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on
Sustainable Development of Dams & River Basins



DAM BREACH ANALYSIS: CASE STUDY OF PHUKOT KARNALI (480 MW) HYDROELECTRIC PROJECT IN NEPAL

by

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INTRODUCTION

- Hundreds of dam failure events were reported in the past centuries and still today structures breach every year due to high water levels, often with catastrophic consequences
- But for high dams storing large amount of water results in generation of massive amount of flood wave inundating downstream reaches of dam
- This study is presented for dam breach analysis of Phukot Karnali HEP(480 MW) for preparation of inundation mapping.
- The peak outflow discharge, flow depth and travel time of peak discharge at d/s of dam and emergency action plan from the result of dam breach analysis is summarized

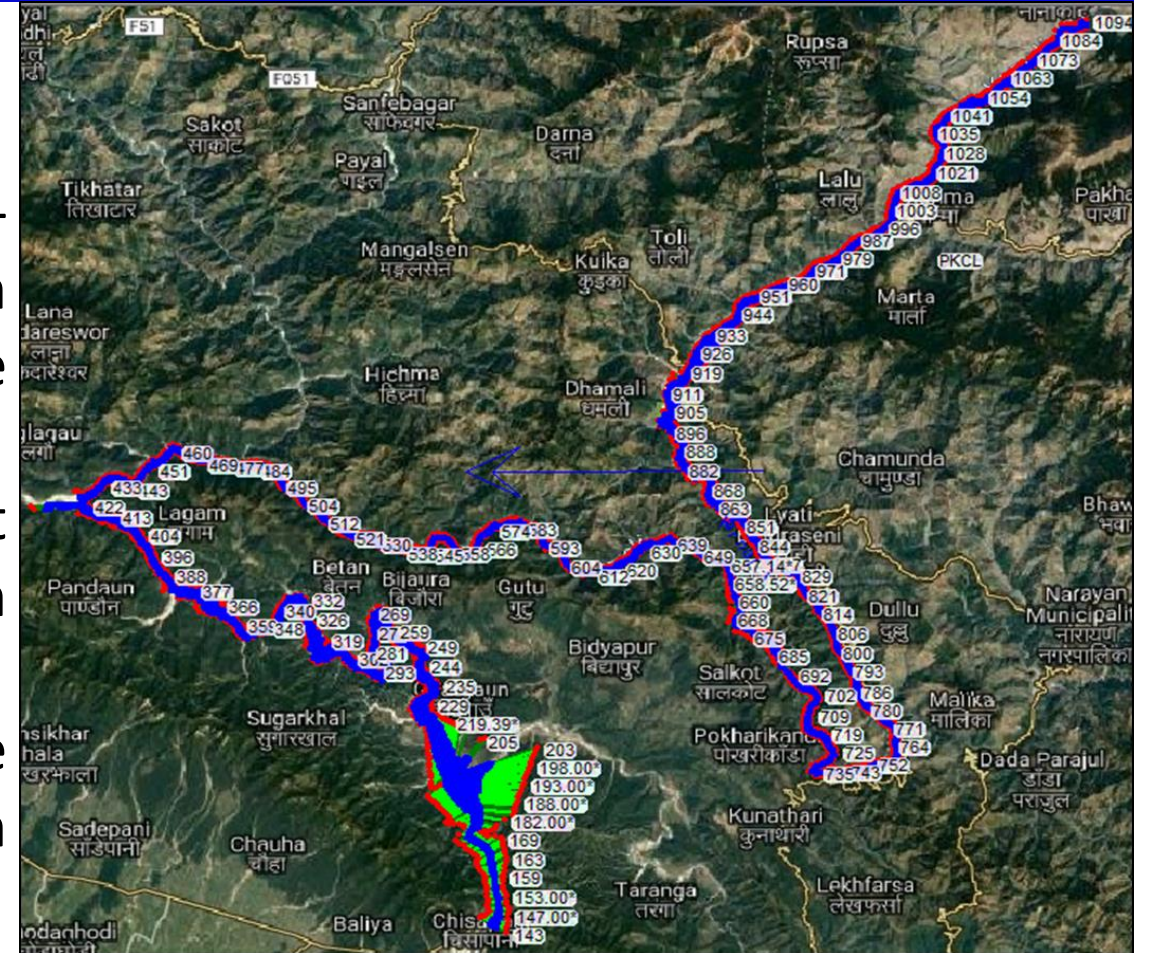


