INCOLD
Indian National Committee on Large Dams

INTERNATIONAL DAM SAFETY CONFERENCE

Dam Rehabilitation & Improvement Project

Central Water Commission

Probabilistic Dam Breach Modelling of Mahi Bajaj Sagar Dam using Monte Carlo Simulation Technique

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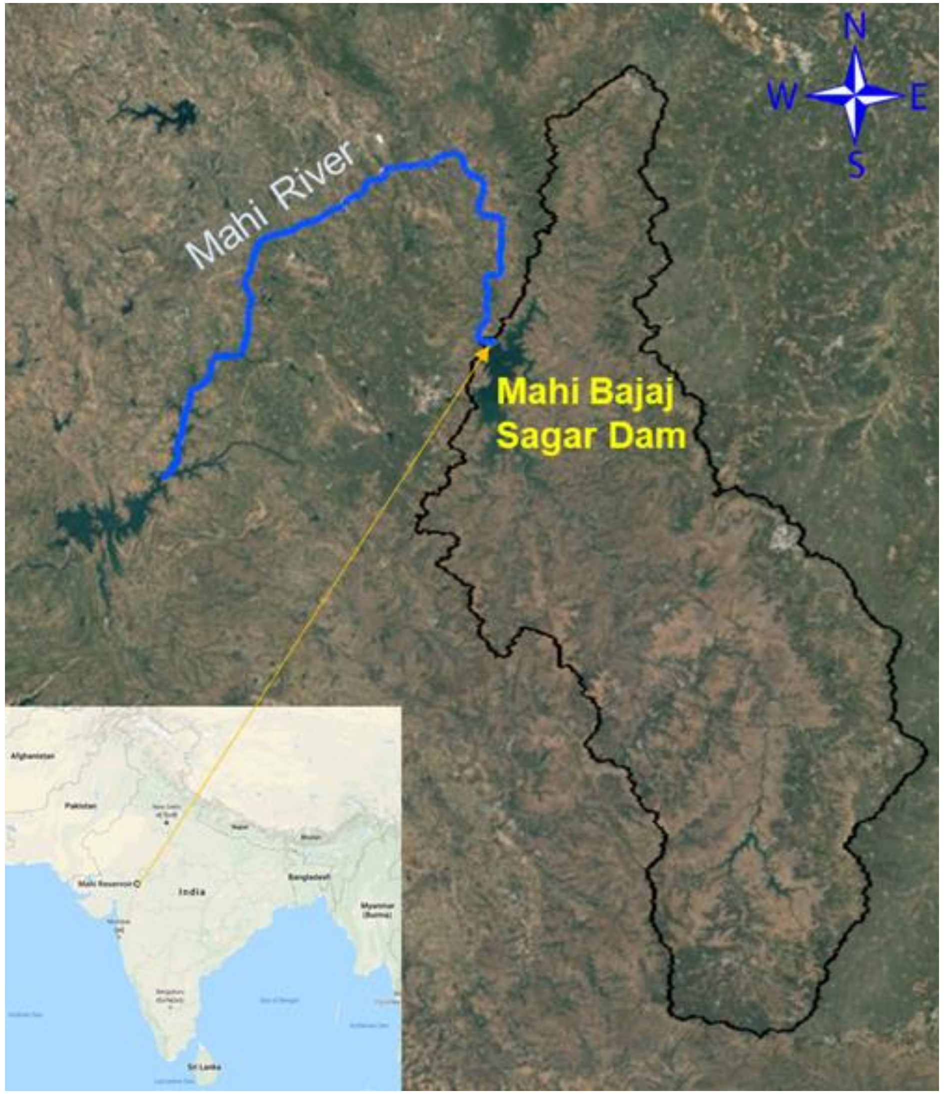
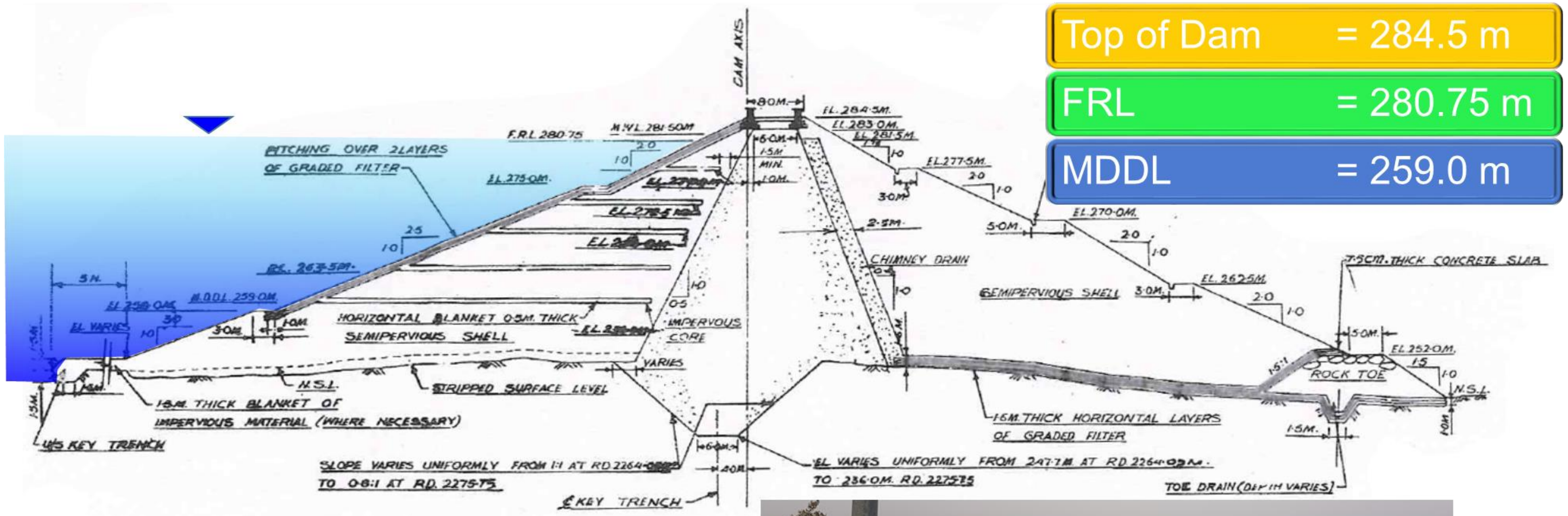
Study Area

