FLOOD INUNDATION DUE TO ASSUMED BREACHING OF ATTABAD LANDSLIDE DAM, PAKISTAN

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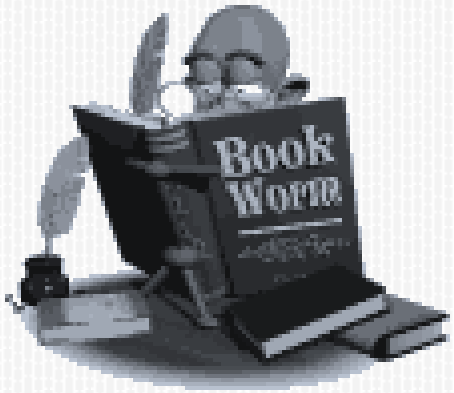
PRESENTATION OUTLINES

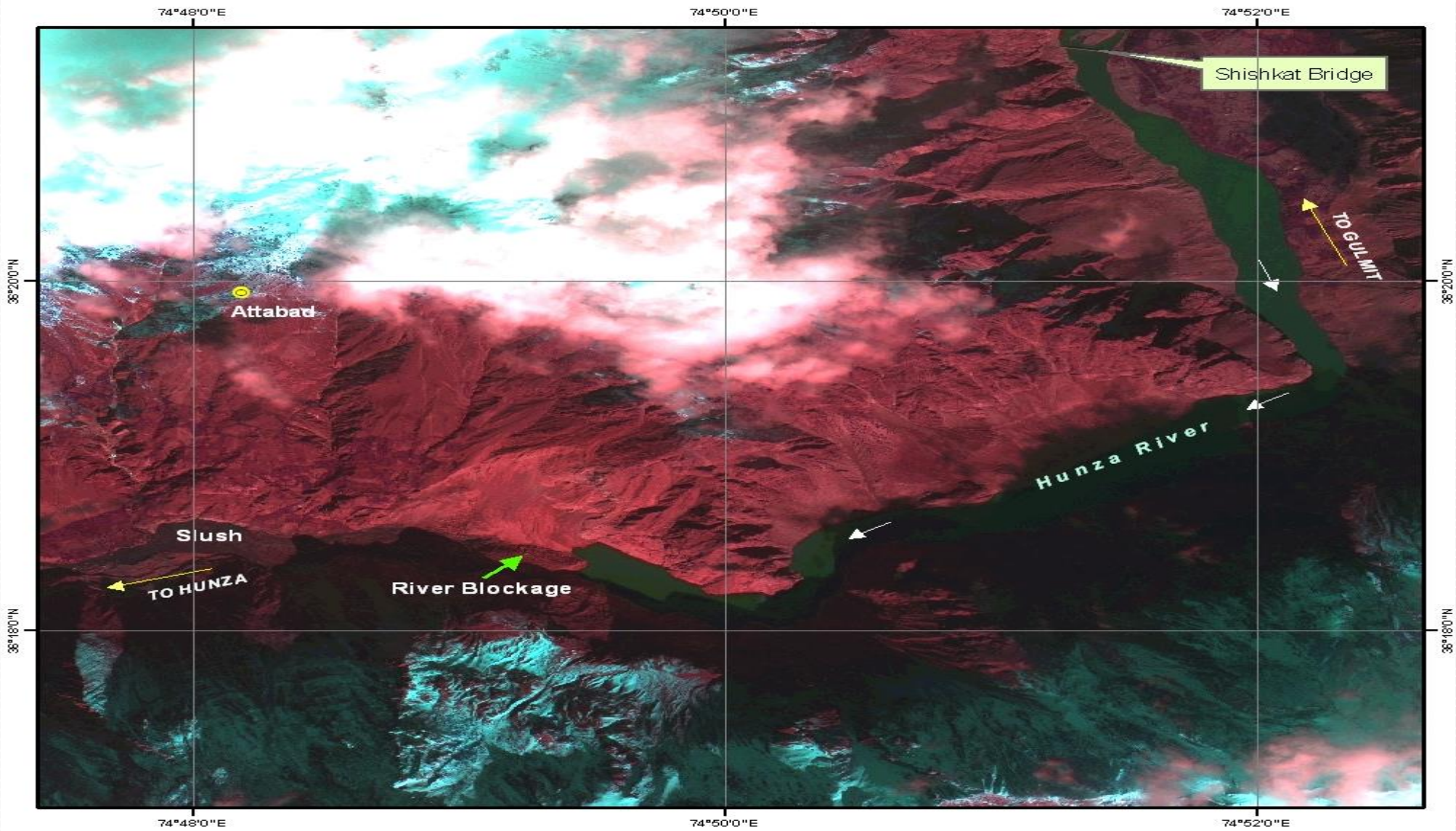


- INTRODUCTION
- OBJECTIVES
- METHODOLOGY
- RESULTS
- DISCUSSIONS
- CONCLUSION
- RECOMMENDATIONS

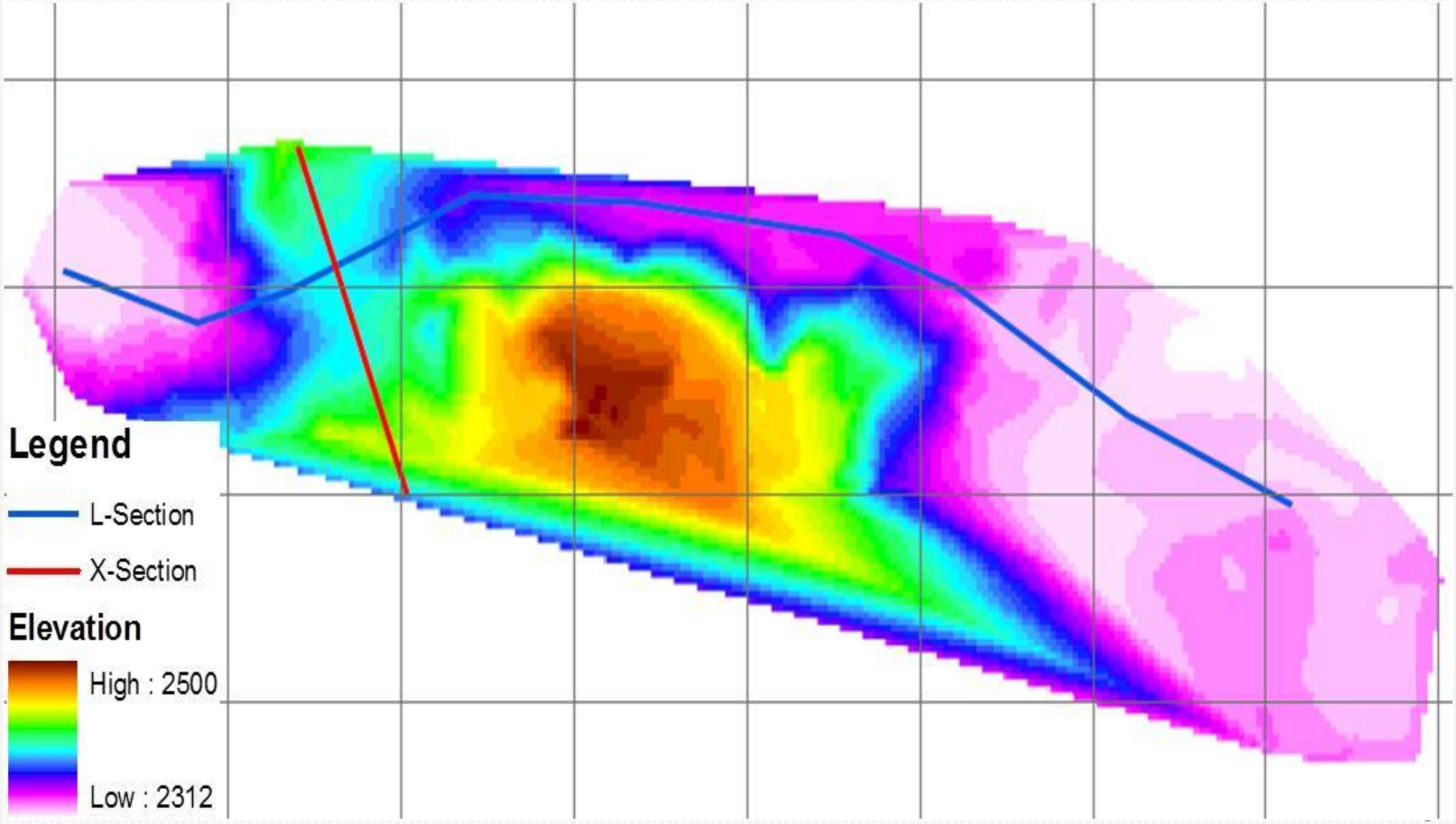
INTRODUCTION

- A massive landslide occurred in Hunza river basin on January 04, 2010 near Attabad village, about 100 km upstream of the confluence of Hunza and Gilgit rivers.
- Due to this landslide, a natural dam of **126 m to 210 m** height has been created across Hunza River.
- Width of dam crest is approximated as **350 m** whereas its length along the river is **2 km**.
- Due to the blockage, created by the landslide, the water of the Hunza River started accumulating as a lake, upstream of the so formed land slide dam.
- The length of reservoir was reported as **15.5 km** on 7th May 2010.
- **305 MCM** is volume of the water that could be stored in the lake up to the top of the landslide.

SATELLITE IMAGERY OF THE LANDSLIDE AREA



LAYOUT PLAN OF LANDSLIDE MASS



NEED OF STUDY

- The landslide mass at Attabad contains huge rock blocks (weighing up to hundreds of tons), stones and fine soil.
- The composition of the landslide material visible on the surface is mostly blackish organic soil with sand and gravel and some small boulders.
- As there is no spillway in the landslide mass, it will eventually overtop after being water-filled to its top level.
- The overtopping of the landslide mass would cause erosion of the soil, which is expected to progress rapidly as the downstream slope of the landslide dam is quite steep (roughly **1H: 0.7V**).
- This rapid erosion of the soil can progress so fast that it may washout most of the landslide mass within a few hours; which in the case of a dam break event is very high.
- This study has been carried out to ‘Plan for efficient action’ rather than ‘reacting to the crisis’.

RESEARCH BACKGROUND

DAM BREAK STUDY

Dynamics of Breach Section Development

- Characteristics of breach triggering phenomenon
- Progress of the breach
- Computations of out-flow hydrograph

Routing of Resulting Flood Wave

- Determination of the change in flow characteristics of the flood wave during its propagation in a channel, flood plains, or a network of channels, as per the situation in hand