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STUDY AREA

- The Karnali River is a perennial trans-boundary river originating on the Tibetan Plateau near Lake Manasarovar and joins the Sharda River at Brahmaghat in India.
- The proposed RCC dam of PKHEP is located at $29^{\circ}12'38.40''$ N and $81^{\circ}37'25.57''$ E in western Nepal.
- The location of dam with respect to the distance from the Nepal India border at an elevation of 200 masl



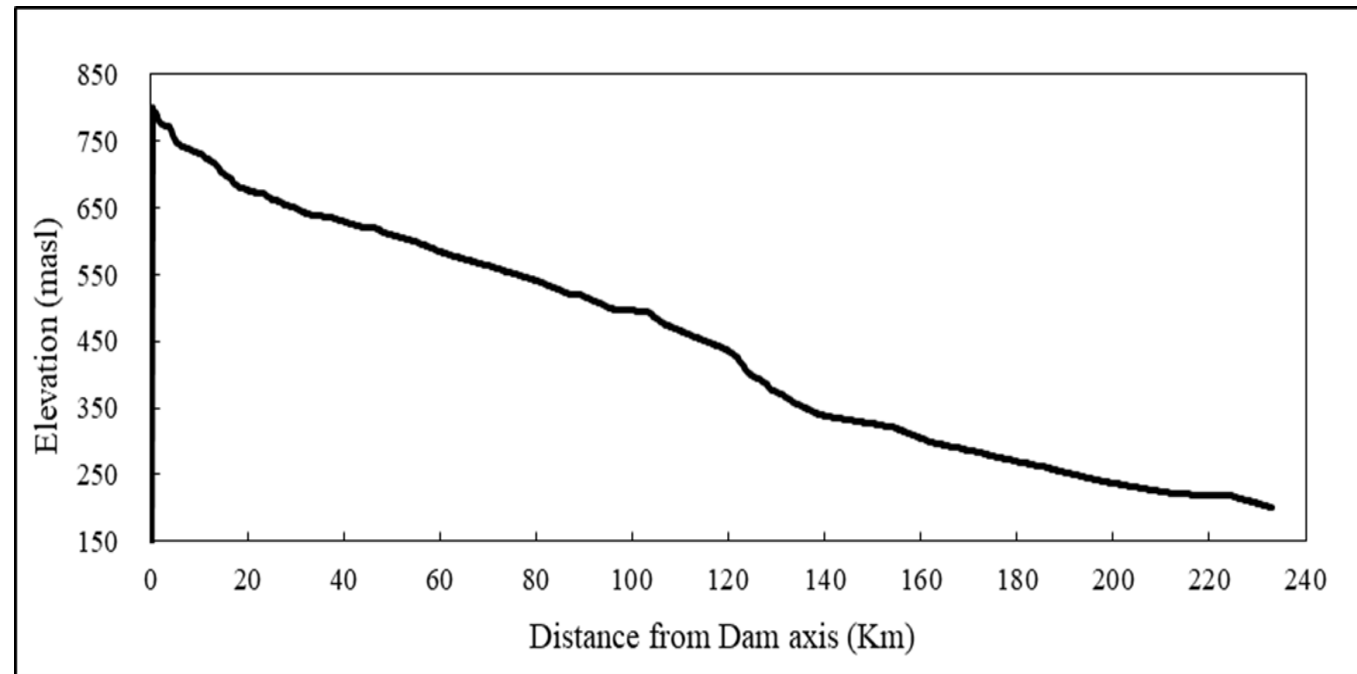


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PROJECT DESCRIPTION

- The PKHEP comprises a high concrete gravity dam with Crest elevation at 915 masl.
- 109.00 m high (from riverbed) Roller Compacted Concrete (RCC) dam live storage volume 37.00 Mm³
- Three overflow spillways and three breast wall spillways are proposed to safely spill the design flood of 15600 Cumec.