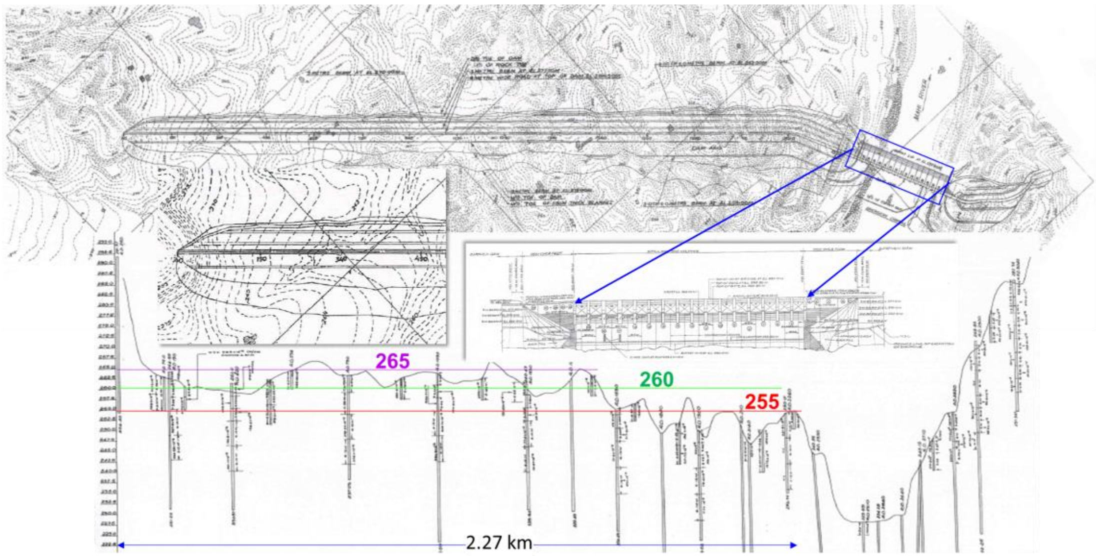
River	Mahi river
Catchment Area	6149 km^2
Type of dam	Earthen cum Masonry Dam
Length of dam	3109 m (435 m masonry & 2674 m embankment)
Top elevation	284.50 m
Height of dam above lowest river bed level	43 m
Lowest river bed level	241.50 m
Maximum water level	281.50 m
MDDL	259 m
Live storage	1833.56 MCM
Gross storage	2180.40 MCM