DAM BREACH – TRIGGERED DUE TO OVERTOPPING

Gibson Dam, Montana

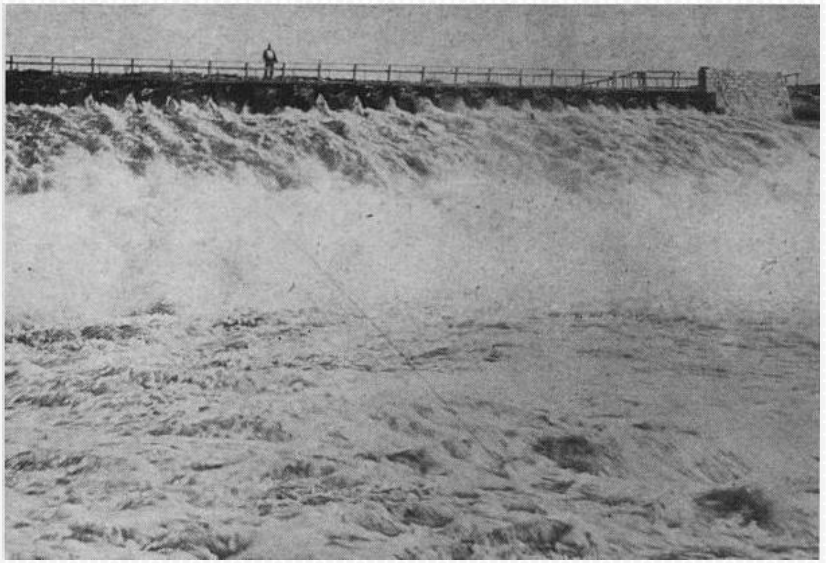
Taum Sauk Dam, North America

Rainbow Dam, Michigan

Auburn Cofferdam, California

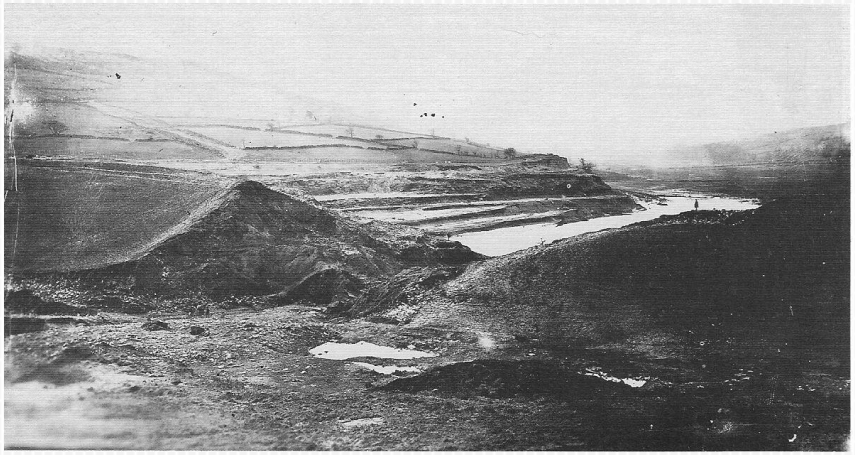
DAM BREACH – TRIGGERED DUE TO PIPING

Teton Dam, Idaho



Avalon Dam, United States

CSC Orchards Frost Protection Pond, USA



Dale Dyke Dam, England

TETON DAM, IDAHO – PRESENT DAY

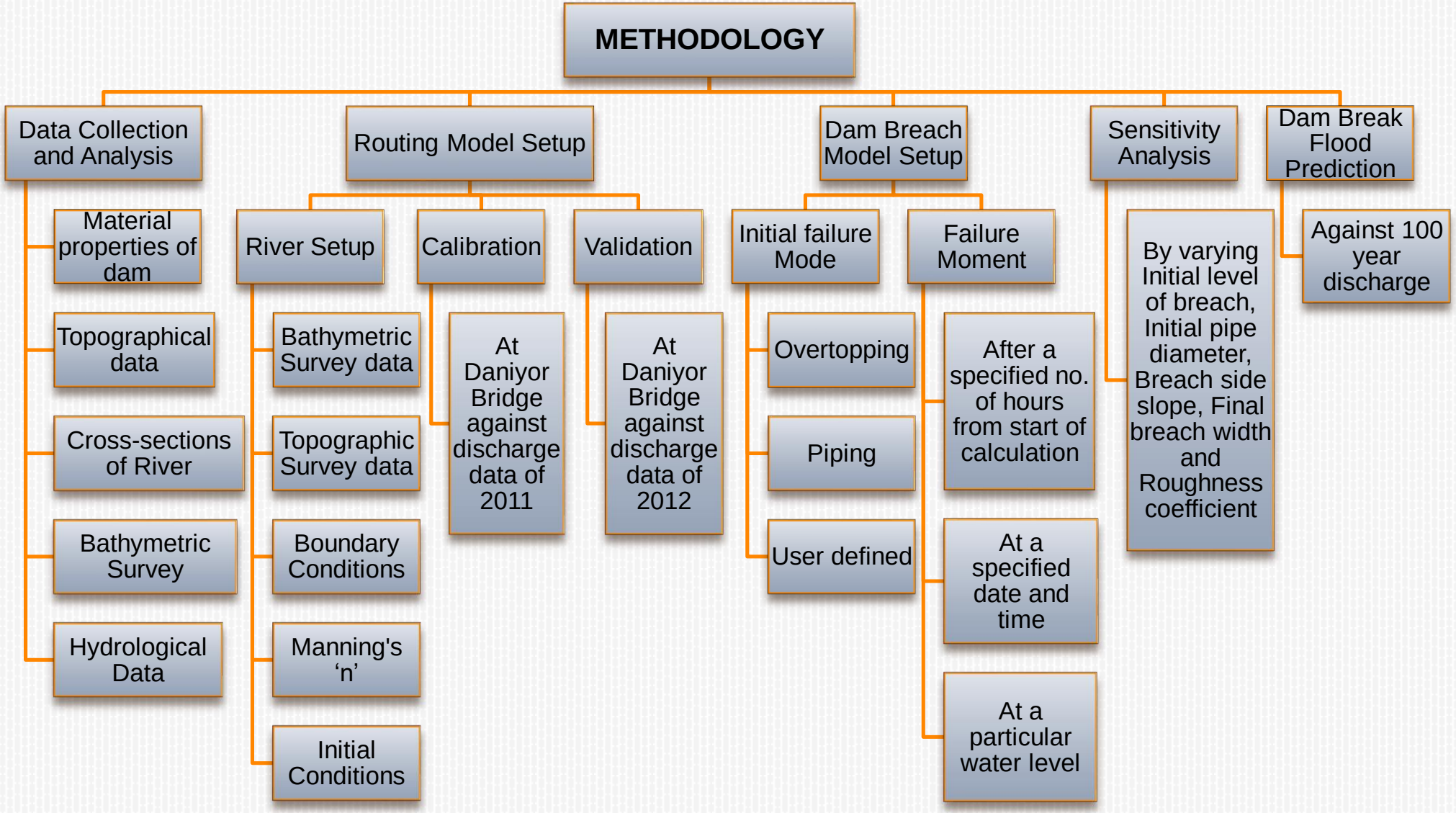
RESEARCH OBJECTIVES

To simulate dam breach using Erosion based modeling and User Specified dam breach parameters