METHODOLOGY

- One dimensional Unsteady model in HECRAS
- Basic theory for dynamic routing

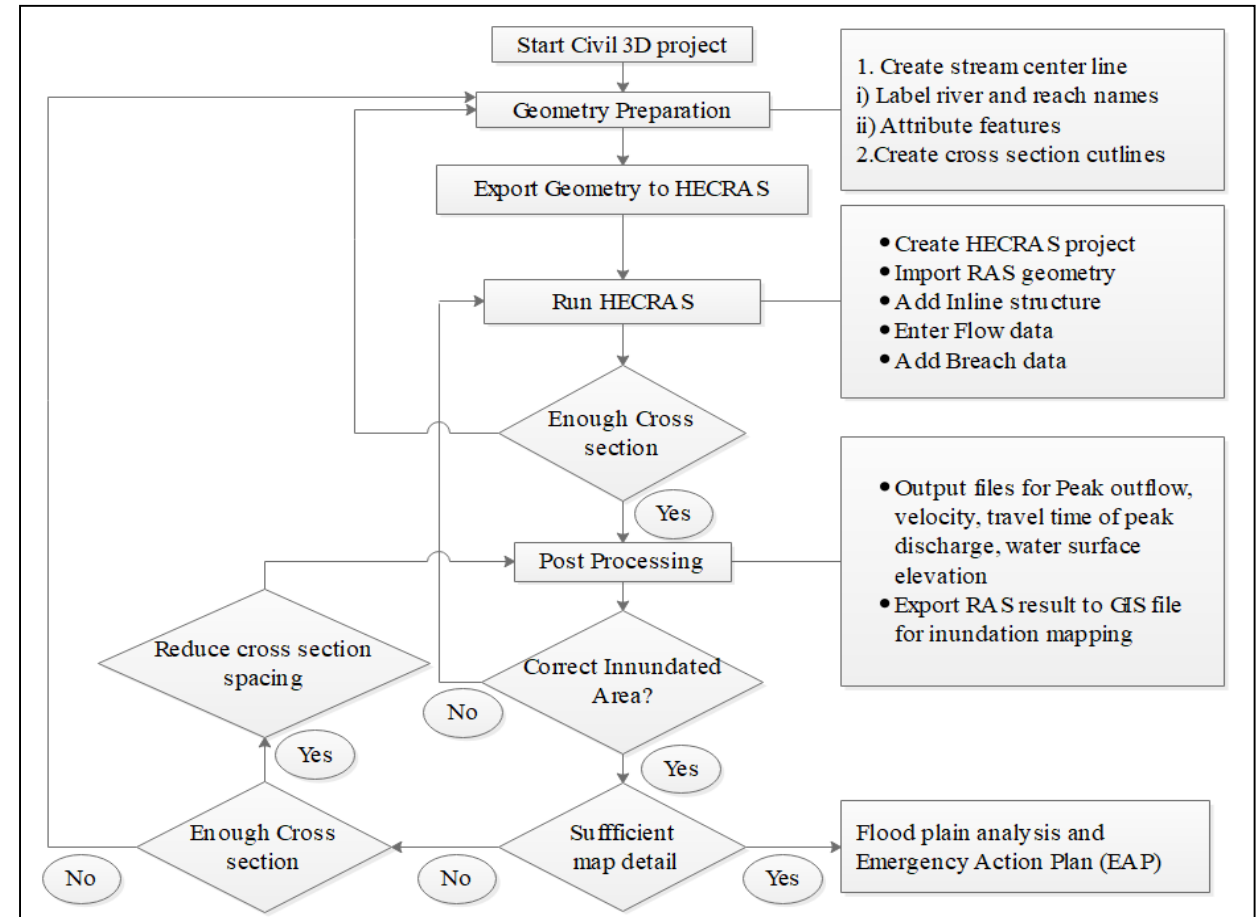
continuity equation

$$(\partial Q / \partial X) + \partial (A + A_0) / \partial t - q = 0$$

Momentum equation

$$(\partial Q / \partial t) + \{ \partial (Q^2 / A) / \partial X \} + gA$$

$$((\partial h / \partial X) + S_f + S_c) = 0$$

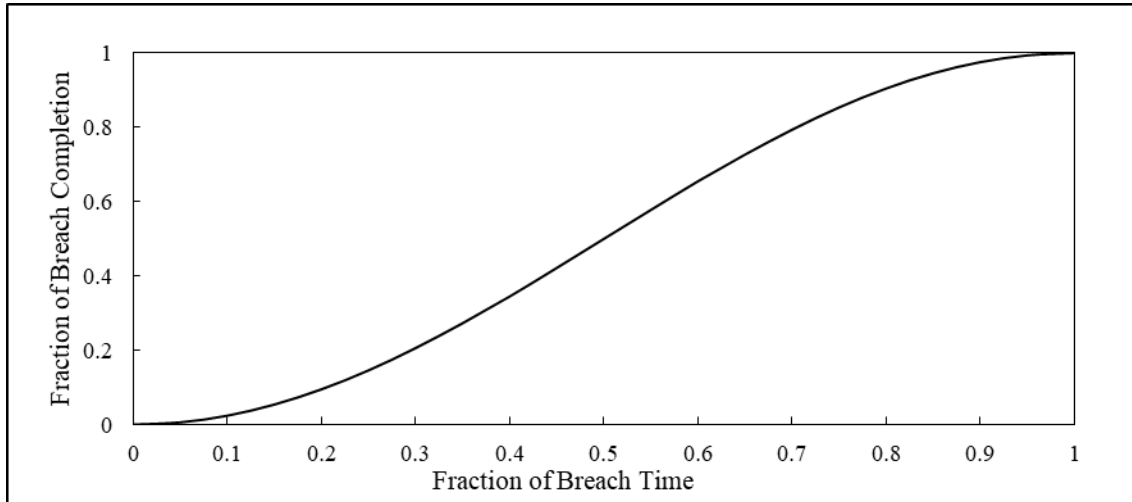




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MODEL SETUP



Breach Parameters	Complete Collapse	Partial collapse
Breach Geometry Shape	Trapezoidal	Rectangular
Final Bottom width of Breach geometry	60 m	98 m
Final Bottom elevation	805.5 m	820 m
Left Side Slope	1.35 H: 1V	0
Right Side Slope	0.66 H: 1V	0
Breach Formation time	0.25 hr	0.20 hr
Failure mode	Overtopping	Overtopping
Breach Progression type	Non-Linear	Non-Linear

- Geometry: 250 m intervals cross section data
- Inflow: Probable maximum Flood 15600 Cumecs
- D/s distance from dam axis: 232.95 KM