Data

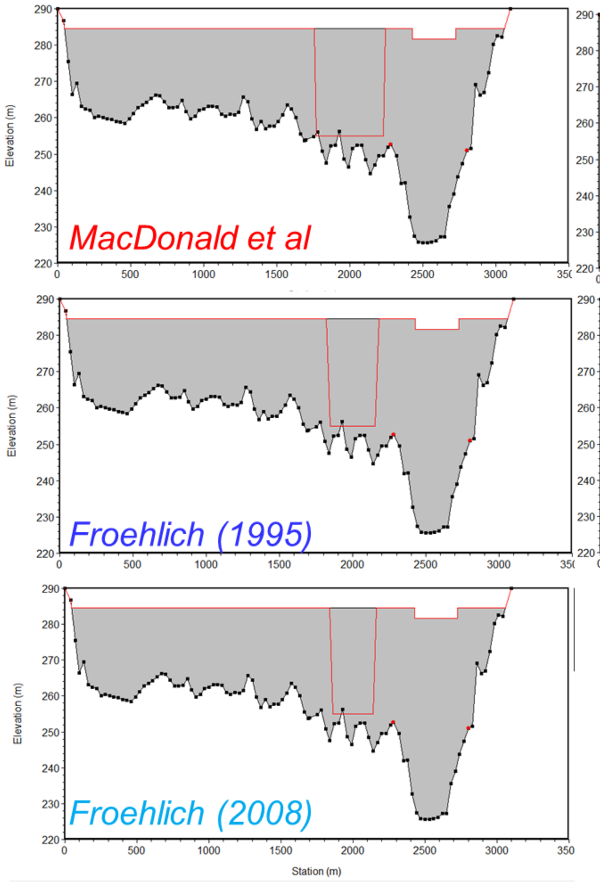


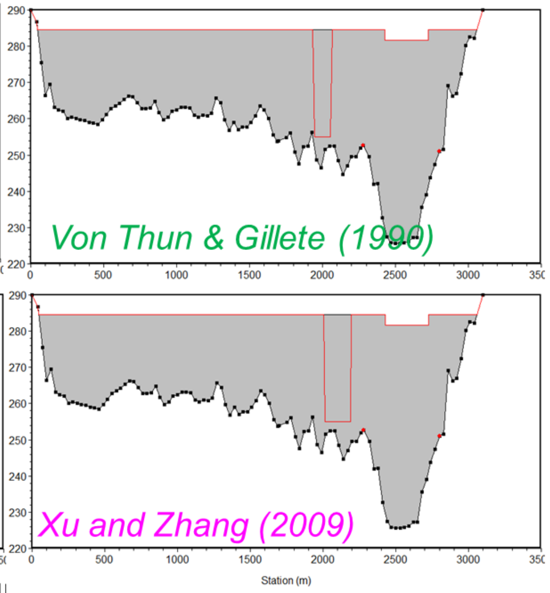
Top of Dam	= 284.5 m
FRL	= 280.75 m
MDDL	= 259.0 m



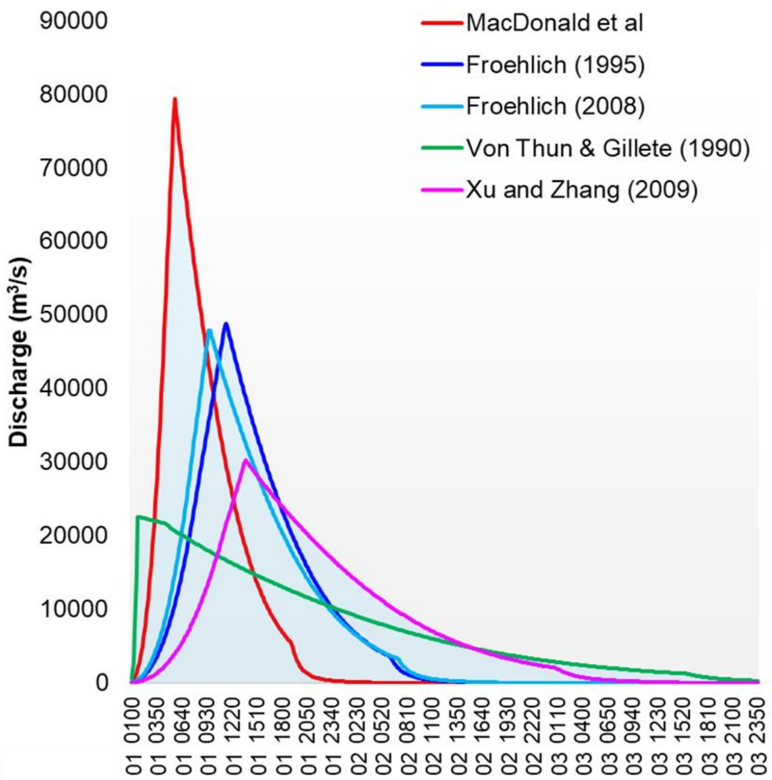
Lowest river bed level	= 220 m
Deepest foundation level	= 210 m
Height of dam	= 60 m
Top width of dam	= 8.0 m

Dam Breach Outflow

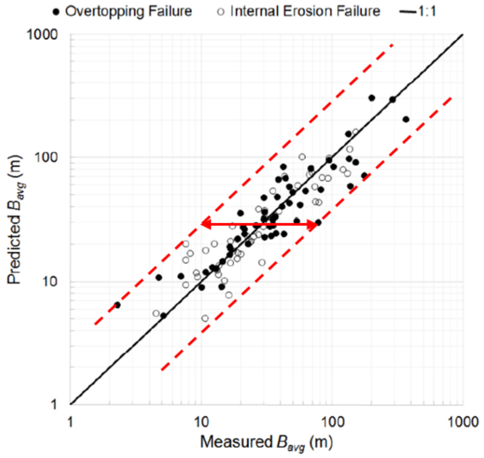




Method	Breach Bottom Width (m)	Side Slopes (H:V)	Breach Development Time (hrs)
MacDonald et al	461	0.5	4.96
Froehlich (1995)	307	0.9	10.75
Froehlich (2008)	280	0.7	8.87
Von Thun & Gillete	106	0.5	0.78
Xu & Zhang	174	0.26	12.97 *



Breach Parameters



$$\hat{B}_{avg} = 0.23 \times k_M \times V_W^{1/3}$$

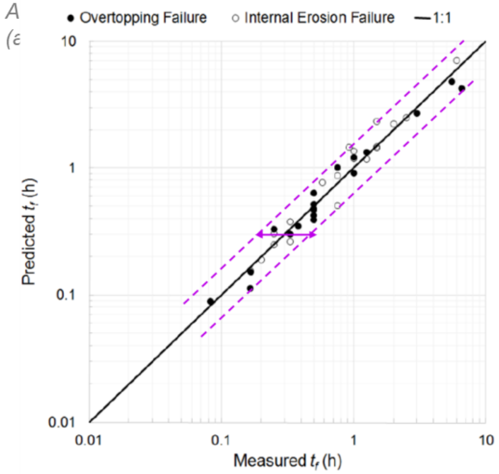
$R^2 = 0.82$; $SE = 0.407$

$$k_M = \begin{cases} 1.0, \text{ for internal erosion failures} \\ 1.5, \text{ for overtopping failures} \end{cases}$$

V_W = Volume of water above breach bottom in cubic meters (m^3)

$$\hat{B}_{avg} = 0.28 \times k_M \times k_H \times V_w^{1/3} \times W_{avg}^{-1/6} \times H_b^{1/6}$$