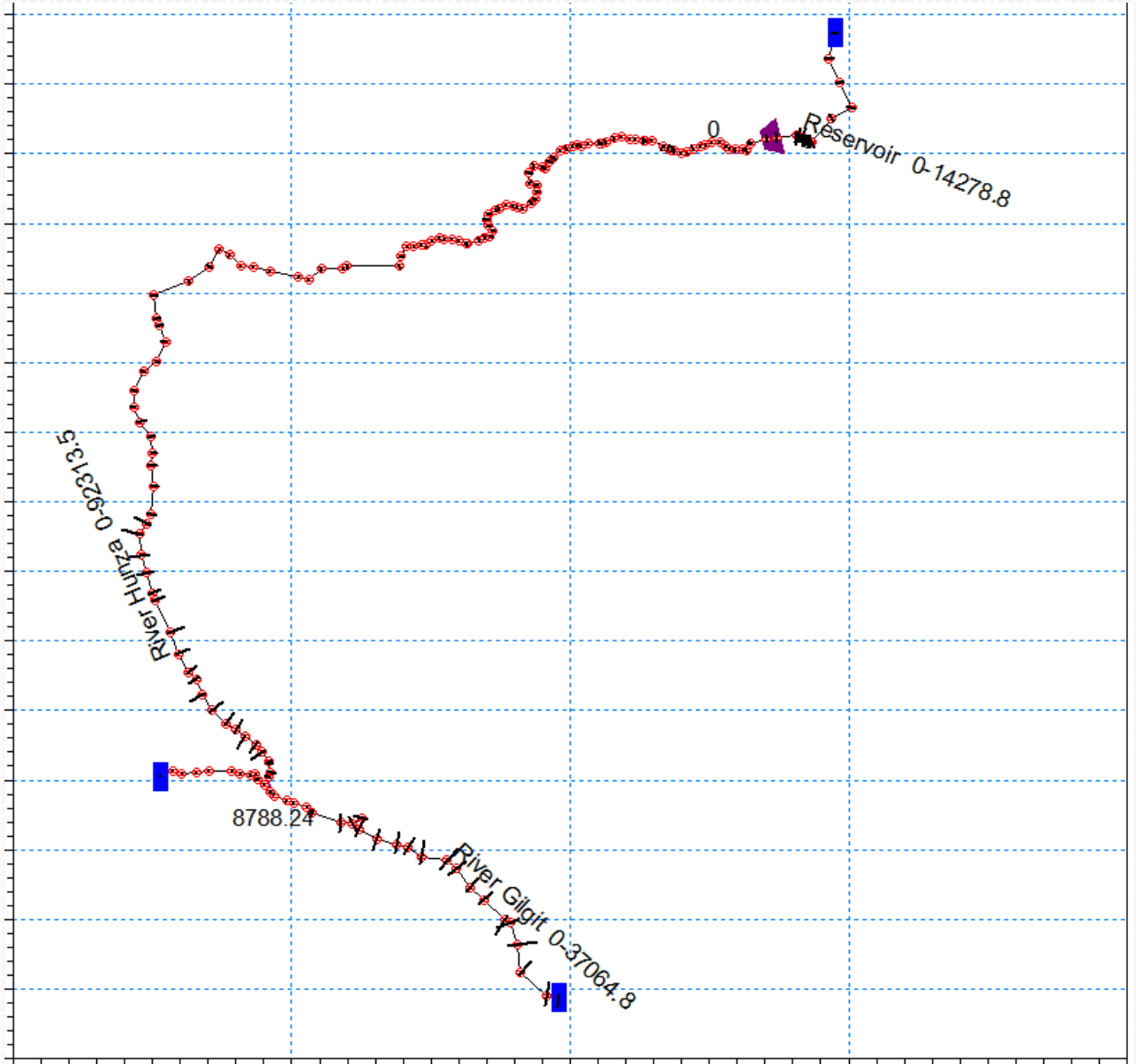
To compare the effects of scenarios of breaching section development (triangular, trapezoidal etc.) on flood wave as a consequence of dam overtopping and piping

To perform sensitivity analysis of breaching duration of dam

To predict the height and arrival time of flood wave front at Dainyor Bridge


METHODOLOGY
Data Collection and Analysis
Material properties of dam
Topographical data
Cross-sections of River
Bathymetric Survey
Hydrological Data
Routing Model Setup
River Setup
Bathymetric Survey data
Topographic Survey data
Boundary Conditions
Manning's 'n'
Initial Conditions
Calibration
At Daniyor Bridge against discharge data of 2011
Validation
At Daniyor Bridge against discharge data of 2012
Dam Breach Model Setup
Initial failure Mode
Overtopping
Piping
User defined
Failure Moment
After a specified no. of hours from start of calculation
At a specified date and time
At a particular water level
Sensitivity Analysis
By varying Initial level of breach, Initial pipe diameter, Breach side slope, Final breach width and Roughness coefficient
Dam Break Flood Prediction
Against 100 year discharge