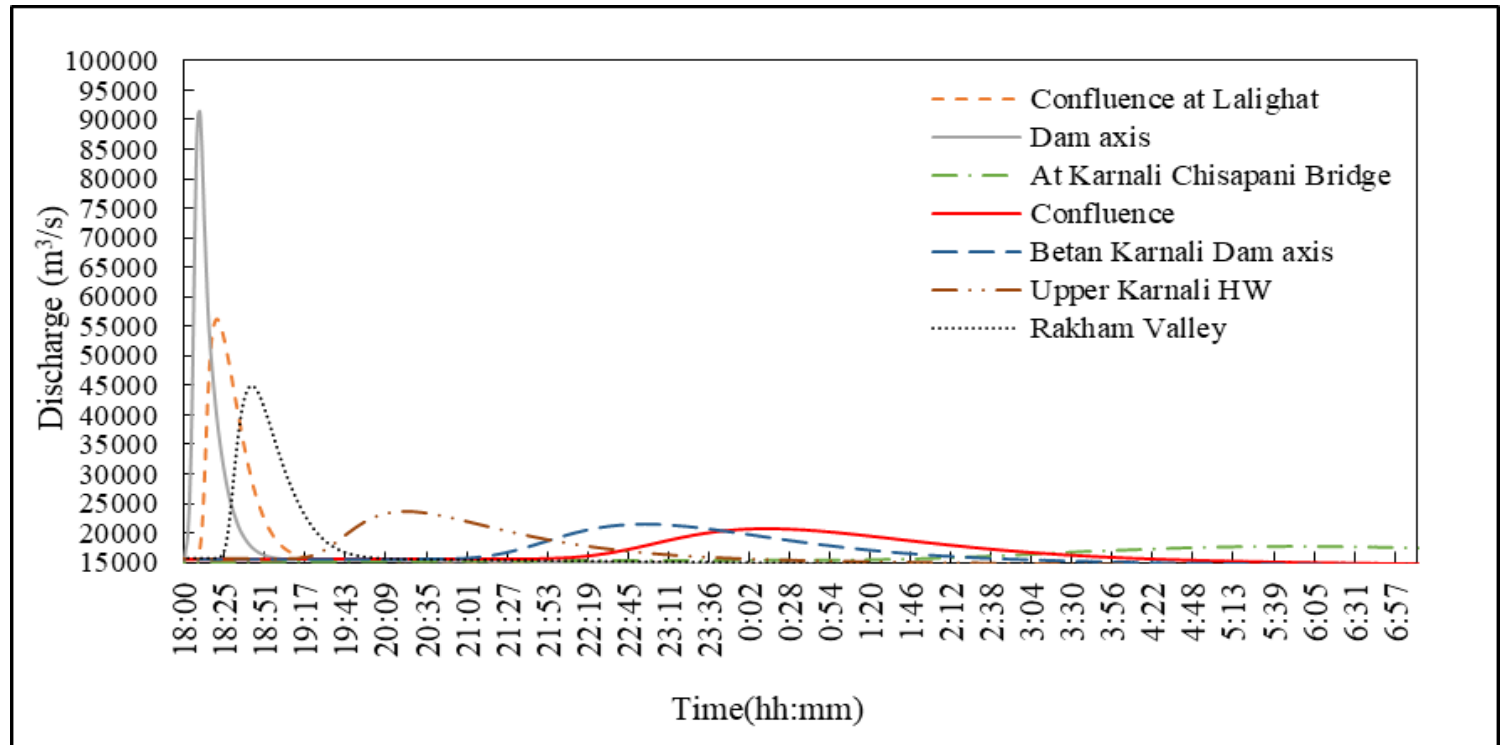


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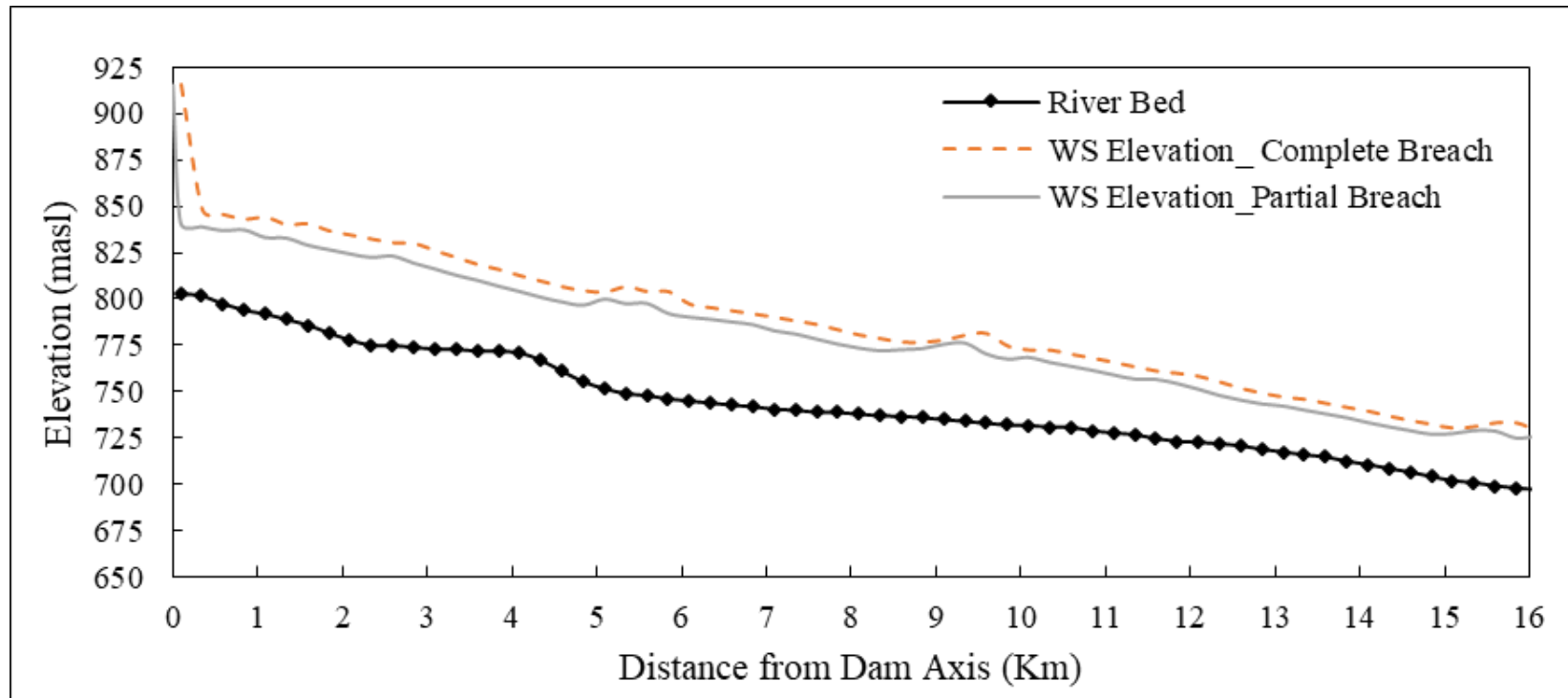
RESULTS AND DISCUSSION

- Maximum WSL at time of dam breach : 915.43 m
- Peak Discharge at dam: 91418.15 Cumecs
- Maximum velocity at 0.2 KM from dam axis: 11.71 m/s
- Peak Flood Travel time at most d/s: 16.8 hr