$R^2 = 0.838$; $SE = 0.391$



Breach Formation Time: measured and predicted (adopted from Froehlich, 2016)

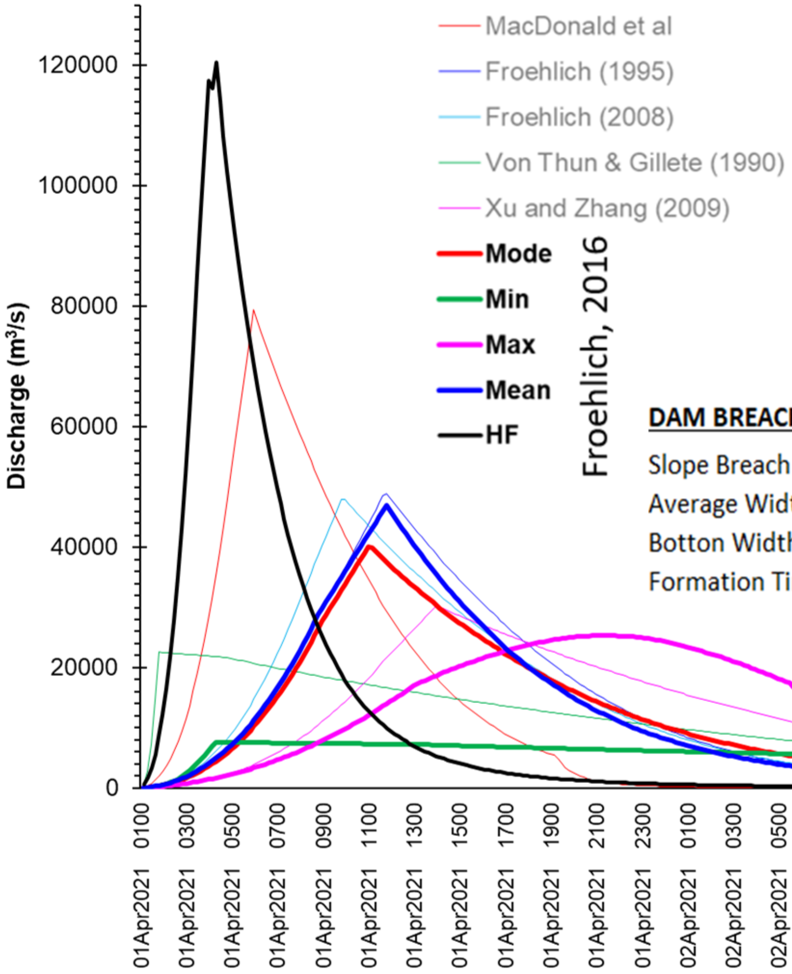
$$\hat{t}_f = 50 \times \sqrt{\frac{V_w}{gH_b^2}} \times \left(\frac{W_{avg}}{H_b}\right)^{1/4}$$