RIVER NETWORK



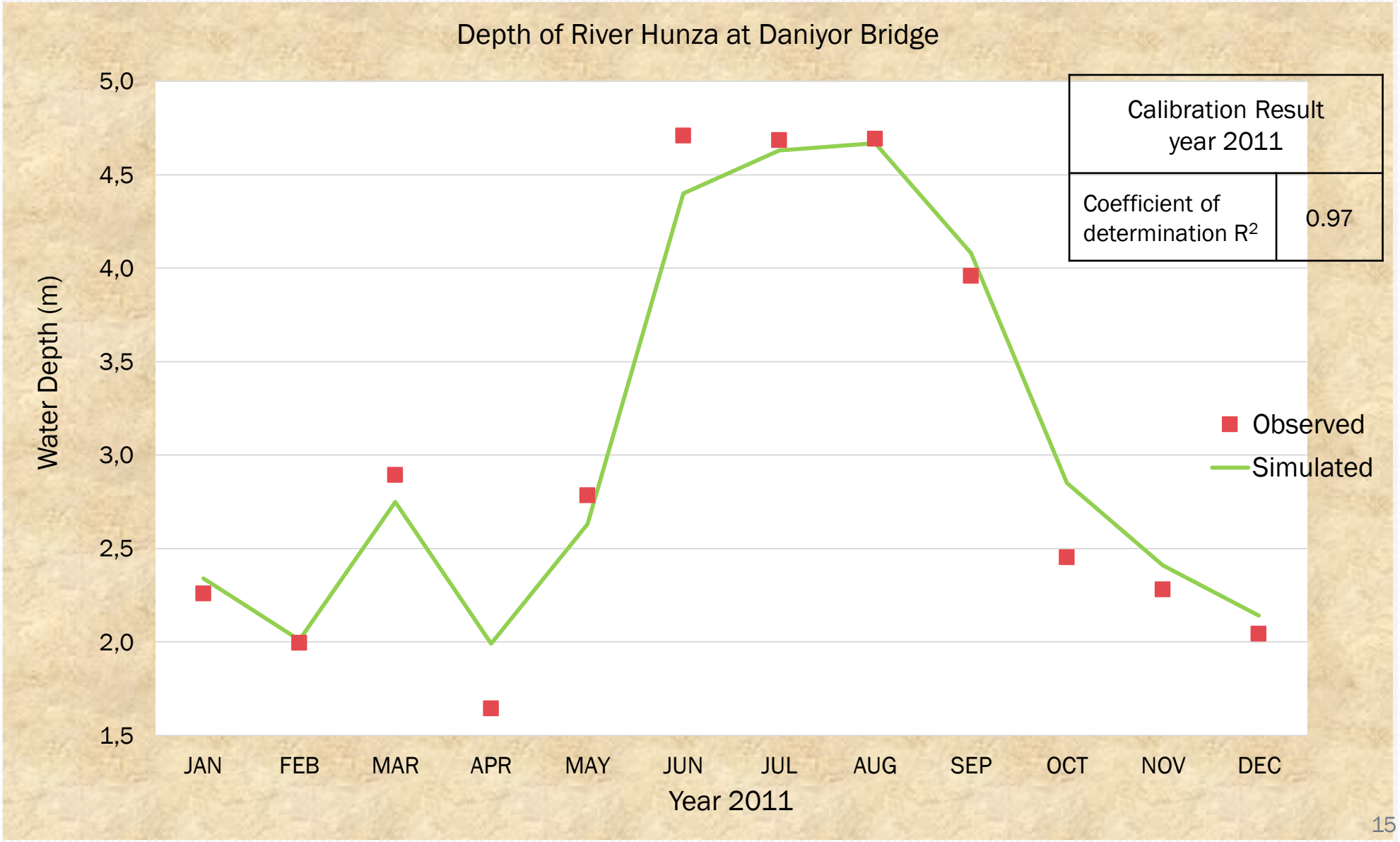
LEGEND

- Boundary Points
- Landslide Mass
- Cross sections

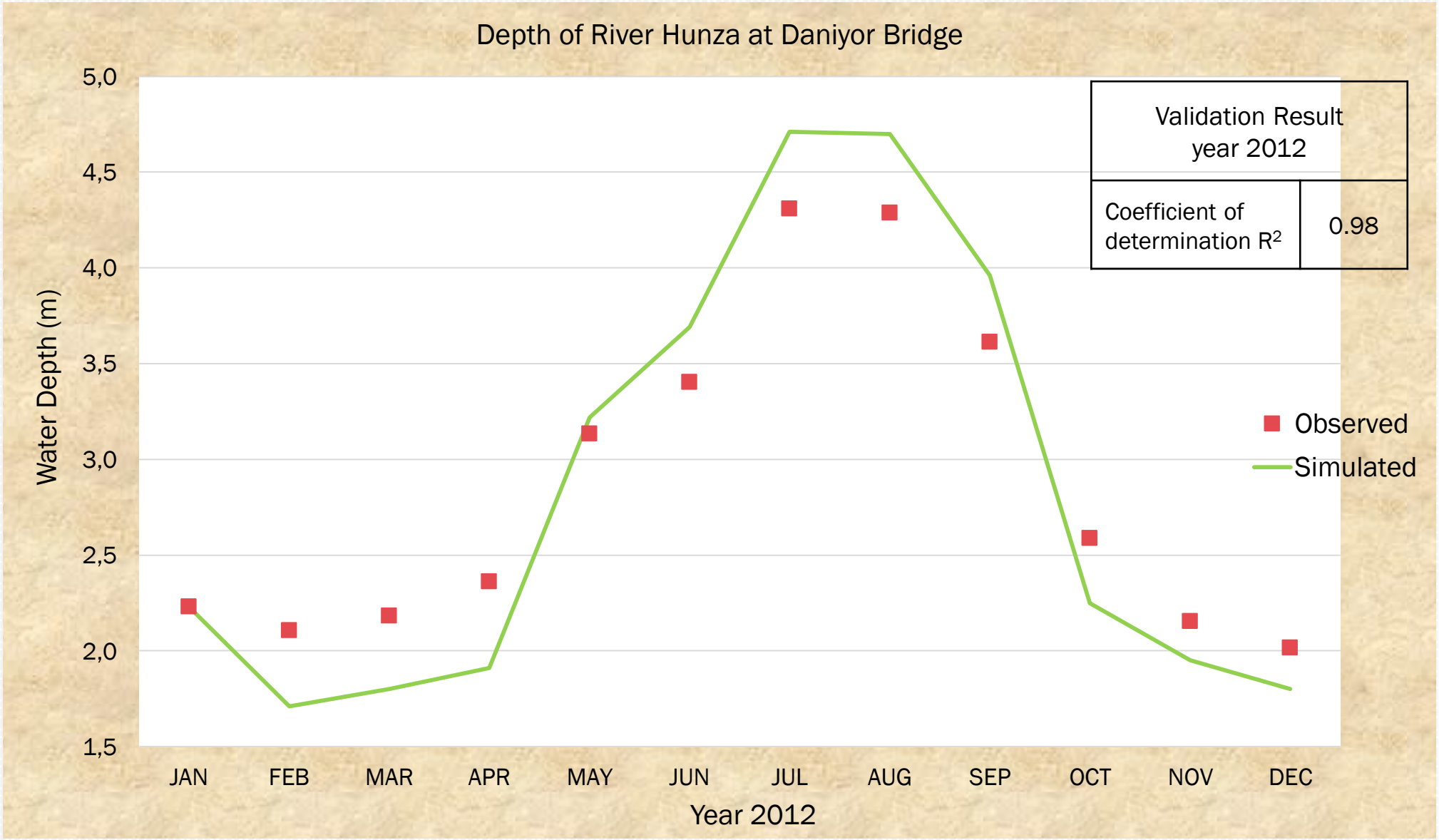
CALIBRATION AND VALIDATION

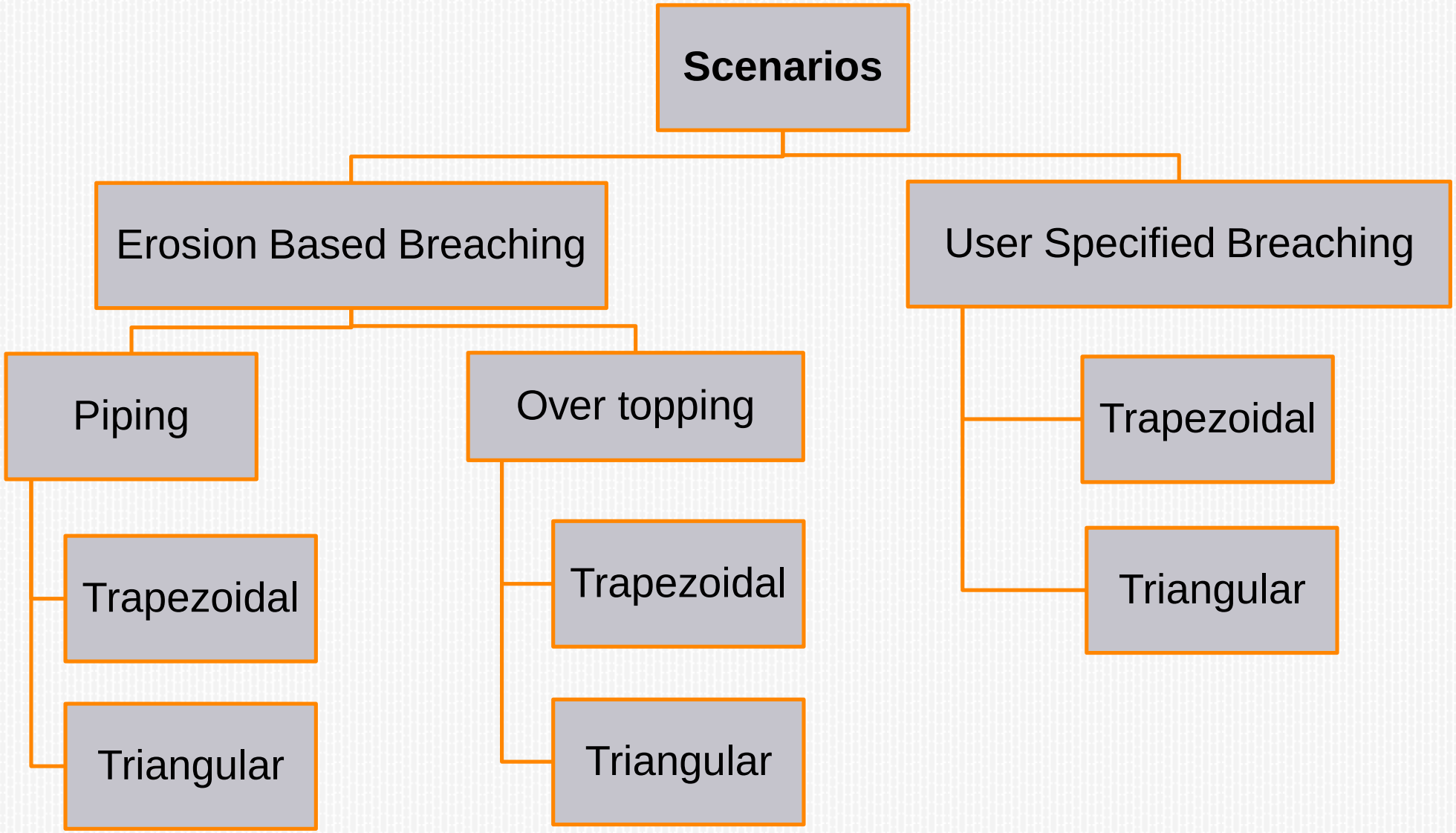
- CALIBRATION
  - U/S boundary: Inflow Hydrograph of River Hunza (2011)
  - D/S boundary: Rating curve at Alam Bridge (River Gilgit)
- VALIDATION
  - U/S boundary: Inflow Hydrograph of River Hunza (2012)
  - D/S boundary: Rating curve at Alam Bridge (River Gilgit)
- Manning's roughness coefficient 0.03 is taken (Chow, V.T.1966) which depicts that the channel is very much rough having boulders and rocks in it.

