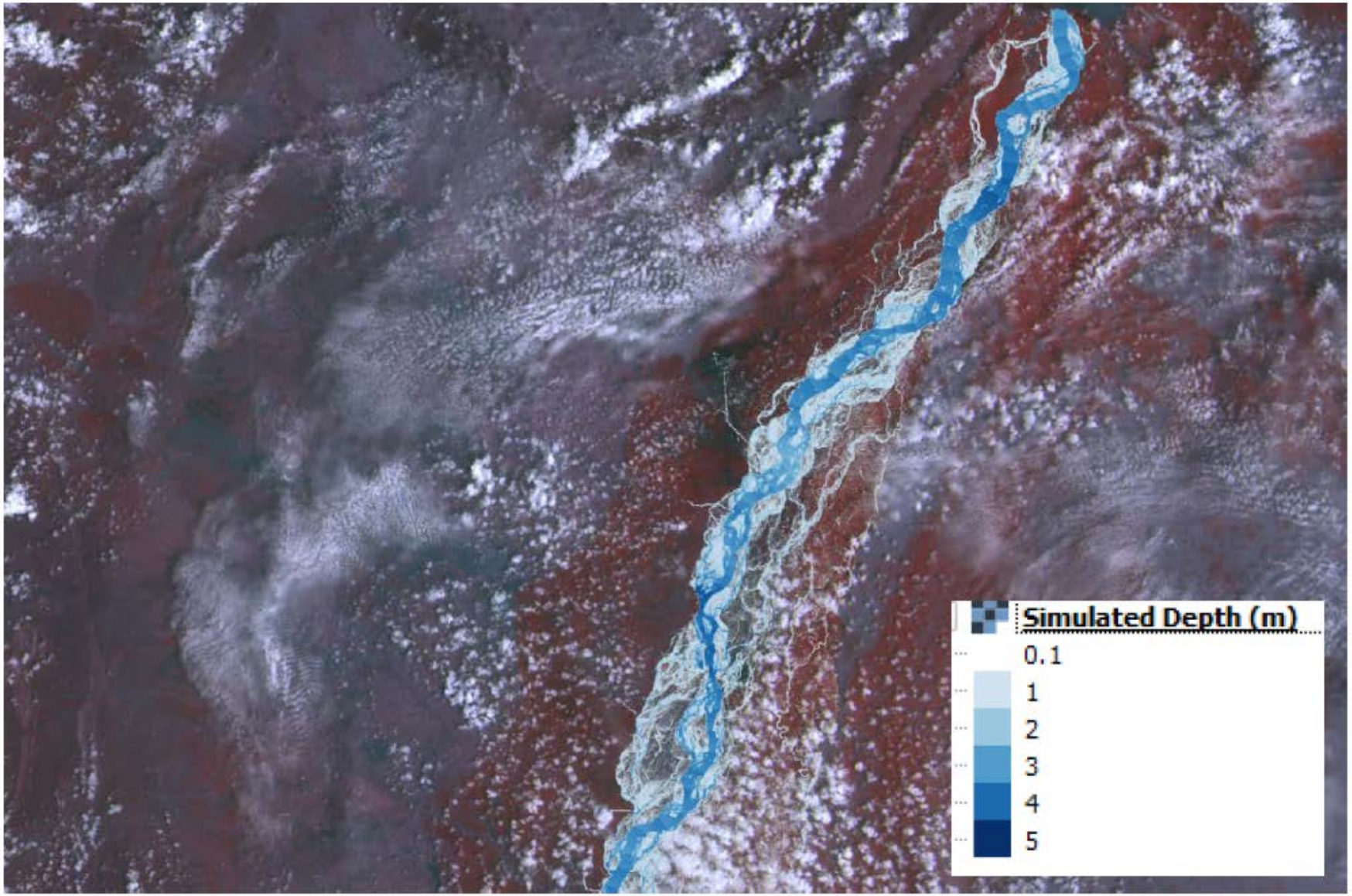
Hydrographs Comparison



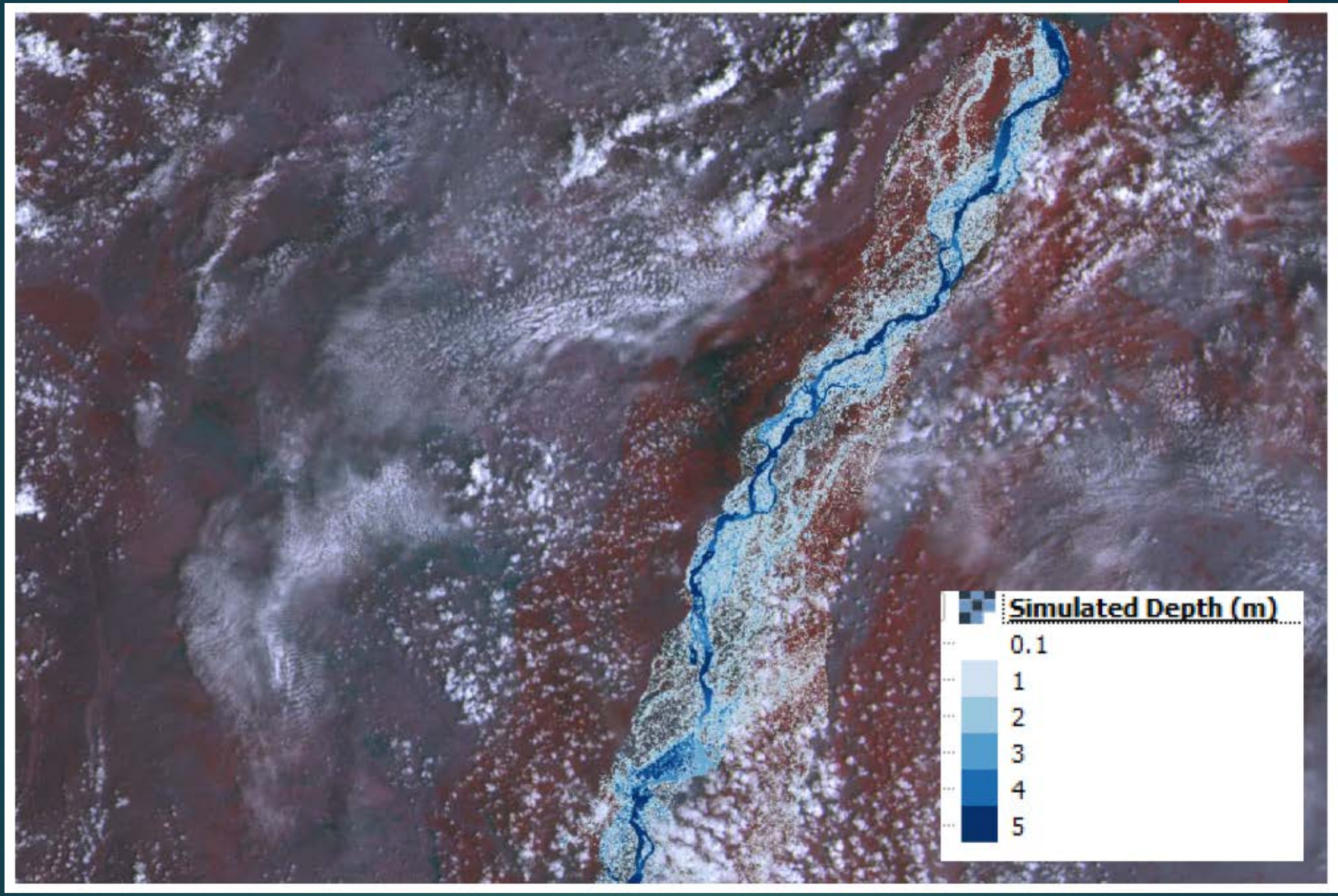
Simulated Depth for WorldDEM and SRTM

Point	WorldDEM depth (m)	SRTM depth (m)
1	3.28	6.78
2	4.07	5.58
3	3.46	4.74
4	3.32	7.70
5	2.95	3.36
6	3.01	2.84