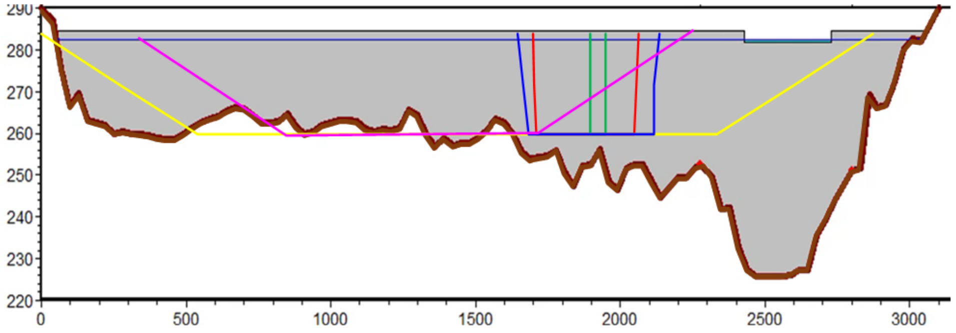
$R^2 = 0.959$; $SE = 0.21$

$$\hat{t}_f = 60 \times \sqrt{\frac{V_w}{gH_b^2}}$$

$R^2 = 0.654$; $SE = 0.22$

Breach Parameters

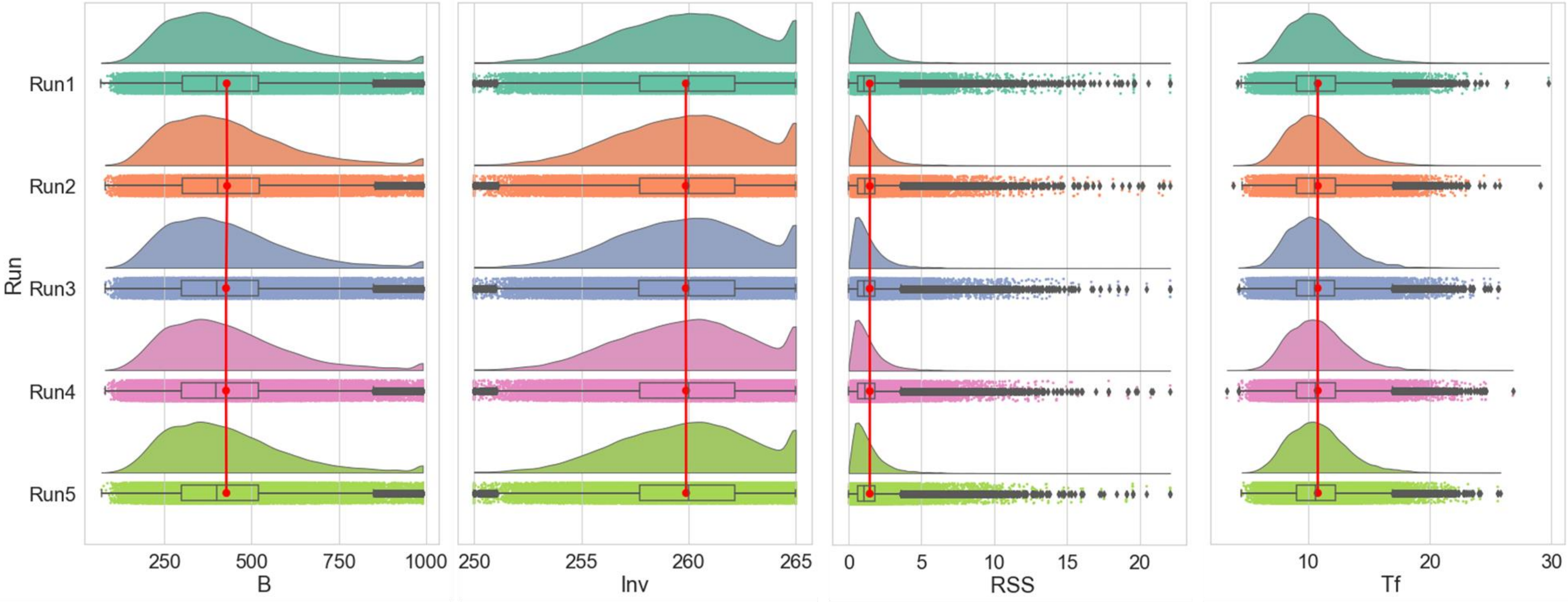




DAM BREACH PARAMETERS		Mode (most likely)	Min.	Max.	Mean
Slope Breach	z	0.6	0.02	22.07	1.49
Average Width (m)	Baveg	354	54	2336	453
Botton Width (m)	Bbotton	339	53	1795	434
Formation Time (h)	Tf	10.04	3.26	30.91	10.82