CALIBRATION RESULT



VALIDATION RESULT

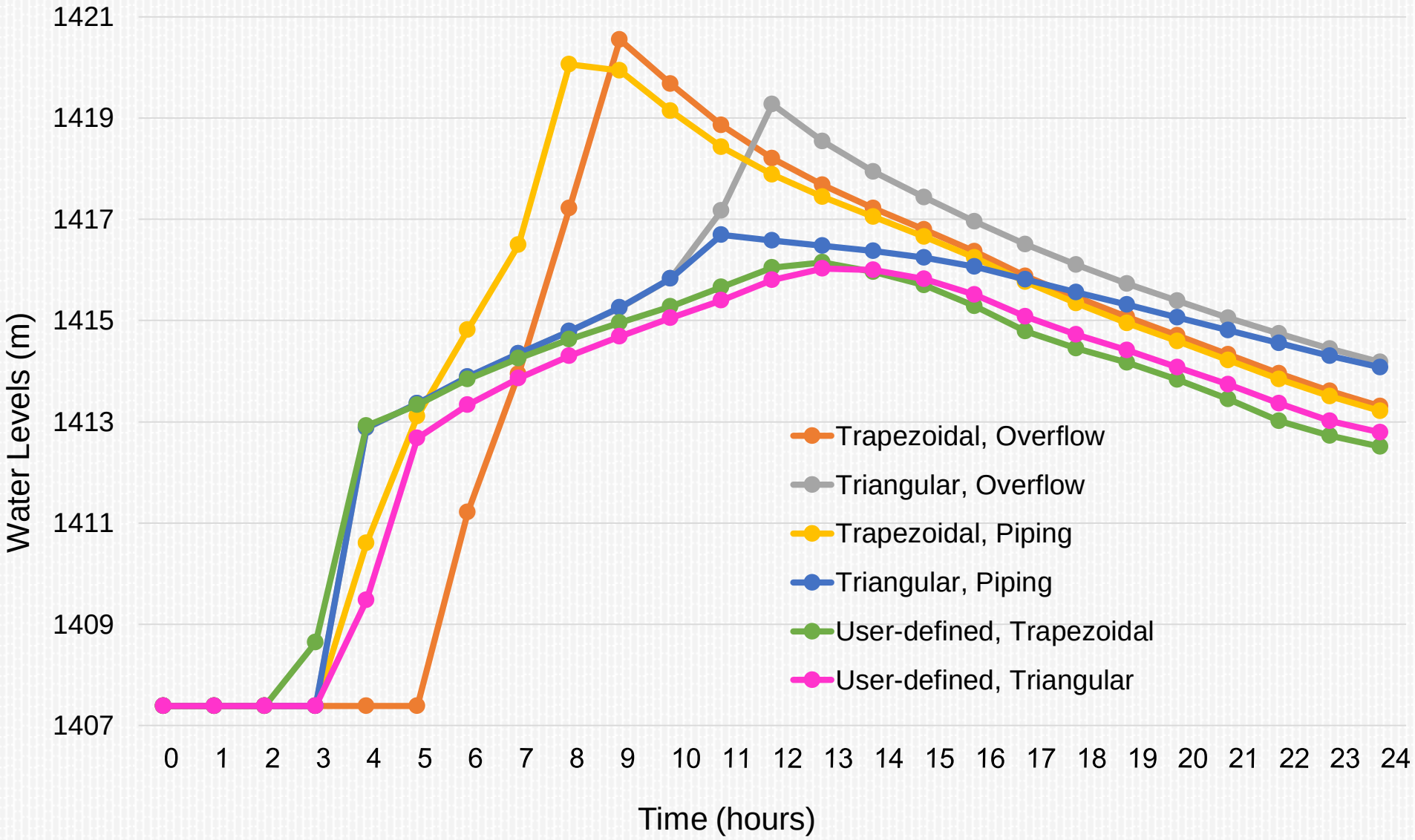



Scenarios
Erosion Based Breaching
User Specified Breaching
Piping
Over topping
Trapezoidal
Triangular
Trapezoidal
Triangular
Trapezoidal
Triangular

COMPARISON OF PEAK WATER LEVEL B/W DIFFERENT DAM-BREAK CASES

Breach Growth	Triggering	Shape of Breach	Peak Water Level at Daniyor Bridge (m, amsl)	Water Depth at Daniyor Bridge (m)	Time to peak (hrs)
Erosion	Piping	Trapezoidal	1420.06	12.67	8.0
		Triangular	1416.69	9.30	11.0
	Over-topping	Trapezoidal	1420.55	13.16	9.0
		Triangular	1419.27	11.88	12.0
User-specified		Trapezoidal	1416.15	8.76	13.0
		Triangular	1416.03	8.64	13.0

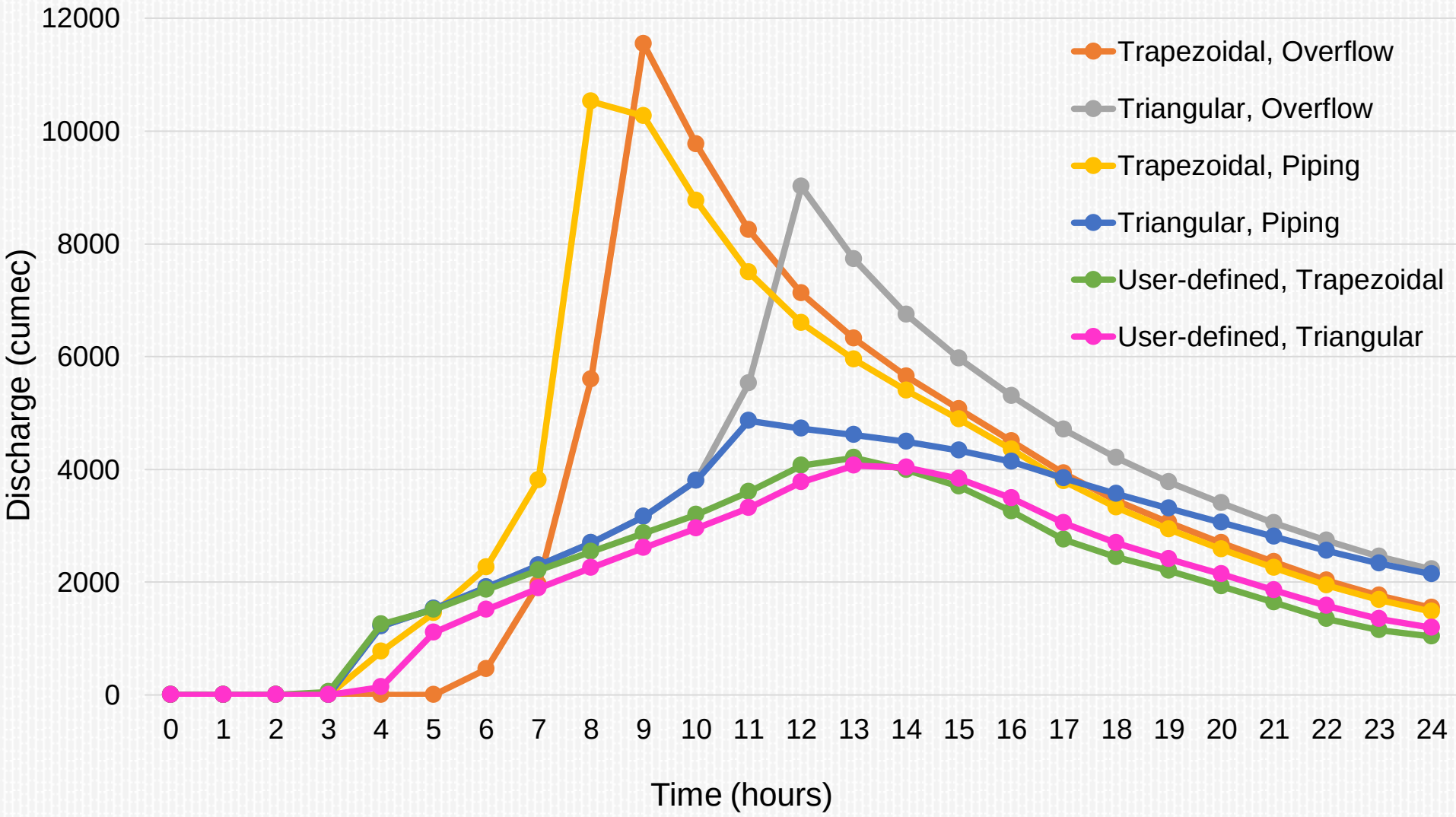
COMPARISON OF PEAK WATER LEVEL B/W DIFFERENT DAM-BREAK CASES



COMPARISON OF DISCHARGE B/W DIFFERENT DAM-BREAK CASES

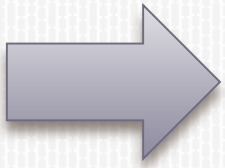
Breach Growth	Triggering	Shape of Breach	Discharge at Daniyor Bridge (cumec)	Time to peak (hrs)
Erosion	Piping	Trapezoidal	10,528	8.0
		Triangular	4,862	11.0
	Over-topping	Trapezoidal	11,545	9.0
		Triangular	9,017	12.0
User-specified		Trapezoidal	4,205	13.0
		Triangular	4,069	13.0