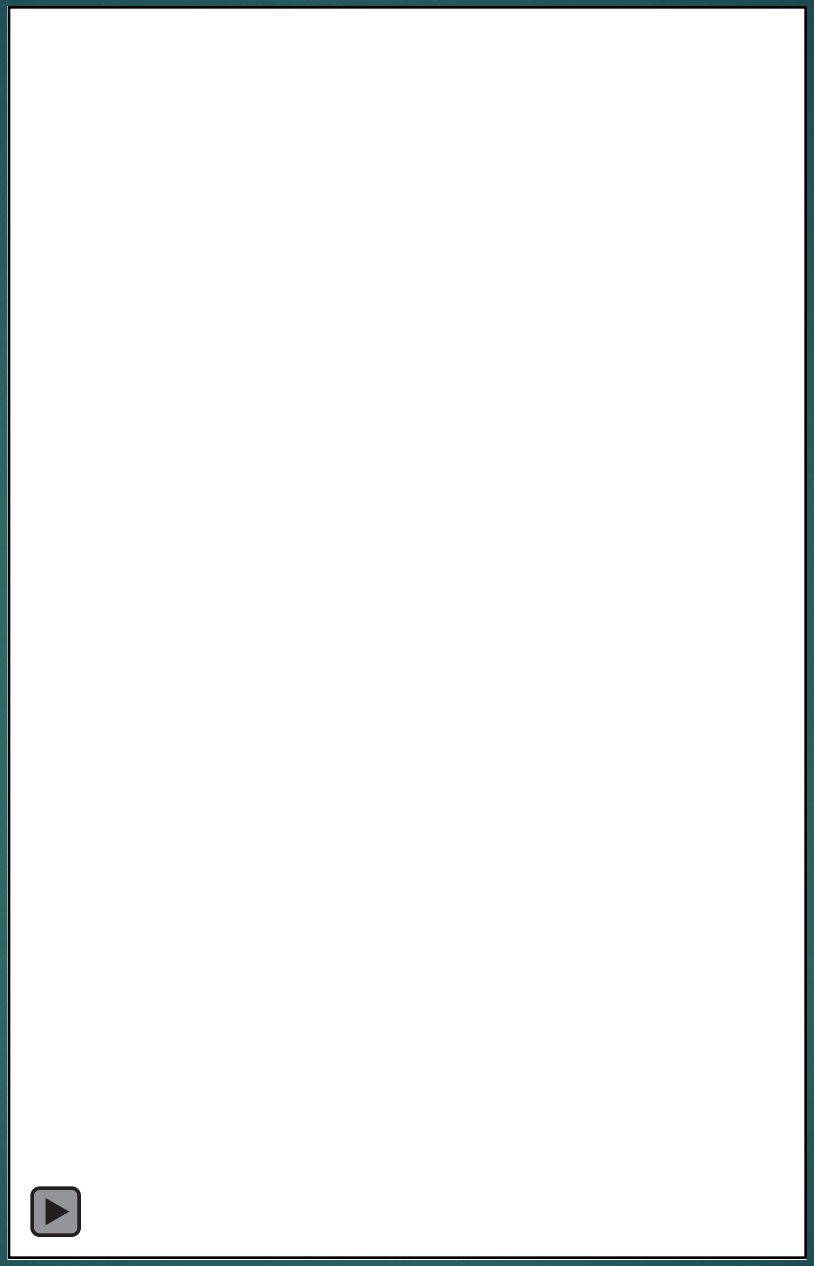
Flood Depth Comparison



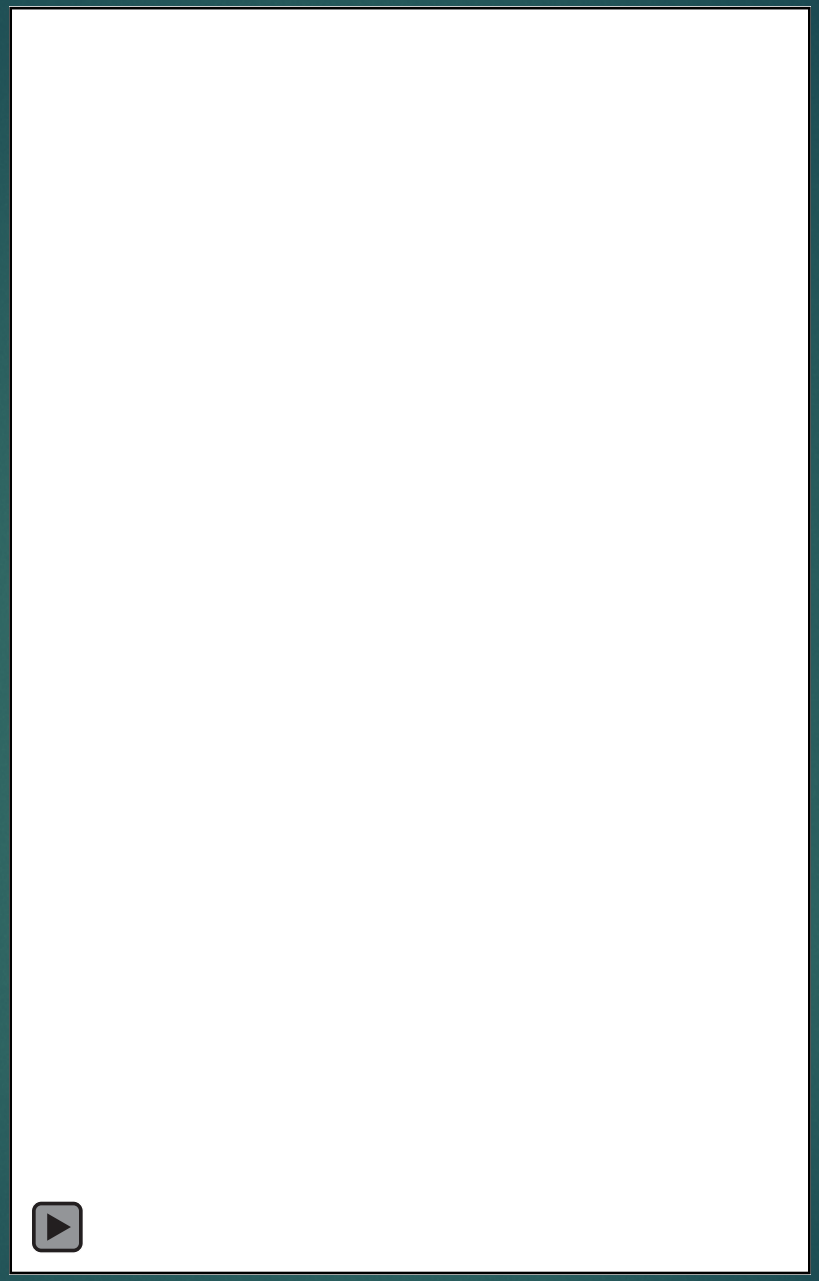
Simulated Depth from WorldDEM Overlay on Landsat-5 Imagery



Simulated Depth from SRTM Overlay on Landsat-5 Imagery



SRTM Simulated depth animation



WorldDEM Simulated depth animation

Conclusion & Recommendation

- WorldDEM provides more details in floodplain
- WorldDEM based river L-section profile (elevation and slope) represent smooth river bed characteristics due to the techniques adopted for hydro-enforcement.
- WorldDEM profiles provide recent active river body. The difference between WorldDEM and SRTM river body depth varied from 1-5m.
- WorldDEM based simulated depth, extent and hydrographs are in agreement with observed.

Thank you