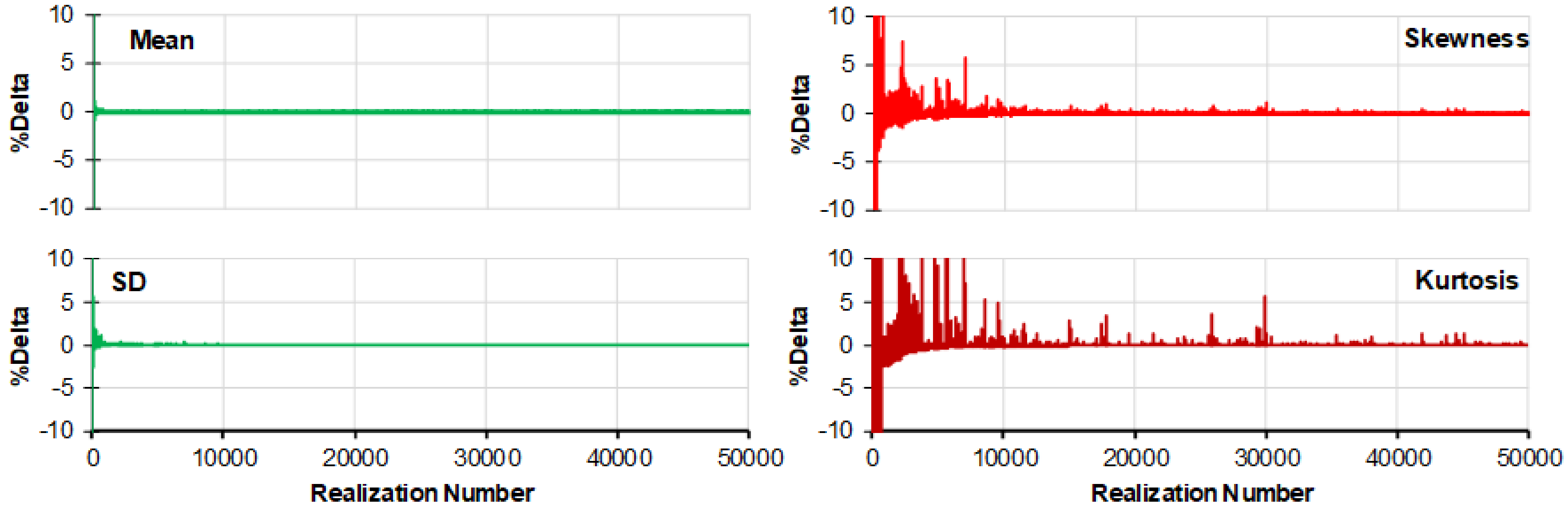
Breach Parameters: Probabilistic

 # Realizations = 50,000



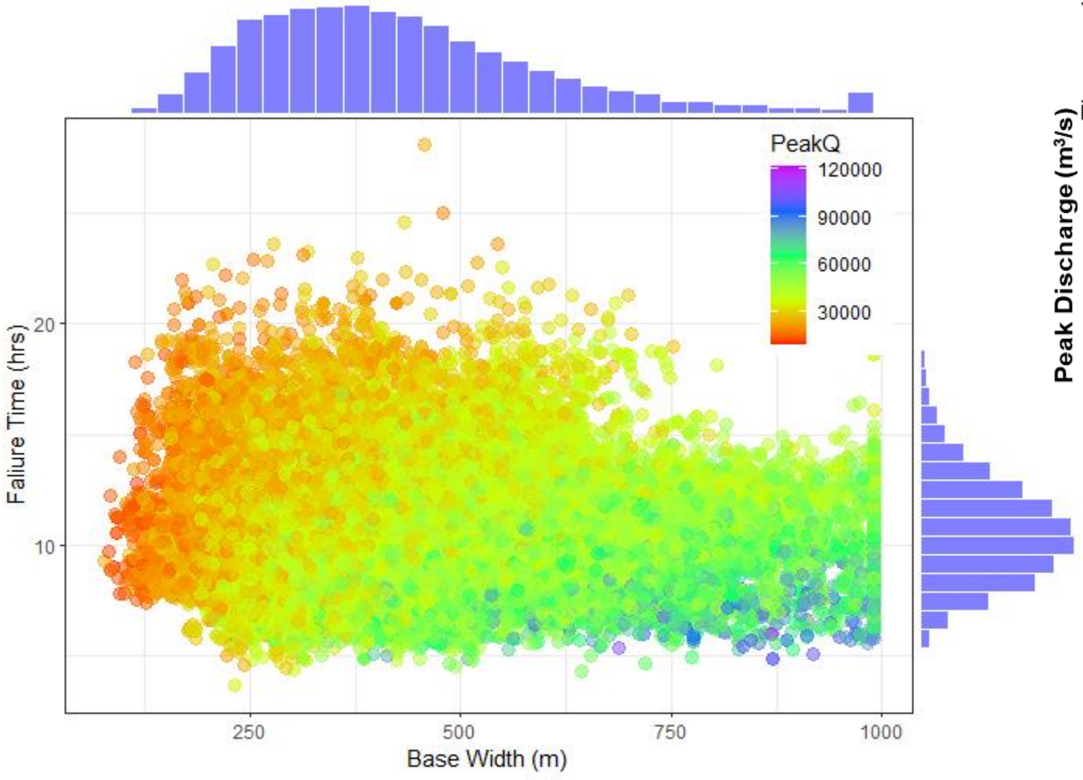
Bottom Width, m | **Invert El., m** | **Right Side Slope , m/m** | **Formation Time, hr**