Peak flood hydrograph for complete collapse of dam

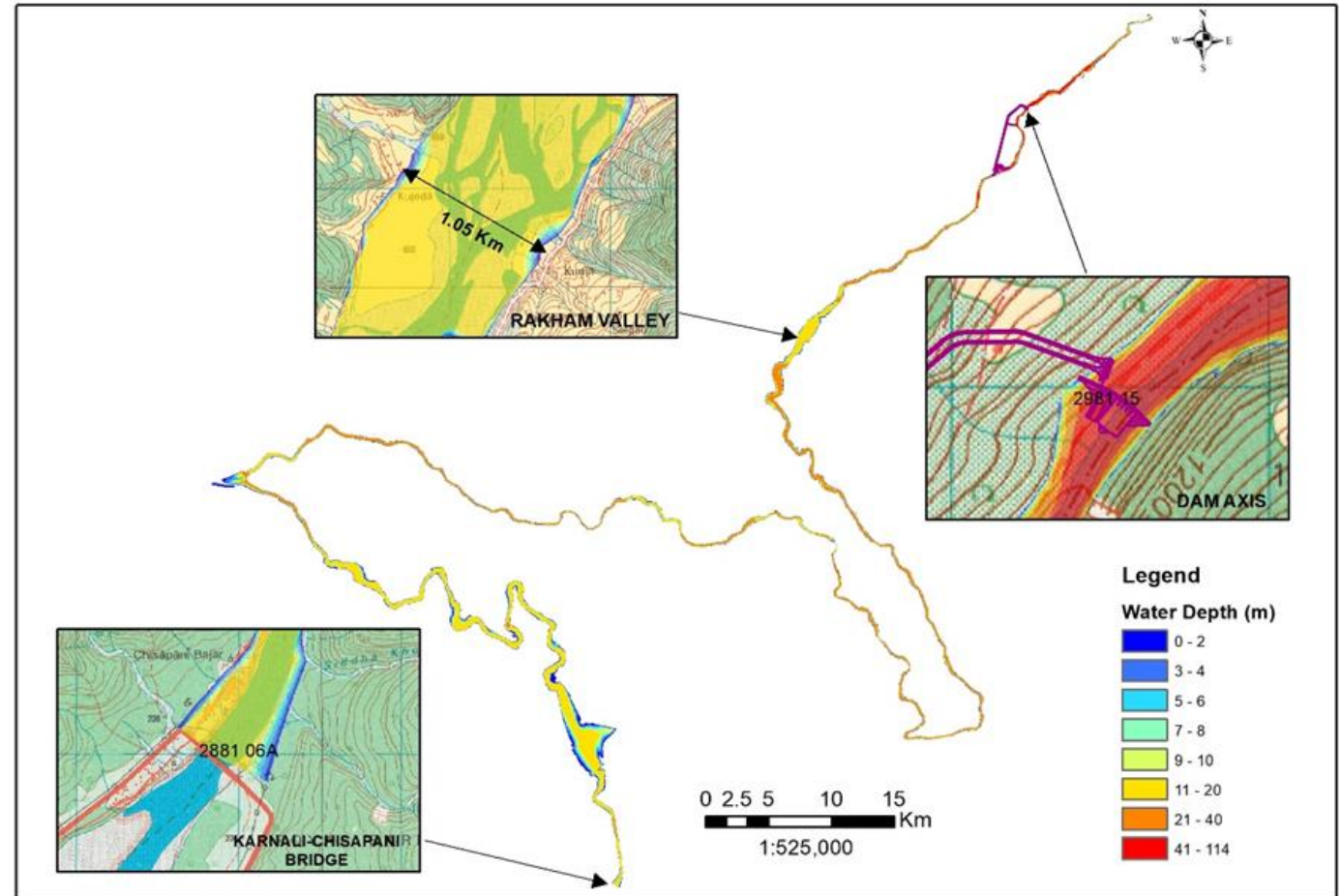
RESULTS AND DISCUSSION (contd..)



Comparison of Complete and partial collapse of dam

INUNDATION MAPPING

- For complete collapse of dam body during PMF event
- Major impact area at Rakham valley, Top width = 1.05 KM
- Karnali Chispani Bridge, at 232.95 KM from dam axis, Flow depth =10.5 m (Danger level according to Department of Hydrology, Nepal)





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EMERGENCY ACTION PLAN

- Indirect impacts from the dam breach are complex and hardly quantifiable
- The local economic activities will be interrupted or drastically slowed down
- The early warning system can be planned from the obtained result and flood inundation mapping to minimize the downstream impacts
- Further study should be carried to access the safest place near the urban area to relief from immediate impact
- The hospitals and public services infrastructure such as schools, fire stations, police and military barracks should be located in safe areas in order to allow mobilization and quick implementation of the emergency plan.



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CONCLUSION

- Details of the water surface elevations, discharges, time reach for peak discharges and flow velocities at different locations of 232.95 KM d/s area has been extracted
- Most of the valleys along the Karnali River at the d/s of the PKHEP dam will be severely affected
- Emergency action plans are briefly summarized
- The major human settlement at Rakham valley need to be evacuated where the peak flood will arrived within 50 minutes of dam breach



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