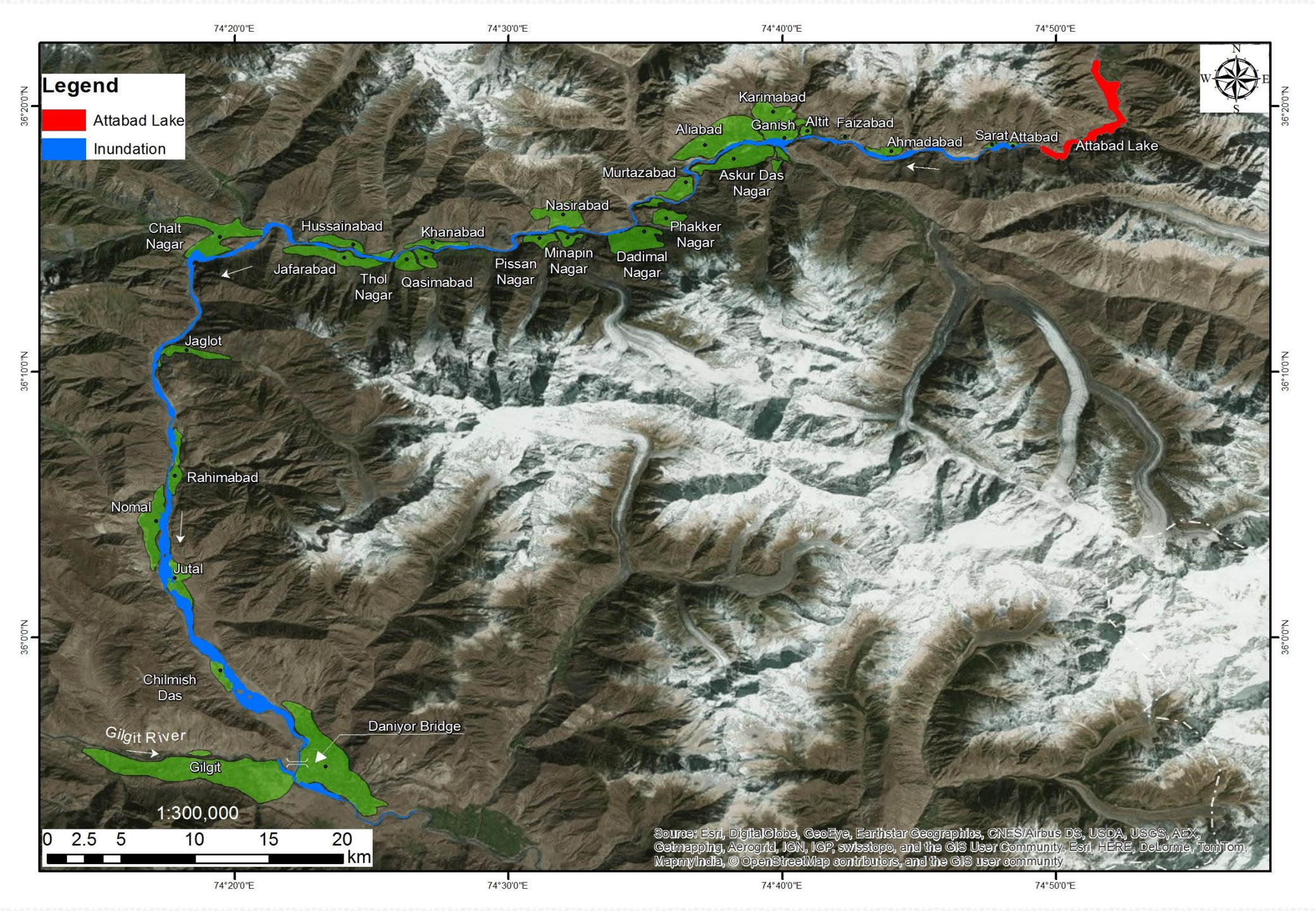
COMPARISON OF DISCHARGE B/W DIFFERENT DAM-BREAK CASES



RESULTS

- Routing of the resulting flood wave has been animated
- Flood Inundation map




Legend
Attabad Lake
Inundation
74°20'0"E
74°30'0"E
74°40'0"E
74°50'0"E
36°20'0"N
36°10'0"N
36°0'0"N
N
S
E
W
Karimabad
Aliabad
Ganish
Altit
Faizabad
Ahmadabad
Sarat
Attabad
Attabad Lake
Murtazabad
Askur Das Nagar
Nasirabad
Phakker Nagar
Chalt Nagar
Hussainabad
Khanabad
Jafarabad
Thol Nagar
Qasimabad
Pissan Nagar
Minapin Nagar
Dadimal Nagar
Jaglot
Rahimabad
Nomal
Jutal
Chilmish Das
Daniyor Bridge
Gilgit River
Gilgit
1:300,000
0 2.5 5 10 15 20
km
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

CONCLUSIONS

- Erosion based trapezoidal breach due to overtopping of the landslide mass is the ‘worst case scenario’ causing maximum flood peak of 11,545 cumec to occur at Daniyor Bridge and the depth of water to be 13m.

- Peak flow reaching Daniyor Bridge due to trapezoidal breach = 2.3 times the historic maximum flood whereas, for triangular breach it is 1.5 times the flood magnitude (i.e. 5000 cumec) which Daniyor has faced in 1967.

RECOMMENDATION

- Researchers should try to incorporate the randomness of breaching initiation in future numerical models and investigate characteristics on the initial breach in order to determine the worst case scenario of a dam breach.

THANK YOU