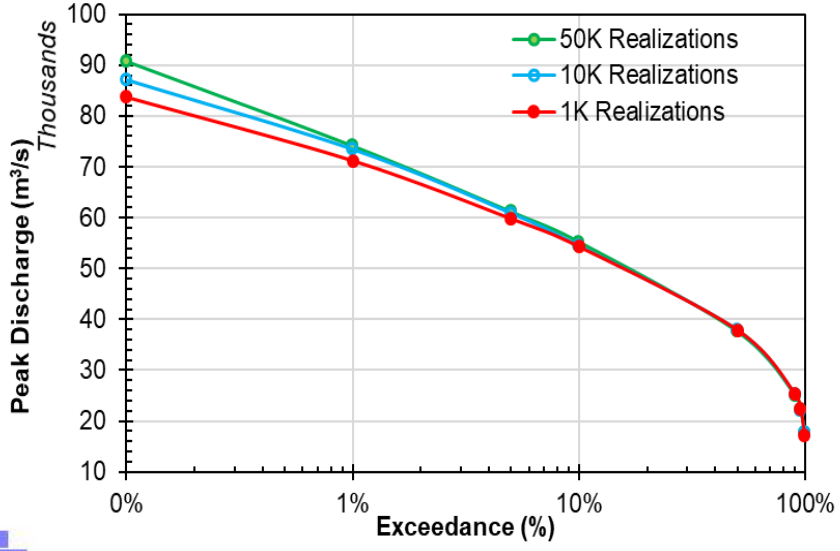
Breach Parameters: Probabilistic



Convergence of statistical moments

Probabilistic Beach Outflow

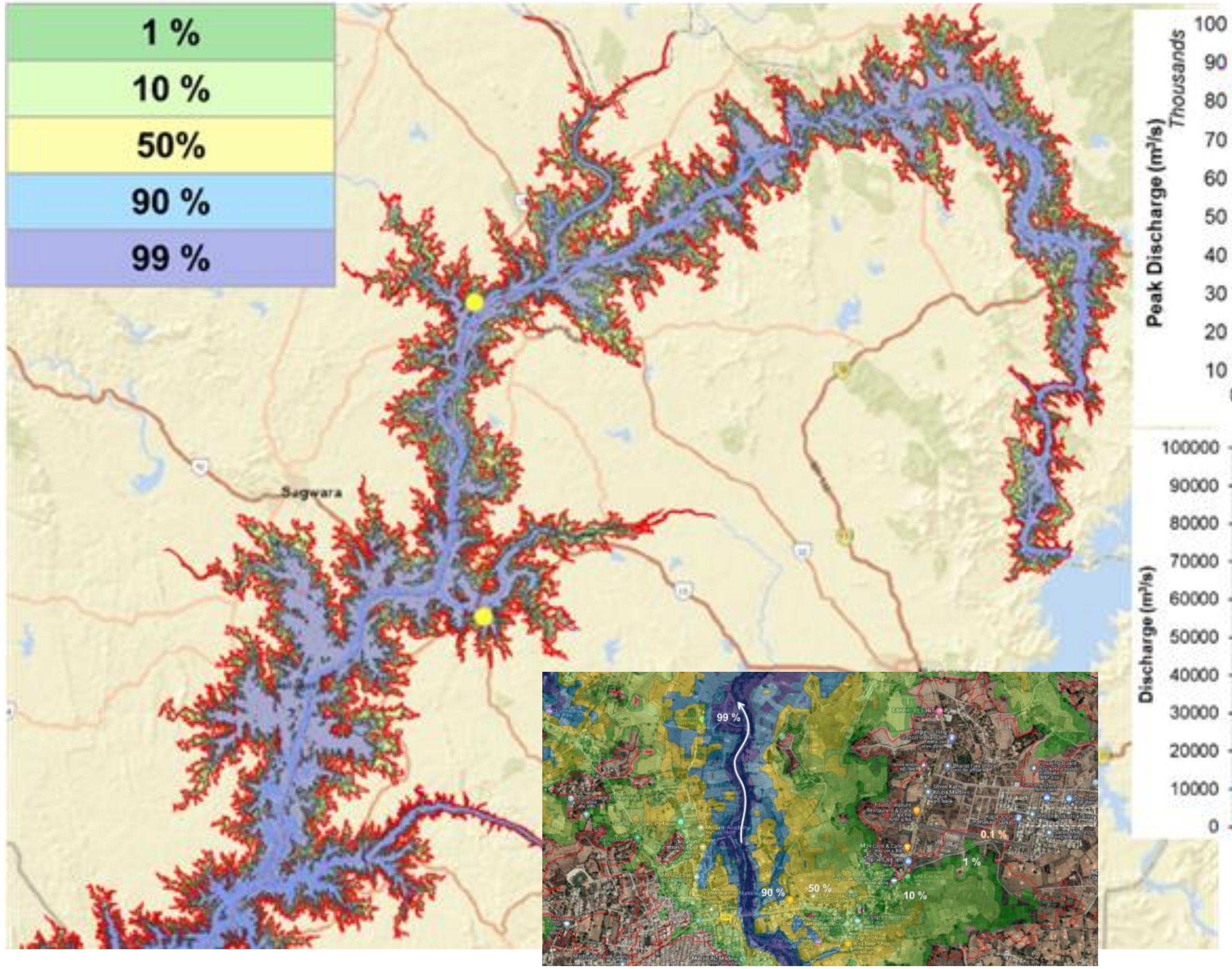


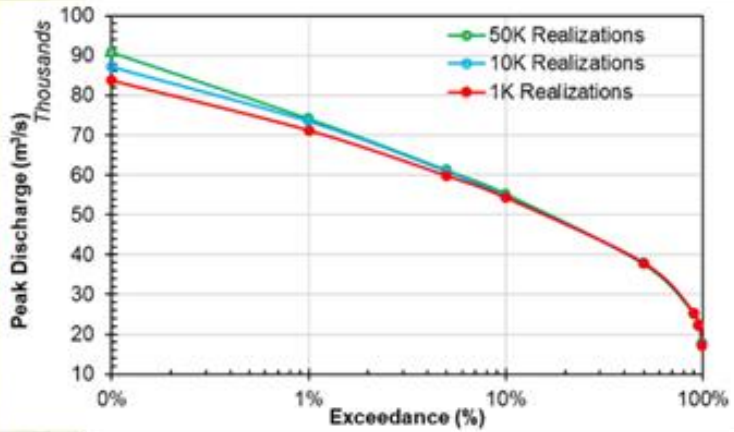


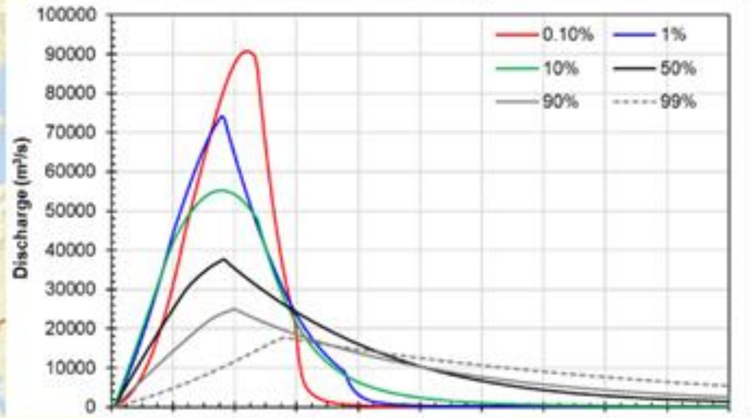
Exceedance probability

	0.1%	1%	5%	10%	50%	90%	95%	99%
Peak Discharge, m^3/s	**90,753**	**74,100**	**61,183**	**55,221**	**37,612**	**25,072**	**22,286**	**17,791**

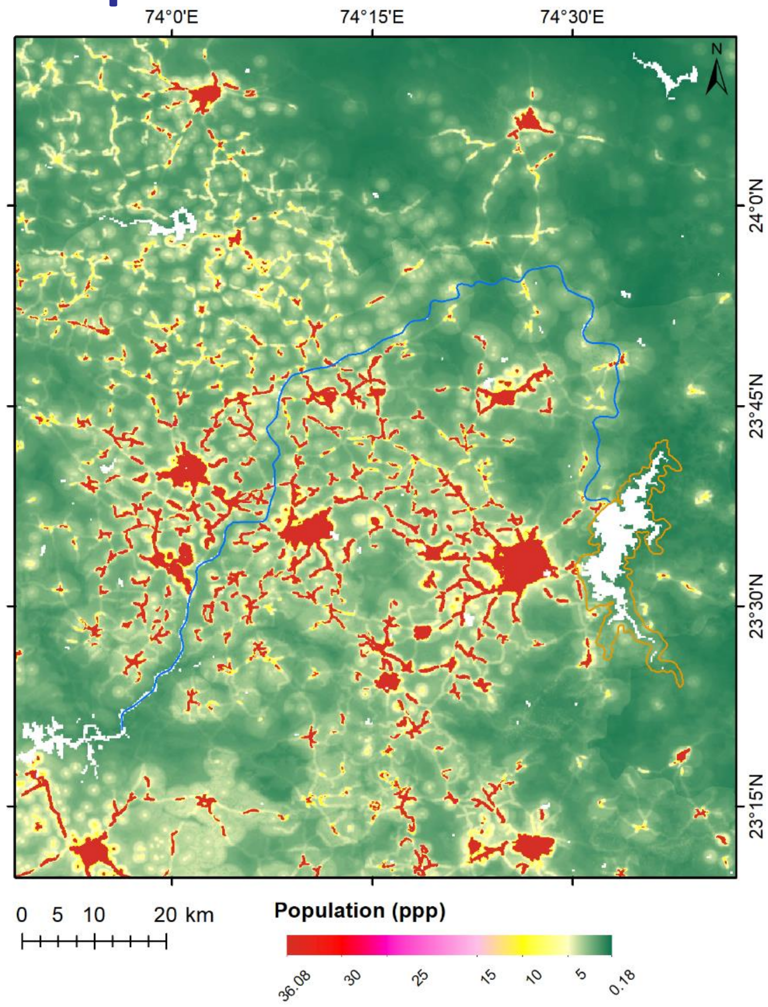
Exceedance Probability Inundation (EPI) maps

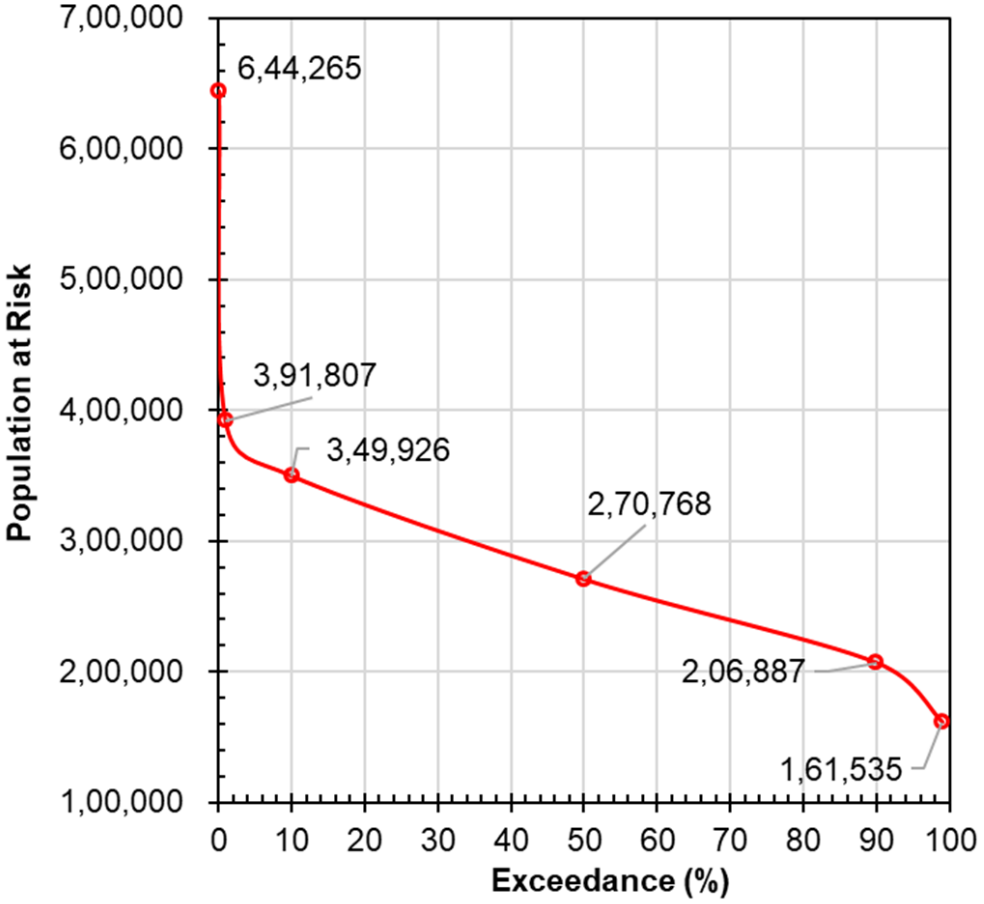






Population at risk





Conclusions

- The skewness and kurtosis of % deviation in peak breach outflow has not converged up to 10000 realizations and convergence of statistical moments are found to be adequate for 50000 realizations.
- The estimated peak discharge at 1%, 5%, 10% and 50% EP are estimated as 74100 m^3/s, 61183 m^3/s, 55221 m^3/s and 37612 m^3/s respectively.
- Even at 1% EP there is no significant difference in the peak discharge between 10000 and 50000 realizations
- The inundation area at 1%, 10% and 50% EP are estimated to be 967 km^2, 874 km^2, and 706 km^2 respectively.
- The EPI maps will be more useful in risk informed decision making process by further analysis of flood hazard and population at risk.

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